THE AMERICAN COLLEGE, MADURAI – 625 002
UG DEPARTMENT OF ZOOLOGY
Choice Based Credit System
Program for B.Sc. Zoology– 2019-2020 onwards

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
1	I	TAM/FRE/HIN/ 0000		**3**	**2**	**30**
1	II	ENG 1201	Conversational skills	**3**	**2**	**30**
1	IIIC	ZOO 1621	Invertebrata	**6**	**6**	**90**
1	IIIC	ZOO 1223	Invertebrata Laboratory	**2**	**2**	**30**
1	IIIC	ZOO 1531	Cell Biology (Theory cum Lab)	**(3+2) 5**	**5**	**75**
1	IIIS	BOT 1437	Plant Biology - I	**(3+2) 5**	**4**	**60**
1	IVE	NME 0000	Non Major Elective 1	**3**	**2**	**30**
1	IVLS	XXX0000	Life Skill course - I	**3**	**2**	**30**
1	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**25**	**375**
2	I	TAM/FRE/HIN/0000		**3**	**2**	**30**
2	II	ENG 1202	Reading & Writing Skills	**3**	**2**	**30**
2	IIIC	ZOO 1622	Chordata	**6**	**6**	**90**
2	IIIC	ZOO 1224	Chordata Laboratory	**2**	**2**	**30**
2	IIIC	ZOO 1532	Economic Zoology(Theory cum Lab)	**(3+2) 5**	**5**	**75**
2	IIIS	BOT 1438	Plant Biology – II	**(3+2) 5**	**4**	**60**
2	IVE	NME 0000	Non Major Elective 2	**3**	**2**	**30**
2	IVLS	XXX 0000	Life Skill course - II	**3**	**2**	**30**
2	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**25+1**	**375/390**
3	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
3	II	ENG 2201	Study Skills	**3**	**2**	**30**
3	III C	ZOO 2623	Microbiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
3	III C	ZOO 2625	Animal Physiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
3	III C	ZOO 2433	Genetics	**4**	**4**	**60**
3	III C	ZOO 2335	Evolution	**3**	**3**	**45**
3	III S	CHE 2413	Chemistry for Zoologist - I	**5**	**4**	**60**
3	V	XXX 0000 or XXX 0000	NCA/NCN/NSS or Extension activity SLP			
			Total	**30**	**27**	**405**

SEM	Part	Course No.	Course Title	Hours	Credits	Marks
4	I	TAM/FRE/ HIN/0000		**3**	**2**	**30**
4	II	ENG 2202	Career Skills	**3**	**2**	**30**
4	III C	ZOO 2624	Biological Chemistry (Theory cum Lab)	**(4+2) 6**	**6**	**90**
4	III C	ZOO 2626	Ecobiology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
4	III C	ZOO 2428	Molecular Biology	**4**	**4**	**60**
4	III C	ZOO 2330	Molecular Biology Laboratory	**3**	**3**	**45**
4	III S	CHE 2414	Chemistry for Zoologist -II	**5**	**4**	**60**
			Total	**30**	**27+1**	**405/420**
5	III C	ZOO 3637	Immunology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3639	Entomology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3641	rDNA technology (Theory cum Lab)	**(4+2) 6**	**6**	**90**
5	III C	ZOO 3543	Developmental Biology (Theory cum Lab)	**(3+2) 5**	**5**	**75**
5	IV LS	XXX 0000	Life Skill course-III	**3**	**2**	**30**
5	IV	ZOO 3200	Environmental Studies	**4**	**2**	**30**
			Total	**30**	**27**	**405**
6	III C	ZOO 3838	Biotechnology (Theory cum Lab)	**(5+3)8**	**8**	**120**
6	III C	ZOO 3446	Project	**4**	**4**	**60**
6	III C	ZOO 3642	Biodiversity (Theory cum Lab)	**(4+2) 6**	**6**	**90**
6	III C	ZOO 3544	Bioinformatics (Theory cum Lab)	**(3+2) 5**	**5**	**75**
6	IV LS	XXX 0000	Life Skill course – IV	**3**	**2**	**30**
6	IV VE	VAL 0000	Value Education	**4**	**2**	**30**
			Total	**30**	**27**	**405**
			Grand Total for Semester I – VI	**180**	**158+2**	**2370/2400**

C: CORE S: SUPPORTIVE E: NON MAJOR ELECTIVE LS: LIFESKILL VE: VALUE EDUCATION

Courses offered by the Department of Zoology to Non-Major Students

Part III Supportive

SEM	Course No.	Course Title	Hrs.	Cr	Marks
III	ZOO 2447	General Zoology – I Theory cum Lab	**(3+2) 5**	**4**	**60**
IV	ZOO 2448	General Zoology – II Theory cum Lab	**(3+2) 5**	**4**	**60**
		Total	**10**	**8**	**120**

Part IV Non-Major Electives

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1251	Human Biology	**3**	**2**	**30**
II	ZOO 1252 or ZOO 1254	Forensic Biology or Apiculture	**3**	**2**	**30**
		Total	**6**	**4**	**60**

Part IV: Life Skill Courses

SEM	Course No.	Course Title	Hrs.	Cr	Marks
I	ZOO 1249	Poultry Farming	**3**	**2**	**30**
II	ZOO 1256	Ornamental Fish Culture	**3**	**2**	**30**
V	ZOO 3255 or ZOO 3257	Medical Lab Technology or Ornithology	**3**	**2**	**30**
VI	ZOO 3258	Human Reproduction and Conception Control	**3**	**2**	**30**
		Total	**12**	**8**	**120**

B.Sc. Zoology

PROGRAMME SPECIFIC OUTCOMES

Upon completion of this Programme, the graduates will be able to:

1. Apply the knowledge of Zoology in various aspects of society, industry and nature.
2. Identify and analyze problems using the principles of natural science.
3. Design solution for problems in areas in public health, environment and society.
4. Conduct investigations of higher order to solve problems in society and environment.
5. Perform procedures as per laboratory standards.
6. Apply concepts for the benefit of society from areas such as Economic Zoology, Entomology, Immunology and Evolution.
7. Contribute to the sustainability of the environment from the areas of Environment Studies, Ecobiology and Biodiversity.
8. Develop work and environment ethics based on the inputs from Biotechnology, Biodiversity and Genetics.
9. Develop communication skills through seminars & oral presentations, and become competent to take up careers in academics, research and to pursue higher studies.
10. Integrate individual and team work by laboratory and project work.

Mapping of Courses with Programme Specific Outcomes (PSOs)

Course Code	PSO1	PSO2	PSO3	PSO4	PSO5	PSO6	PSO7	PSO8	PSO9	PSO10
ZOO 1621	✓		✓	✓	✓					
ZOO 1223	✓					✓		✓	✓	✓
ZOO 1531	✓	✓								
ZOO 1251	✓	✓								
ZOO 1249	✓		✓			✓				
ZOO 1622	✓	✓								
ZOO 1224	✓	✓							✓	✓
ZOO 1532	✓					✓	✓			
ZOO 1254	✓					✓	✓		✓	
ZOO 1252		✓	✓	✓	✓	✓			✓	
ZOO 1256	✓	✓				✓	✓		✓	
ZOO 2623	✓	✓		✓	✓	✓	✓		✓	
ZOO 2625	✓	✓								
ZOO 2433	✓			✓	✓	✓		✓	✓	
ZOO 2335	✓	✓		✓		✓				
ZOO 2447	✓	✓		✓					✓	
ZOO 2624	✓				✓					
ZOO 2626		✓	✓	✓	✓		✓	✓	✓	✓
ZOO 2428	✓	✓		✓						
ZOO 2330					✓				✓	✓
ZOO 2448	✓		✓			✓			✓	
ZOO 3637	✓				✓	✓				
ZOO 3639	✓		✓			✓			✓	
ZOO 3641			✓		✓				✓	
ZOO 3543	✓	✓			✓				✓	
ZOO 3255		✓		✓	✓			✓		✓
ZOO 3257	✓	✓	✓				✓		✓	
ZOO 3200	✓	✓					✓	✓	✓	
ZOO 3838				✓	✓	✓		✓	✓	
ZOO 3446		✓	✓	✓					✓	✓
ZOO 3642			✓		✓		✓	✓	✓	
ZOO 3544					✓				✓	
ZOO 3258	✓	✓				✓				

Mapping of Programme Specific Outcomes (PSOs) with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
PSO1	✓	✓		✓	✓		✓	✓	✓	
PSO2	✓	✓		✓		✓	✓	✓		
PSO3	✓	✓	✓	✓		✓	✓		✓	✓
PSO4	✓	✓	✓	✓		✓	✓	✓	✓	✓
PSO5	✓	✓	✓			✓	✓	✓		
PSO6	✓	✓		✓	✓	✓	✓	✓	✓	✓
PSO7	✓	✓	✓	✓	✓	✓	✓		✓	✓
PSO8	✓	✓	✓	✓		✓	✓			✓
PSO9	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
PSO10	✓	✓	✓	✓		✓	✓			

ZOO 1621 **Invertebrata** **(6h/wk) (6cr)**

This theory course provides basic knowledge about the general characteristic features and classification of invertebrate phyla up to class level. A specific animal will be studied in detail as a typical representative for each phylum. General topics of importance in each phylum will be taught.

Course Outcomes

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

i. Outline the rules of taxonomy and the principles of animal classification.
ii. Identify the general characteristics of Porifera and Coelenterata.
iii. Explain body organizations and unique characters of Helminthes and Annelida.
iv. Evaluate general characters of Arthropoda and Mollusca.
v. Discuss the importance of Minor phyla and Echinodermata.

1. **Protozoa:** Levels of organization – Binomial nomenclature – outline classification up to phylum with examples – general characteristics – classification up to class level with examples **–** *Paramecium* sp. – life cycle of *Plasmodium* sp. – nutrition, reproduction and protozoan diseases.

2. **Porifera and Coelentrata:** General characteristics – classification up to class level with examples **–** Porifera – *Scypha* sp. – spicules – canal system – Coelenterata – *Obelia* sp. – asexual reproduction – Biology of corals and coral reefs – asexual reproduction.

3. **Platyhelminthes, Aschelminthes and Annelida:** General characteristics and classification up to class level with examples - Platyhelminthes, Aschelminthes and Annelida – *Taenia* sp. – Parasitic adaptations – life cycle – *Ascaris* sp. – *Pheretima* sp. – economic importance.

4. **Arthropoda and Mollusca:** General characteristics and classification up to class level with examples **–** Arthropoda and Mollusca **–** *Penaeus* sp. – *Pila* sp. – torsion – larval forms – Crustaceans.

5. **Echinodermata and Minor Phyla:** General characteristics and classification up to class level with examples – Echinodermata - *Asterias* sp. – water vascular system – larval forms – Echinodermata – habit – habitat – distribution – nutrition – special characteristics of Ctenophora – Ectoprocta – Endoprocta – Rotifera – connecting links – *Limulus, Peripatus.*

Text book

Jordan EL and PS Verma (2013) Invertebrate Zoology, S. Chand & Co Ltd, New Delhi.

References

Agarwal VK (2000) Invertebrate Zoology, First Edition, S. Chand and Co, Ltd, New Delhi.
Ayyar E (1993) Manual of Zoology Vol.I-Invertebrata, S.Viswanathan (Printers & Publishers) Pvt, Ltd, Chennai.

Kotpal RL (2014) Modern Textbook of Zoology Vertebrates. 11th Edition, Rastogi Publishers, Meerut.
Kotpal RL (2003) A Text book of Minor Phyla. 11th Edition, Rastogi Publications, Meerut.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3		2				
CO4					5	
CO5				4		

Mean = 3.4

ZOO 1223 Invertebrata Laboratory (2h/wk) (2cr)

The Invertebrate Laboratory helps to appreciate the diversity of Invertebrates. This course gives an insight in the preparation of permanent slides.

Course Outcomes

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

i. Identify and classify Protozoa, Porifera and Coelenterata.
ii. Create awareness about conservation of coral reefs and the prevention of helminthic diseases.
iii. Assess the importance of Minor phyla, Arthropoda and Mollusca.
iv. Explain the evolutionary significance of Echinoderms.
v. Plan to visit different habitats and document animal diversity.

The Laboratory exercises includes Identification and adaptation of animals classified under the following phyla

- Protozoa
- Porifera
- Coelenterate polyp and medusoid forms
- Corals
- Platyhelminthes
- Aschelminthes
- Annelida
- Minor phyla (Ctenophora – Ectoprocta – Endoprocta – Rotifera)
- Arthropoda
- Mollusc
- Echinoderm
- Preparation of protozoan cultures, and making permanent slides

Field study

- Observation of Terrestrial invertebrate
- Economically important invertebrates

References

Agarwal VK (2000) Invertebrate Zoology, S. Chand and Co, Ltd, New Delhi.

Ayyar E (1993) Manual of Zoology Vol. I - Invertebrata, S. Viswanathan (Printers & Publishers) Pvt., Ltd, Chennai.

Lal SS (2014) Practical Zoology Invertebrates, 11th Edition, Rastogi Publications, Meerut.

ZOO 1223 **Invertebrata Laboratory**

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2						6
CO3					5	
CO4		2				
CO5				4		

Mean = 3.8

ZOO 1531 **Cell Biology** **(3+2=5h) (3+2=5cr)**
(Theory cum Lab)

The course is designed to enable the students to learn - principles and applications of tools and techniques used in cell biology -the structure and functions of cell membrane, cell organelles and phases and mechanisms involved in mitosis and meiosis. Emphasis is also given to the study of cancer cells.

Course Outcomes

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

i. Use microscopy to visualize cells and micrometry to fractionate cellular components.
ii. Outline cellular and membrane structures in prokaryotes and eukaryotes.
iii. Discuss the structure and functions of ER, Golgi complex, Lysosomes and Ribosomes.
iv. Evaluate the structure and functions of Mitochondria and Nucleus.
v. Compile various phases of cell cycle, cell division and abnormalities of cancer cells.

1. **Microscopy and microtechniques:** Magnification and resolving power of microscope – Light, Phase contrast and Electron microscopy – measurement of cells – Fundamentals of microtechniques (cell fractionation, fixation, stains and staining methods).

2. **Structure of cells and cell membranes:** Milestones, cell theory, protoplasm theory, Structure of prokaryotic and eukaryotic cells – Plasma membrane, fluid mosaic model, transport mechanisms – cytoplasmic matrix and vascular system.

3. **Cellular components:** Cellular components and their structure, composition and function — Endoplasmic reticulum, Golgi complex, Ribosomes – ultrastructure and function – Lysosomes – types, functions and significance.

4. **Mitochondria and Nucleus:** Mitochondria – organization and function – Nucleus – nucleoplasm, nuclear membrane, nuclear pore complex, nucleolus – Organization and significance of chromatin, chromosomes, giant chromosomes.

5. **Cell cycle and Cell Division:** Cell cycle – control of cell cycle – Mitosis – Meiosis – chromosomal movement – centrioles and microtubules – cancer cells.

Laboratory exercises include

- Microscope – parts, function and magnification principle
- Observation of specialized cells (nerve cell, muscle cell etc)
- Micrometry
- Outline sketch of cells using Camera Lucida
- Permanent slide preparation I – principle, killing and fixation, dehydration, embedding
- Permanent slide preparation II – sectioning, staining, mounting
- Study of mitosis using onion root tip
- Preparation of giant chromosomes from salivary glands of Chironomous larvae
- Plasmolysis – with different plant cells with different NaCl and sucrose solution concentration

- Hemolysis I – Principle, influence of NaCl solution of various concentrations
- Hemolysis II – Influence of temperature, molecular size, organic solvents
- Observation of cell division stages using permanent slides

Text book

De Robertis EDP and De Robertis EMF (1996) Cell and Molecular biology. 8th Edition. BI Waverly Pvt. Ltd. New Delhi.

References

Karp G (2013) Cell Biology, 7th Edition, International Student Version, John Wiley & Sons, Inc.

Cooper GM and Hausman RE (2007) The cell a molecular approach. 4th Edition, ASM Press. Washington DC.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2		2		4		
CO3		2		4		
CO4		2		4		
CO5		2		4		

Mean = 3.8

ZOO 1622 **Chordata** **(6hrs/wk) (6cr)**

This course provides a general and basic understanding of chordates. It discusses the diversity, adaptations, affinities, organisation, comparative study and taxonomic status of chordates. Type study for each class is also included.

Course Outcomes

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

i. Outline and classify prochordates and chordates.
ii. Explain the characteristics of Agnatha and Pisces.
iii. Assess the adaptations and evolutionary importance of Amphibia and Reptilia.
iv. Outline and classify Aves and Mammalia with examples.
v. Compare the various systems of Chordates.

1. **Chordata and Prochordata:** Salient features – outline classification of phylum chordata up to class level with examples – Prochordates – classification – *Amphioxus* sp., *Balanoglossus* sp. and *Ascidian* sp. – life history – affinities – retrogressive metamorphosis.

2. **Agnatha and Pisces:** Classification up to orders with examples – *Petromyzon* sp.– life history, comparison between lampreys and hag fishes – scales – fins – S*coliodon* sp. Electric organs – parental care – migration – economic importance of fishes – accessory respiratory organs – fishery resource of South India.

3. **Amphibia and Reptilia:** Origin – evolutionary tree – classification up to orders with examples – adaptive features of Anura, Urodela, Apoda – *Rana* sp.– parental care – *Calotes* sp. – status of *Sphenodon* sp. – identification of poisonous and non-poisonous snakes – biting mechanisms – poison apparatus – venom – Jacobson's organ – South Indian amphibians and snakes.

4. **Aves and Mammalia**: Classification up to orders with examples – flight adaptations – migration, adaptive radiation of beaks and feet – characters of *Archaeopteryx* – features of Ratitae – *Columba* sp., *Rattus* sp. – adaptation of aquatic mammals, flying mammals – dentition and adaptive radiation in mammals – economic importance – South Indian birds and mammals.

5. **Comparative anatomy:** Integument and its derivatives – endoskeleton – skull, girdles – digestive system – respiratory system – circulatory system – urinogenital system – nervous system – sense organs.

Text book

Jordan EL and Verma PS (2013) Chordate Zoology, S.Chand & Co Ltd., New Delhi.

References

Romer AS (1992) The vertebrate body, 3rd Edition,Vakils, Fefer and Simons Pvt. Ltd, Mumbai.

Ayyar E (1982) Manual of Zoology Vol.II-.S.Viswanathan (Printers & Publishers) Pvt. Ltd., Chennai.

Kotpal RL (2014) Modern textbook of Zoology Vertebrates. 3rd Edition Rastogi Pubications, Meerut.

Saxena RK and Saxena S (2008) Comparative anatomy of vertebrates. Viva books Pvt. Ltd., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3					5	
CO4		2				
CO5				4		

Mean = 3.0

ZOO 1224 **Chordata Laboratory** **(2/wk) (2cr)**

The laboratory course is aimed to identify, describe and classify chordate specimens in the museum and in the field. It will help the students to appreciate the diversity in the animal kingdom.

Course Outcomes

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

i. Identify and classify the members of Prochordata.
ii. Compare and classify Agnatha and Pisces.
iii. Analyze the relationship between Amphibia and Reptilia.
iv. Compare the characteristics of Aves and Mammalia.
v. Explain the architecture of skull, girdles and vertebrae in Chordates and undertake field survey.

The Laboratory exercises include:

Identification of

- Prochordates
- Agnathans
- Chondrichthyes
- Osteichthyes
- Amphibians
- Reptiles
- Birds
- Mammals
- Skull
- Girdles
- Vertebrae

Field study

- Campus study of birds
- Visit to CMFRI Mandapam
- Visit to Guindy National park and Crocodile bank, Chennai
- Wetlands Bird study

References

Kotpal RL (2014) Modern textbook of Zoology Vertebrates. 3rd Edition Rastogi Pubications, Meerut.

Lal SS (2014) Practical Zoology Vertebrates. 11th Edition, Rastogi Publications, Meerut.

ZOO 1224 **Chordata Laboratory**

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4	5	
CO3				4		
CO4				4	5	
CO5		2				

Mean = 3.7

ZOO 1532 **Economic Zoology (Theory cum Lab)** **(3+2=5 hr/wk) (5cr)**

This course is designed to make the students understand the technical and commercial aspects of rearing edible freshwater fish, shrimps, cattle, pig, poultry and earthworms.

Course Outcomes

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

i. Explain the aquacultural practices.
ii. Outline shrimp culture methods and hatchery management.
iii. Apply the knowledge of dairy and pig farming.
iv. Analyze the methods of poultry farming, diseases and control measures.
v. Assess the methods and uses of vermicomposting.

1. **Edible Freshwater Fish Culture:** Aquaculture - salient features - types - farming practices - cultivable fishes - major carps - exotic carps - minor carps - murrels - cat fishes - pond preparation - management. Composite fish culture. Fishery byproducts.

2. **Shrimp farming:** Biology - cultivable species - methods of culture-pond site - artificial breeding - live feeds - hatchery management.

3. **Dairy and Pig farming:** Breeds of cow, buffalo, goat and pig. Breed improvement - cross - breeds. Milch cattle - reproduction. Dairy Products - milk processing - Piggery management and products.

4. **Poultry Farming:** Breeds - layers - broilers. Methods of poultry keeping - food and feeding - management. Egg. Diseases of Poultry - Ranikhet, Coccidiosis, Fowl Cholera and Aspergillosis

5. **Vermiculture:** Earthworm - varieties - biology - optimal conditions for culture - culture practices - vermicompost - vermicast - vermiwash.

Laboratory exercises include

- Identification of commercially important fresh water fishes.
- Gut content analysis of fish with different feeding habits.
- Morphomertic measurement of fishes.
- Preparation of fish pituitary extract
- Identification of spawn, fry and fingerlings of Rohu, Catla and Mrigal
- Identification of fish diseases and parasites
- Identification of commercially important shrimps.
- Gut content analysis of shrimps.
- Breeds of cattle.
- Natural and artificial feed formulation for cattle.
- Dairy products.

- Breeds of pig.
- Pigsty maintenance- disinfection, vaccination.
- Byproducts of pig farm.
- Breeds of poultry.
- Poultry house maintenance.
- Poultry diseases.
- Varieties of earthworms.
- Analysis of nutrients in vermicompost.
- Effect of vermicompost on the growth of plants.
- Visit to fish, shrimp, pig, dairy and vermiculture farms

Text book

Jaiswal V and Jaiswal KK (2014) Economic Zoology. PHI Learning Private, Limited, Delhi, India.

References

Pandey K and Shukla JP (2005) Fish and Fisheries. Rastogi Publications, Meerut, India.

Gnaanamani MR (2003) Modern Aspects of Commercial Poultry keeping, Giri Publication, Madurai, India.

Nigam HC (1996) Modern Trends in Biology. Shoban Lal Nugin Chand and Co, Jalandhar, India.

Ismail SA (1997) Vermicology – The biology of earthworms. Orient Longman Ltd., Chennai.

Edwards CA and Bohlen PJ (1996) Ecology of earthworms. 3rd edition, Chapman and Hall, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1					5	
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.8

ZOO 1251 **Human Biology** **(3h/wk) (2cr)**
(Non Major Elective)

This course is offered to give a basic understanding of human anatomy and physiology. Functioning of digestive, respiratory, circulatory, nervous, endocrine, immune, excretory and reproductive systems in man will be taught.

Course Outcomes

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

i. Explain the structure and functions of skin, skeleton and muscles.
ii. Evaluate the nutritive value of food and the physiology of digestion.
iii. Discuss the structure and function of heart, lungs, brain, kidney, sense organs and endocrine glands.
iv. Compare the male and female reproductive organs and the role of sex hormones.
v. Outline the disorders of skin, stomach, heart, lungs and kidney.

1. **Skin, Skeleton and Muscles:** Skin –structure and functions – skeleton-bones, cartilage, joints – ligaments – muscles-types – muscle contraction – skin diseases.

2. **Nutrition and Digestion:** Vitamins, minerals, balanced diet – calorific value of foods; Digestive organs – secretions, digestion and absorption – gastric disorders.

3. **Respiratory and Circulatory systems:** Structure and functions of lungs and heart – Hemoglobin and respiratory gas exchange – blood circulation – blood components –blood groups – Tuberculosis – Atherosclerosis.

4. **Endocrine, Nervous and Immune systems:** Endocrine glands and secretions – hyper and hypo secretory disorders – structure and functions of brain – Sense organs– Immune system, types of immunity.

5. **Excretory and Reproductive systems:** Kidney – structure and function –Male and female reproductive organs – Sex hormones – renal disorders.

Text book

Widmaier E, Raff H and Strang K (2014) Vander's Human Physiology. Mc Graw Hill Education, New York.

References

Sherwood L (2008) Human Physiology: from cells to systems. 7th Edition, Brooks/Cole: Cengage Learning, Canada.

Davies A, Blakeley AGH and Kidd C (2001) Human Physiology, Churchill Livingstone, Toronto.

ZOO 1251 **Human Biology**

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2		4		
CO2		2		4		
CO3		2		4		
CO4		2		4		
CO5		2		4		

Mean = 3.0

ZOO 1252 **Forensic Biology** **(3hr/wk) (2cr)**
(Non Major Elective)

This course deals with the scientific methods of crime investigation. It contains collection, identification and preservation of physical evidences. The course dwells on fire arms, tool marks and impressions, finger prints, wounds and sexual offences. Forensic entomology, drugs and food poisons are comprehensively included.

Course Outcomes

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

i. Analyze the evidences for crime investigation.
ii. Assess the offences based on firearms, tool marks and impressions.
iii. Explain the common biological techniques adopted in crime investigations and predict the sexual and non-sexual offences.
iv. Identify the insects of forensic importance and explain the methods employed in forensic entomology.
v. Outline the classification and sources of drugs and poisons and to discuss the ill effects and withdrawal symptoms.

1. **Evidences:** Classification – identification – comparison – collection methods – preservation of hair, nail, fiber, paint, glass, soil etc. – socio-economic offences.

2. **Fire arms, tool mark and impressions:** Fire arms – bullet comparisons – cartridge cases – gun powder residues – primer residues – collection and preservation of fire arm evidences – tool marks and impressions.

3. **Finger prints, blood, wounds, lethal and sexual offences:** Dermatoglyphics – henry system – primary classification – computerized prints –digital forensics – types of injuries, wounds and signs in sexual and non-sexual offences – symptoms of death – time of death – post-mortem changes – blood stains – blood grouping – semen analysis – disputed paternity – DNA tests – case study.

4. **Forensic Entomology:** Insects of forensic importance – sarcophagi – venoms and poisons – methods employed for forensic purposes – forensic lab visit.

5. **Drugs and food poisons:** Classification – sources of drugs, narcotics, cosmetics and abortifacients – physiological and psychological effects – withdrawal syndrome – signs of food poisoning – types of poisons – medico legal cases.

Text book

Parikh CK (1999) Parikh's textbook of medical jurisprudence, forensic medicine and toxicology. 7th Edition, CBS Publishing and distributors, New Delhi.

References

Saferstein R (1978) Criminalistics, an introduction to forensic science. Prentice Hall of India, New Delhi.

Simpson K (1979) Forensic Medicine. 8th Edition, ELBS, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.2

ZOO 1254 **Apiculture** **(3h/wk) (2cr)**
(Non Major Elective)

This course aims to give a basic understanding of the biology, rearing and management of honeybees. It includes the study of interaction of bees with plants, their diseases and prospects of apiculture. It imparts knowledge in various aspects of bee keeping.

Course Outcomes
Upon completion of this course, students will be able to:

i. Compare past and present status of apiculture in India.
ii. Explain the biology of honey bees and their communication.
iii. Discuss the rearing management of different bees and honey extraction.
iv. Identify the different diseases of honey bees and control measures.
v. Evaluate the prospects of apiculture and entrepreneurship.

1. **History**: Bee keeping past and present – present status of apiculture in India – life of Lorenzo Langstroth – bees in warfare – economic importance – Types of honeybees – wild bees.

2. **Biology**: Bee colony – castes – morphology – anatomy – division of labour – communication – habit of field bees – queen bee insemination – artificial mating.

3. **Pasturage and Rearing**: Nectar composition – bee foraging – bee flora of India – types of bee hive – queen rearing, management – bee keeping equipment – seasonal maintenance – honey extraction.

4. **Diseases**: Natural enemies – infection – diseases – signs and symptoms– causes – transmission – control.

5. **Prospects of Apiculture**: Bee hive products – uses of honey – wax – bee venom – propolis – royal jelly. Entrepreneurship – preparing proposal for financial assistance – funding agencies – field visits.

Text book

Abrol DP (2013) A comprehensive guide to bees and bee keeping. Scientific publishers, New Delhi, India.

References

Bailey L and Ball BV (1991) Honey bee pathology. 2nd Edition. Academic press, London.
Graham JM (1992) The hive and the honey bee. Dadant & Sons, Illinois.
Mishra RC (1995) Honeybees and their management in India. ICAR pub, New Delhi.

ZOO 1254 **Apiculture**

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1	1					
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.0

ZOO 1249 **Poultry Farming** **(3h/wk) (2cr)**
(Life Skill Course)

This is an economically important and job oriented course. It deals with different aspects of poultry biology, breeds, housing equipment, nutrition management, diseases and Entrepreneurial skills.

Course Outcomes

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

i. Outline the growth of poultry industry in India and explain the biology of fowl with its economic importance.
ii. Identify Indian and exotic breeds.
iii. Explain various types of housing and poultry farm equipments.
iv. Assess energy requirements, feed formulations and management.
v. Evaluate various poultry diseases.

1. **Biology of Fowl:** External features – digestive and reproductive systems – poultry industry in India – 5 year plans – poultry manure – NECC – role of egg and meat in human nutrition –economic importance.

2. **Breeds of Layers and Broilers:** Classification – Indian and exotic breeds – production of commercial laying stock – cross breeds – sexing in one day old chicks – popular breeds of layers and broilers in India.

3. **Housing and Equipment:** Location of the farm – construction of poultry sheds – layout of broiler and layer farms – 1 +3 – housing system, All – in and all out system – deep litter system – cage rearing – waterer – feeder – nest box – brooders – dropping pit.

4. **Nutrition and Management:** Energy – carbohydrates – fats – proteins – vitamins – minerals – feed stuff – feed formulation – non nutritive feed additives – feed grinder – home made mineral mixture of feed for chick – grower – layer – broiler and finisher – Incubation – management of growers – layers – summer and winter management – forced moulting – debeaking – culling – marketing.

5. **Diseases:** Bacterial, fungal and viral diseases – transmission – symptoms – treatment – vaccination – antibiotics – nutritional deficiencies – Entrepreneurship – funding agencies – visit to poultry farm.

Text book

Gnaanamani MR (2003) Modern Aspects of Commercial Poultry Keeping. 9th Edition, Giri Publications, Madurai.

References

Chauhan HVS and Roy S (2007) Poultry Diseases, Diagnosis and Treatment. 3rd Edition, New Age International, New Delhi.

Jaiswal V and Jaiswal KK (2014) Economic Zoology, PHI Learning Private Limited, New Delhi.

Jull MA (1976) Poulty Husbandry. 3rd Edition, Tata McGraw Hill Publishing Company Ltd. New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3		2				
CO4				4		
CO5					5	

Mean = 3.0

ZOO 1256 **Ornamental Fish Culture** **(3h/wk) (2cr)**
(Life Skill Course)

This course deals with the basic and applied aspects of ornamental fish culture. Various freshwater and marine ornamental fishes, breeding techniques and wild collections are dealt with. Ornamental aquatic plants are also included along with diseases and economic importance.

Course Outcomes

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

i. Design the types of fresh water aquaria.
ii. Identify the popular ornamental fishes.
iii. Formulate breeding and hatchery techniques.
iv. Design marine Invertebrate aquaria.
v. Identify the common diseases and control measures in aquarium fishes.

1. **Aquarium keeping:** Types of aquaria–freshwater and marine species–setting up–aquarium plants–accessories–maintenance.

2. **Popular ornamental fishes:** Biology, sexing, courtship, feeds and feeding, breeding and mass production of fresh water fishes–gold fish, gouramy, angel fish and koi carps breeding – rearing of marine anemone fish and damsel fish – wild collections.

3. **Breeding and Hatchery:** Wild seed collection techniques and rearing. Seed production techniques–induced maturation–spawning–rearing.

4. **Ornamental invertebrates:** Marine invertebrates species – culture of corals – keeping and maintenance of echinoderms and molluscs in aquarium – marine aquarium management.

5. **Diseases and economics:** Common diseases – disease control measures and cure – aquarentine tanks – conditioning, packing and transport methods – Entrepreneurship – agencies involved in popularization and extension – maintaining pet shops and purchasing aquarium accessories – field visits.

Text book

Yadav BN (2006) Fish and fisheries. 4th Edition. Daya Publishing house, New Delhi.

References

Axelrod HR (1967) Breeding aquarium fishes. TFH publication Inc., England.

Santhanam R, Sukumaran N and Natarajan P (1990) A manual of freshwater aquaculture. Oxford and IBH Publishing Co. Pvt. Ltd. New Delhi

Cato JC and Brown CL eds. (2003) Marine ornamental species: collection, culture and conservation. Blackwell Publishing, Ames, Iowa.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4						6
CO5		2			5	

Mean = 3.3

ZOO 2623 **Microbiology** **(4+2=6 h/wk) (6cr)**
(Theory cum Lab)

This theory cum laboratory course deals with structure and applications of microorganisms. The major areas include history, scope of microbiology and various classifications of microorganisms. The theory part deals with microbial taxonomy, microbial interactions, food borne microbes and medically important microbial diseases. The laboratory part includes the study of ubiquitous nature of microbes, growth curve, type of food borne microbes, medically and agriculturally important bacteria and coliform analysis.

Course Outcomes

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

i. Explain the characteristic features of microbes and microbial evolution.
ii. Discuss the nomenclature, structure and classification of bacteria, virus, algae, fungi and protozoa.
iii. Evaluate food spoilage, food borne diseases and industrially important microbes.
iv. Identify the role of microbes in environment and agriculture.
v. Assess the important diseases caused by bacteria, viruses, fungi and protozoa and their control.

1. **Fundamentals of microbiology:** Members of the microbial world - Characteristics of prokaryotic and eukaryotic cells - Microbial evolution - Phylogeny - Sterilization methods - Culture media - Microbiology and its origin - Microbiology today.

2. **Microbial taxonomy and Microbial physiology:** Nomenclature and classification of bacteria - Structure and classification of viruses, algae, fungi and protozoa - Ultrastruture - cell wall, flagellum, fimbria, capsules, sheath, prostheca, stalk, spore and cyst - Bacterial growth curve - Factors affecting bacterial growth.

3. **Food and Industrial microbiology:** Food contamination - Spoilage and preservation of milk, meat, fish, chicken, vegetables and fermented foods - Microbes of perishable, semi perishable and non-perishable foods - Food borne diseases – Salmonellosis, Botulism and Parasitic disorders - Microbial enzymes - Selection and production of industrially important organisms and their products - Fermentors - Fermentations - Production of antibiotics and single cell proteins.

4. **Agricultural and Environmental Microbiology:** FDA regulations - Agricultural products - Transgenic foods and their disorders - Fungal and bacterial diseases transmitted by crop plants - Microbial interactions and microbial associations - Purification of water and coliform analysis.

5. **Medical Microbiology and Virology:** Host-microbe relationships - Normal microbial biota of humans - Nosocomial diseases - Zoonotic diseases - Epidemic, endemic and pandemic diseases - Bacterial, fungal and protozoan diseases – Diagnosis and treatment of diseases with antimicrobial agents - Structure of HIV, adenovirus and pox viruses - Antiviral chemotherapy and vaccines.

The laboratory component includes the following exercises:

- Principle and working of laminar flow and autoclave.
- Sterilization methods – wet heat and dry heat sterilization.
- Preparation of media and culture methods.
- Preparation of bacterial smear and staining methods.
- Inoculation methods.
- Biochemical tests – IMVic, TSI, Starch hydrolysis, Caesin hydrolysis, urea hydrolysis and gelatin liquefaction.
- Bacterial growth curve.
- Quality analysis of food samples – Methylene blue reduction test of milk.
- Coliform analysis.
- Study of Rhizobium from the roots of leguminous plants.
- Isolation of medically important bacteria.
- Kirby-Bauer method – Studying antimicrobial agents.
- Industrial / Field visit.

Text book

Willey UM, Sherwood LM and Woolverton CJ (2011) Precott's Microbiology. 8th Edition, Mc Graw-Hill international. 8th edition

References

Gunasekaran, P (1995) Laboratory Manual in Microbiology. New Age International Pvt. Ltd., New Delhi.

Pelczar MJ, Chan ECS and Kreigh NR (2000) Microbiology. 8th Edition, Tata McGraw Hill, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1	1					
CO2		2				
CO3			3			
CO4			3	4		
CO5			3	4	5	

Mean: 3.1

ZOO 2625 **Animal Physiology (4+2= 6h/wk)(4cr)**
(Theory cum Lab)

The theory part of this course covers the principles, mechanism and adaptations in digestion, excretion, respiration, circulation, thermo regulation, osmo-iono regulation, muscle contraction, neuronal conduction, sensory perception and hormonal control are discussed in detail. The laboratory component is complementary to the theory which includes experiments on enzyme activity, analysis of excretory products, types of respiration, temperature effects on metabolism, osmo-iono regulation, heart beat recording, blood glucose level testing and muscle twitch.

Course Outcomes

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

i. Discuss the mechanism of digestion and excretion in various animals.
ii. Compare different types of respiration in various animals.
iii. Analyze the adaptations of animals with respect to heat and osmotic changes.
iv. Explain the physiology of nerve conduction, muscle contraction and sensory organs.
v. Compile the regulatory actions of different endocrine glands and their hormones.

1. **Digestion and Excretion:** Intracellular and extracellular - Digestion and absorption of carbohydrate, protein, lipid and fat - Coprophagy – Cellulose digestion in animals. Protonephridia - Metanephridia - Nitrogenous wastes - Antennal gland - Malpighian tubules - Glomerular filtration - Mechanism and regulation of urine formation.

2. **Respiration and Circulation**: Mechanism of tracheal, gill, cutaneous and pulmonary respirations - Air breathing by fishes - Transport of respiratory gases – Types of heart - Mammalian heart - Regulation of heart beat - Capillary circulation – Composition and function of blood, Blood coagulation and pigments.

3. **Thermal and Osmo-iono regulation**: Heat balance - Temperature regulations of homeotherms - Torpor and hibernation - Hypo regulation - Osmo-iono regulation in Elasmobranchs and Teleosts.

4. **Neuro-muscular and Sensory Physiology**: Action potential - Nerve impulse - Synaptic transmission - Myosin and actin filament - Sliding filament theory - Neuro-muscular junction. Mammalian visual cycle, Physiology of vision, mechanism of hearing, taste in mammal, electricity in ray fish.

5. **Endocrine Physiology:** Mechanism of hormone action - Regulatory action of pituitary, thyroid, parathyroid, adrenal, pancreas and sex glands - Neuro-endocrine glands - Role of hormones in reproduction – Endocrine glands in crustacean and insects.

Laboratory component includes exercises as follows:

- Enzyme activity: Influence of temperature and pH.
- Respiration in fishes: Estimation of dissolved oxygen with reference to body sizes and activity.
- Respiration in terrestrial insects – Manometer technique.
- Opercular movement in fishes: Influence of temperature and calculation of Q10.

- Temperature preference by fishes.
- Study of human heart beat.
- Measurement of blood pressure of students and interpretation of variation.
- Water regulation and ionic regulation in animals such as crab and earthworm.
- Analysis of samples containing excreta of various animals.
- Blood sugar analysis in rabbit at normal condition and after injection of insulin.
- Simple muscle twitches and kymograph.
- Observation of circadian rhythm pattern in selected animals.

Text book

Schmidt-Nielson, K (2005) Animal Physiology: Adaptation and Environment. 5th Edition. Cambridge University Press, London.

References

Hoar WS (1989) General and comparative physiology. Prentice Hall, New Delhi.
Kulshrestha, W (1977) Experimental physiology. Vikas Publishing House Pvt. Ltd., New Delhi.
Siddique, AH (1974) Experimental physiology. Oxford and IBH Pub. Co, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4		2				
CO5					5	

Mean = 3.0

ZOO 2433 **Genetics** **(4h/wk) (4cr)**

This course aims to focus on the basic principles of genetics by presenting the important concepts of classical, microbial, population and human genetics. It deals with basic concepts of simple inheritance characters and gene mapping.

Course Outcomes

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

i. Analyze the patterns of Mendelian and non-Mendelian inheritance.
ii. Explain linkage and crossing over.
iii. Predict the genetic basis of behavior.
iv. Explain the mechanisms of genetic recombination in bacteria and viruses.
v. Assess the concepts of human genetics, compute gene and genotypic frequencies.

1. **Mendelism and chromosomal basis of Mendelism** Mendel's study of heredity - multiple alleles - gene interactions - quantitative traits - inbreeding - chromosome theory of heredity - non-disjunction - sex chromosomes and sex determination - dosage compensation - variation in chromosome number and structure.

2. **Linkage, crossing over and chromosome mapping**: Linkage as exception to Mendel's principle of independent assortment - cytological proof for crossing over - mechanism of recombination - chromosome mapping from recombination data - tetrad analysis.

3. **Behavioural genetics**: Nest cleaning behavior - defensive behavior - hoarding behaviour in honey bees - biological rhythms in Drosophila - *per* gene - single gene mutations and human behavior.

4. **Genetics of viruses and bacteria**: Genetic recombination in phage - transformation, conjugation and transduction - mechanisms - significance - experiments of Griffith, Zinder and Lederberg, Woolman and Jacob.

5. **Human and population genetics**: Mendelian traits in man - pedigree analysis - karyotype analysis - chromosomal abnormalities - twin studies - nature and nurture - genetic diseases - inborn errors of metabolism - genetic counseling - theory of allele frequencies - calculating gene and genotypic frequencies.

Text book

Snustad, DP and Simmons, JM (2010). Principles of Genetics 5th Edition. John Wiley & Sons Inc.

References

Hexter, W and Yost, HT (1980) The Science of Genetics. Prentice Hall of India Pvt Ltd., New Delhi.

Levine, L (1969) Biology of the Gene. The CV Mosby Company, St. Louis, USA.

ZOO 2433 **Genetics**

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2	3	4		
CO2		2		4		
CO3		2	3		5	
CO4		2			5	
CO5	1	2	3	4	5	

Mean = 3.1

ZOO 2335 **Evolution** **(3h/wk) (3cr)**

Evolution influences every aspect of the form and behavior of organisms. This course includes origin of life and evidences for evolution, theories of evolutionary thought, fossilization, isolation, speciation, natural selection and emphasis the biological and cultural evolution of man.

Course Outcomes

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

i. Explain the origin of life and evidences for evolution
ii. Analyze the various theories of evolution
iii. Discuss the concepts of evolutionary trends
iv. Analyze the isolating mechanisms and adaptations
v. Evaluate the evolution of horse and human

1. **Origin of life and evidences for evolution:** Origin of life - theories - creation - Cosmozoic - spontaneous generation - Chemical evolution - Bio-elements - selection - opinion of J.B.S. Haldane and A.L. Oparin - Urey Miller hypothesis - Origin of bio-molecules - Coacervation - Origin of pro- and eukaryotic cell – Evidences - Comparative, anatomical, vestigial organs, physiological, embryological, Biochemical evidences - Geographical distribution and realms.

2. **Theories of evolution:** Greek thinkers - ideas of evolution before Darwin - Lamarckism and Neo-Lamarckism - Darwinism and Neo-Darwinism - Germplasm theory - Mutation theory - Modern synthetic theory - Hardy Weinberg law and its importance.

3. **Trends in evolution:** Geological eras - Fossils and fossilization - dating of fossils - Extinctions - Living fossils – Adaptations – variations and origin - adaptive trends - Polymorphism - transient and stable – Mimicry and Coloration - Batesian and Mullerian – Sexual selection – Convergent, Divergent and Parallel evolution – Co-evolution.

4. **Isolation and its role in evolution:** Isolating mechanisms - different types - Species concepts - definition of species - origin of species - Allopatric and Sympatric speciation – Genetic drift - Founder's Principle.

5. **Evolutionary Processes:** Natural selection in action - Industrial Melanism - Evolution of horses - Time and place of origin, major evolutionary trends, phylogeny of probable sequence species of horse - Eocene, Oligocene, Miocene, Pliocene, and Pleistocene forms - Orthogenesis – Evolution of man - evolutionary trends in humans - Ancestors of primates - Apes-the closest relatives of man - fossil ancestors of man - Dryopithecus, Australopithecus (The Man-Ape of Africa), *Homo habilis* (The Handy Man), *H. erectus, H. Neanderthalensis* (Neanderthal man), The Cro-magnon, *Homo sapiens* (Modern man) - Socio-cultural evolution.

Text book

Stebbins GL (1966) Process of Organic Evolution. Prentice Hall, New Delhi.

References

Darwin, RC (1859) On the Origin of Species by the means of Natural Selection, John Murrey, Abemarel Street London.

Dobzansky, T (1976) Genetics and the origin of species. Oxford and TBH Publishing Co., New Delhi.

Dodson, EO (1960) Evolution: process and product. Affiliated East- West Press, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3	4		
CO4		2		4		
CO5					5	

Mean = 3.1

ZOO 2447 General Zoology-I (3+2=5h/wk) (4cr)
(Theory cum Lab - Supportive course)

This course is an introduction to animal phyla. The theory part deals with the general characters and classification up to class level in animal kingdom. The groups Acoelomata, Pseudocoelomata, Coelomata, Prochordata, Pisces, Amphibia, Reptilia, Aves and Mammalia will be dealt with examples.

Course Outcomes
Upon completion of this course, students will be able to:

i. Identify the invertebrates and classify aceolomates .
ii. Explain and classify pseudocoelomates.
iii. Discuss the economic importance and evolutionary significance of Phylum Arthropoda, Mollusca and Echinodermata.
iv. Identify Prochordates, Pisces and Amphibians.
v. Compare poisonous and non-poisonous snakes and explain the adaptive features in Aves and Mammalia.

1. **Acoelomata:** Levels of organization – Outline classification up to phylum with examples - General characteristics – Protozoa - *Amoeba* sp. - life cycle of *Plasmodium* sp. - protozoan diseases – Porifera - canal system – Coelenterata - *Hydra* sp. - biology of corals and coral reefs.

2. **Pseudocoelomata:** Platyhelminthes - general characters - classification - *Taenia solium* – Life cycle of *Ascaris lumbricoides* - Helminth parasites in man.

3. **Coelomata:** General characteristics - Arthropoda, Mollusca and Echinodermata – *Periplaneta* sp. – Economic importance of insects – *Pila* sp. – torsion – *Asterias* sp. - water vascular system – larval forms.

4. **Prochordata, Pisces and Amphibia:** General characters of *Amphioxus, Balanoglossus* and *ascidia* – General characters of Pisces - *Scoliodon* sp. - accessory respiratory organs in fishes – economic importance of fishes – Amphibia - general Characters - *Rana* sp.

5. **Reptilia, Aves and Mammals:** General characters – Identification of poisonous and non-poisonous snakes – *Columba livia* - flight adaptations in birds - migration in birds - adaptive radiation of beak and feet – *Oryctolagus* sp. - dentition in mammals - aquatic mammals - economic importance of mammals.

The laboratory component includes

- Spotters- microscopic forms
- Spotters – lower invertebrates
- Spotters – higher invertebrates
- Spotters- Pisces
- Spotters – Tetrapods
- Mouthparts and digestive system of cockroach

- Salivary gland of cockroach
- Nervous system of cockroach
- Buccal cavity of frog - entire view
- Viscera of frog
- Digestive system of frog
- Urinogenital system of frog
- Nervous system of frog

Text book

Chaki, KK, Kundu, G and Sarkar, S (2005) Introduction to General Zoology. Vol-1, New Central Book Agency Pvt. Ltd., Kolkata, India.

References

Iyer, E (1993) Manual of Zoology Vol. II. Viswanathan (Printers & Publishers), Chennai.
Jordan, EL and Verma, PS (2013) Chordate Zoology. S. Chand & Co Ltd., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2				4		
CO3		2				
CO4		2			5	
CO5		2			5	

Mean = 3.1

ZOO 2624 **Biological Chemistry (Theory cum Lab)** **(3+3 = 6h/wk) (6cr)**

Biological chemistry includes enzymes, and mechanism of enzyme action. It also includes chemistry and metabolism of carbohydrates, amino acids & proteins, lipids & nucleic acids. Citric acid cycle and oxidative phosphorylation are also included.

Course Outcomes

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

i. Assess the structure and metabolism of carbohydrates.
ii. Analyze the various metabolic pathways and their significance.
iii. Assess the chemistry and metabolism of lipids.
iv. Explain the metabolism of nucleic acid and convergence of metabolic pathways.
v. Discuss the mechanism of enzyme action and the regulation of enzyme activity.

1. **Chemistry and metabolism of carbohydrates:** Monosaccharides – Structure - Classification - Disaccharides – Polysaccharides - Glycosaminoglycans- Glycoproteins and glycolipids – Basic concepts of metabolism – Glycolysis – Fermentation - Glycogen metabolism - Gluconeogenesis – significance of HMP shunt – Biological significance of carbohydrates.

2. **Chemistry and metabolism of amino acids and proteins:** Standard and non standard amino acids – Protein - Structure - Primary, secondary, tertiary and quaternary – Amino acid metabolism - deamination – transamination – transmethylation - Urea cycle - Amino acids as biosynthetic precursors – Biological significance of amino acids and proteins.

3. **Chemistry and metabolism of lipids:** Lipid classification - Lipoproteins – Fatty acid oxidation - Metabolism of cholesterol – Biological significance of lipids.

4. **Chemistry and metabolism of nucleic acid, Citric acid cycle and Oxidative phosphorylation:** Chemistry of nucleotides and nucleic acids - Synthesis of purine and pyrimidine - Nucleotide degradation – Convergence of metabolic pathways - Citric acid cycle- Amphibolic pathway - Electron transport - Oxidative phosphorylation.

5. **Enzymes:** Classification - Substrate specificity - Transition state – Michaelis-Menten equation - Factors affecting rate of enzyme activity – Mechanisms of enzyme action - Regulation of enzyme activity - Enzyme inhibition – Coenzymes and cofactors - Isozymes.

Laboratory component includes exercises as follows:

- Colorimetry
- Spectrophotometry
- pH metry
- Paper Chromatography
- Electrophoresis
- Centrifugation
- Qualitative analysis of carbohydrates
- Qualitative analysis of amino acids & proteins

- Qualitative analysis of lipids
- Enzyme kinetics I
- Enzyme kinetics II

Text book

Voet D and Voet JG (2004) Biochemistry. 3rd Edition. John Wiley & Sons Inc. USA.

References

Murray RK, Granner DK, Mayes PA and Rodwell VA (2000) Harper's Biochemistry. 25th Edition. Appleton & Lange, USA.

Lehninger AC, Nelson DL and Cox MM (2001) Principles of Biochemistry. 4th Edition, W.H. Freeman Company, USA.

Plummer DT (1996) An introduction to Practical Biochemistry. Tata McGraw Hill, New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2		4		
CO2				4		
CO3				4		
CO4					5	
CO5					5	

Mean = 4.0

ZOO 2626 **Ecobiology** **(4+2=6hr/wk) (6cr)**
(Theory cum Lab)

This course deals with the study of living things in relation to their environment. Starting with the abiotic factors of the environment, the course runs through the population dynamics, biotic community structure, development and energy flow model. Unique environmental conditions and faunal adaptations of major habitats will be studied. Finally, major terrestrial biomes and zoogeography will be covered. Laboratory exercises supplement its theory counterpart to ensure better understanding. Physico-chemical analysis of water and soil, identification of planktonic forms and ecological adaptations in animals will be studied. Experiments on primary productivity and pollution analyses will be carried out. Established microcosm will be ecologically investigated. Field studies will be undertaken to observe and understand natural ecosystems in its reality and totality.

Course Outcomes
Upon completion of this course, students will be able to:

i. Analyze the importance of abiotic factors and their ecological effects.
ii. Outline biotic community and ecosystem dynamics.
iii. Assess the characteristics of animal populations.
iv. Evaluate environmental conditions and faunal adaptations in different habitat.
v. Compare Zoogeographic realms of world with emphasis on oriental region.

1. **Limiting and abiotic factors:** Soil profile and types – Limiting factors – Biological effects of temperature, light, water, precipitation, wind, fire and nutrients.

2. **Biotic community and ecosystem dynamics**: Interspecific interactions - Gause principle - Niche concept - Types of niches - Ecological equivalents- Models of Ecosystem development - Theories of climax state – Concept of productivity - Energy flow model – Phosphorus and Nitrogen cycles.

3. **Population dynamics**: Characteristics - Lincoln index - Life table - Survivorship curve - Net reproductive rate - Age pyramids - Growth rate - Point of inflection - Biotic potential - Exponential and logistic growth equations - Phases of logistic growth curve - Attributes of r- and K- selection.

4. **Habitat Ecology:** Environmental conditions and Faunal adaptations in: Halobiotic littoral zone (Rocky and sandy) - Pelagic zone (Neritic and oceanic) - Deep sea - Estuary - Mangroves - Lentic and Lotic systems.

5. **Zoogeography:** Precipitation and temperature regimes of world - Occurrence of biomes based on precipitation and temperature - Major terrestrial biomes of world –Latitudinal and altitudinal life zones – Means of animal distribution - Factors affecting animal distribution - Zoogeographical realms of world with emphasis on Oriental region - Wallace line.

Laboratory component includes the following exercises:

Estimation of:

- Dissolved oxygen
- Carbon di oxide in water
- Salinity in water
- Calcium and Magnesium in water
- Biological Oxygen Demand
- Chemical Oxygen Demand
- Primary Productivity of aquatic ecosystems.

Quantitative analysis of

- Organic carbon in soil
- Zooplankton
- Nutrients in water and soil

- Survey of pollutants
- Observation of Inter- and Intra-specific relationships
- Observation of ecological adaptations in animals.
- Maintenance of Microcosm and investigating the ecological changes.
- Field visits to many ecosystems.

Text books

Odum, EP and Barrett, GW (2012) Fundamentals of Ecology. 5th Edition, Cengage Learning India Pvt. Ltd., Delhi, India.

Stiling, P (2009) Ecology: Theories and Applications. 4th Edition, PHI Learning Pvt. Ltd., New Delhi.

References

Eaton, AD and Franson MAH (2005) Standard methods for the examination of water and waste water. American Public Health Association, American Water Works Association, the Water Environment Federation, Washington DC.

Batish, SK (1992) Freshwater Zooplankton of India. Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.

Sharma, PD (2004) Ecology and Environment. Rastogi Publishers, Meerut.

Subramanyam, NS and Sambamurty, AVSS (2000) Ecology. Narosa Publishing House, Chennai.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2		2				
CO3					5	
CO4					5	
CO5		2				

Mean = 3.6

ZOO 2428 **Molecular Biology** **(4h/wk) (4cr)**

Molecular biology deals with the study of structure and function of genes and genomes. Students will learn the finest details of molecular configurations of genes, their physical properties and their nature of replication, transposition and recombination. This course also introduces how genes express and accurately transmit genetic information, and the mechanism of its regulation.

Course Outcomes

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

i. Explain the structure and properties of nucleic acids and outline genomics, proteomics and metabolomics.
ii. Discuss the mechanisms involved in DNA replication, repair, damage and types of transposable elements.
iii. Compare the steps involved in transcription in prokaryotes and eukaryotes.
iv. Analyze genetic code and steps involved in protein synthesis.
v. Evaluate the mechanism of gene regulation in prokaryotes and eukaryotes.

1. **The molecular nature of DNA and RNA:** Introduction to gene structure and function – DNA double helix – Structure of RNA – Alternate forms of DNA – Physical properties - G:C content, c-value and c_ot curves – Extra nuclear genomes – Introduction to Genomics, Proteomics and Metabolomics – Human genome project.

2. **DNA replication, recombination and transposition:** Semiconservative replication - bidirectional - unidirectional - rolling circle and θ model replication - enzymology of DNA replication – DNA damages and various types of DNA repair mechanisms – Homologous and site specific recombination – Mobile genetic elements in prokaryotes and eukaryotes.

3. **Transcription:** Prokaryotic and eukaryotic RNA polymerases – Events in transcription of prokaryotes and eukaryotes – General transcriptional factors of eukaryotes – Post-transcriptional processing - capping, polyadenylation, splicing and alternate splicing – Catalytic RNA – RNA editing.

4. **Translation:** Genetic code - Deciphering of genetic code - Salient features of genetic code - 3D structure of tRNA – codon-anticodon interaction – Wobble hypothesis – Mechanism of protein synthesis in prokaryotes and eukaryotes – Inhibitors of protein synthesis – Post translational modification of proteins – Polyprotein.

5. **Regulation of gene expression:** i) Gene regulation in prokaryotes: Fine control of prokaryotic transcription - *lac* operon and *trp* operon - Regulatory RNA ii) Gene regulation in eukaryotes: GAL system in yeast - DNA binding proteins - Homeobox in gene regulation.

Text book

Malacinski GM (2003) Freidfelder's Essentials of Molecular Biology. 4th Edition, Narosa Publishing House, New Delhi, India.

References

Brown TA (2007) Genomes 3. 3rd Edition, Garland Science Publishing, New York.

Watson JD, Kopkins NK, Roberts JW, Stertz JA and Weiner AM (1994) Molecular Biology of the Gene. Benjamin and Cummings Pub Co., California, USA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2		4		
CO2				4		
CO3		2				
CO4		2				
CO5			3	4		

Mean = 3.0

ZOO 2330 Molecular Biology Laboratory (3/wk) (3cr)

The laboratory course introduces the basic molecular biological methods of isolation and purification of nucleic acids (DNA and RNA) from prokaryotic and eukaryotic cells. The quantification of DNA, RNA and protein involving both traditional and modern methods are also dealt. Students gain hand-on experience from start to finish in isolation, purification and characterization of nucleic acids and protein.

Course Outcomes

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

i. Prepare various reagents and buffers.
ii. Demonstrate isolation of DNA from various sources.
iii. Demonstrate isolation of RNA from various sources.
iv. Utilize the isolated DNA & RNA for quantification.
v. Assess the molecular weight of nucleic acid by Agarose gel electrophoresis.

Laboratory exercises

1. Basic molecular biology lab – Micropipetting exercises, serial dilution, media and reagent preparation.
2. Isolation and purification of DNA from bacteria.
3. Isolation of DNA from blood.
4. Isolation of RNA from liver cells – Acid phenol extraction and Trizol method.
5. Agarose gel electrophoresis for DNA and RNA.
6. Quantification of DNA and RNA by spectrophotometry.
7. Estimation of DNA by diphenylamine method.
8. Estimation of RNA by Orcinol method.
9. Estimation of protein by Bradford microassay.
10. Study of mutagenesis in *E. coli*.
11. Study of *lac* operon – β-galactosidase activity.
12. Visit to university/institutional laboratories.

References

Rajamanickam C (2001) Experimental Protocols in Basic Molecular Biology. Osho Scientific Publishers, Madurai.

Bansal MP (2013) Molecular Biology and Biotechnology Protocols. TERI, New Delhi.

Carson S, Miller HB and Witherow DS (2012) Molecular Biology Techniques: A classroom Laboratory Manual. Third Edition. Academic Press, San Diego, USA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3			
CO2			3			
CO3			3			
CO4			3			
CO5			3			

Mean = 3.0

ZOO 2448 General Zoology – II (3+2=5h/wk) (4cr)
(Theory cum Lab - Supportive course)

This is a theory cum laboratory, which aims at imparting knowledge about the economical importance and applied aspects of zoology. The theory part deals with the principles and applications of genetics, health and hygiene with reference to man. It also emphasizes details on areas like entomology, immunology and applied zoology. The laboratory part includes the collection and preservation of insects, estimation of metabolic rate in fish, human traits, lymphoid organs of fish, hypersensitivity and experiments related to applied zoology.

Course Outcomes

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

i. Discuss the concepts of human genetics and human genome project.
ii. Explain aspects related to human health and diseases.
iii. Identify beneficial and harmful insects.
iv. Compare immune responses, antigen-antibody interactions and autoimmune disorders.
v. Utilize the knowledge gained in poultry farming, apiculture, aquaculture and vermicomposting to become an entrepreneur.

1. **Human genetics**: Human chromosomes - gene maps - DNA fingerprinting - chromosomal abnormalities - human hereditary traits - Eugenics - Euphenics - Euthenics - Gene therapy - Human Genome Project.

2. **Human health and Hygiene**: Diseases - detection - types - infectious and non-infectious diseases - causes - prevention - treatment and control - drug resistance and abuse.

3. **Entomology**: Introduction - scope - common insects - general characters and structure - metamorphosis - beneficial and harmful insects - integrated pest management.

4. **Immunology**: Immune system - cells - organs - immune responses - antigen and antibodies - vaccines - hypersensitivity - autoimmune disorders.

5. **Applied Zoology**: Introduction to poultry farming and vermicomposting.

Laboratory component includes the following exercises:

- Insect collection, preservation and identification
- Study of beneficial and harmful insects
- Estimation of O_2 consumption in fish
- Lymphoid organs of fish – Demonstration
- Hypersensitivity – Demonstration
- Analysis of human traits – Mendelian's, Fingerprinting/Blood group
- Human karyotype and Ideogram
- Visits to poultry farming, vermicomposting, aquaculture and apiculture.

Text book

Taylor DJ, Green, NPO and Stout SW (2005) Biological Science. R. Soper Editor, Third Edition. Cambridge University Press, United Kingdom.

References

Nigam, HC (1996) Modern Trends in Biology. Shohanlal Naginchand & Co, Jalandhar.
Sobti, RC (1991) Medical Zoology. Shohanlal Naginchand & Co, Jalandhar

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4	5	
CO2		2				
CO3			3			
CO4		2				
CO5			3			

Mean = 3.1

ZOO 3637 **Immunology** **(4+2=6h/wk) (6cr)**
(Theory cum lab)

This course attempts to provide a basic understanding in Immunology. The course covers cells and organs of the immune system, antigens, antibody structure, antibody diversity, antigen-antibody interactions, cell mediated and humoral immune response and complement. In the section on disorders of immune system, autoimmunity, hypersensitivity reactions, immunodeficiency disorders that includes AIDS are dealt. The laboratory component includes identification and enumeration of blood cells, location of lymphoid organs in selected vertebrates, preparation of antigens. Immunization techniques, methods of raising polyclonal antibodies, repetitive bleeding methods, antibody titration, complement mediated hemolysis, ELISA test for AIDS and skin test for allergy reactions.

Course Outcomes
Upon completion of this course, students will be able to:

i. Analyze cells and lymphoid organs of the immune system.
ii. Discuss antigens, antibody and their interactions.
iii. Explain antibody diversity and humoral responses.
iv. Evaluate structure and functions of MHC and cell mediated immunity.
v. Compare regulation of immune response, complement and disorders of immune system.

1. **Cells and organs of the immune system**: Introduction –historical perspectives – innate (non-specific) and acquired (specific) immunity – cells involved – primary & secondary lymphoid organs – tertiary lymphoid tissues.

2. **Antigens, antibody and their interactions**: Epitopes, haptens – immunogenicity- adjuvants - antibody structure - Deducing structure of IgG, IgM and IgA. Biological properties of various Ig classes - Primary interactions-affinity and avidity - secondary interaction-agglutination-precipitation.

3. **Antibody diversity and humoral response**: Multigene organization of Ig genes – generation of antibody diversity - Role of T_H cells in humoral response-primary and secondary response-affinity maturation-class switching-generation of plasma cells and memory cells.

4. **Cell mediated immunity**: Structure and functions of MHC- Antigen processing and presentation- Activation of T_H cells and cytotoxic T cells - NK cells-antibody dependent cell mediated cytotoxicity (ADCC) – delayed type hypersensitivity (DTH).

5. **Regulation of immune response, complement and disorders of immune system**: Cytokines - Immune tolerance - regulation of immune response-complement. Classical and alternative pathways – biological properties of complement components. Auto-immunity-hypersensitivity reactions- Immunodeficiency disorders – AIDS.

The Laboratory component includes exercises as follows:

- Total and differential count of blood cells
- Lymphoid organs in vertebrates I – fish and amphibians
- Lymphoid organs in vertebrates II-reptiles, birds and mammals
- Raising polyclonal antibodies I-preparation of antigens

- Raising polyclonal antibodies II-routes of immunization
- Raising polyclonal antibodies III- bleeding techniques and separation of serum
- Raising polyclonal antibodies IV-antibody titration
- Complement mediated hemolysis
- Ouchterlony double immunodiffusion (ODI)
- Mancini's single radial immunodiffusion (SRID)
- Immunology of ABO blood grouping
- ELISA test for AIDS
- Skin test for allergy reactions

Text book

Coico R and Sunshine G (2009) Immunology – a short course. 6th Edition, Wiley Blackwell, New York.

References

Garvey JS, Cremer NE and Sussadorf DH (1977) Methods in Immunology. 3rd Edition, The Benjamin Cummings Pub co., Massachusetts.

Kindt TJ, Osborne BA and Goldsby RA (2006) Kuby Immunology. 6th Edition. W.H. Freeman and Co., New York.

Hudson, L and Hay, F (1989) Practical Immunology. 3rd Edition, Blackwell Science Publishers, Oxford.

Roitt IM, Brostoff J and Male D (2001) Immunology. 6th Edition, Mosby, London.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2					5	
CO3		2				
CO4					5	
CO5		2				

Mean = 3.6

ZOO 3639 **Entomology** **(3+3 = 6h/wk) (6cr)**
(Theory cum Lab)

This course is designed to make the students know about the basics of insect classification, morphology, anatomy, physiology and other facts of insect's life and about their economic importance. Classification up to order level with a special mention about significant families, their diversity, body plan, structure and function of various organs. Role of insect as pests, as vectors and beneficial insects will be taught. The laboratory course intended to systematically collect, preserve and identify insects. Students are taken to field to gain knowledge in the methods of collecting insects and preservation.

Course Outcomes

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

i. Outline the classification of insects up to order level.
ii. Compare the anatomy of insects of different groups.
iii. Discuss the physiology of insects and metamorphosis.
iv. Identify pests of various crops and assess the damage and control.
v. Assess the insects of economic, medical and forensic importance.

1. **Introduction and insect taxonomy:** Definition, scope of entomology - biological success of insects - insect diversity - insect evolution. Insect collection, preservation, dichotomous key – classifications up to orders.

2. **Insect anatomy:** Integument of insects - Head - Types of mouth parts, antennae, legs and wings.

3. **Insect physiology:** Feeding and digestion - Respiration - Circulation - Nervous system - Endocrine system - Reproductive system - Metamorphosis.

4. **Harmful insects:** Pests of paddy, coconut, sugar cane, cotton, brinjal - damage, symptoms and control.

5. **Beneficial insects**: Biology, rearing and economic importance of silk worm, honey bees and lac insects - Insects of medical and forensic importance.

Laboratory component includes exercises as follows:

- Collection and identification of insects.
- Study of beneficial insects.
- Investigation of a few agricultural pests.
- Investigation of insects of public health importance.
- Identification of storage pests.
- Survey on the insects available in the campus.
- Identification and comments on a few pterygotan insects.
- Evaluation of pesticide toxicity (LC_{50}).
- Identification of economic values of productive insects.
- Estimation of biodiversity of insects in an ecosystem.
- Field study.

Text book

David BV and Ananthakrishnan TN (2004) General and Applied Entomology. Tata McGraw-Hill publishing Company Limited, New Delhi.

References

Ambrose DP (2004). The Insect Structure, Function and Biodiversity. Kalyani publishers, New Delhi.

Fennemore PG and Alka Prakhash (1992) Applied Entomology , Wiley Eastern Ltd., New Delhi.

Richards OW and Davies RG (1977) Imm's General Text book of Entomology Vol. 1 & 2. 10th Edition. B_1 Publication Pvt Ltd., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3						6
CO4			3			
CO5					5	

Mean = 3.6

ZOO 3641 **rDNA Technology (Theory cum Lab)** **(4+2=6h/wk) (6cr)**

This course is intended to introduce gene cloning and DNA analysis. It deals with extraction, purification and manipulation of DNA by restriction and other enzymes. An outline about the conventional and modern methods of rDNA transfer into living cells, the biology of cloning and expression vectors and the methods of gene analysis are also dealt. The course also provides a detailed account on the applications of gene cloning in the welfare of mankind. The laboratory course includes experiments on isolation and purification of genomic DNA and plasmids from bacteria, restriction digestion and ligation of DNA. It also includes exercises on the isolation of DNA from higher organisms and transformation of bacteria using rDNA by conventional competent cell transformation.

Course Outcomes

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

i. Analyze various techniques used in DNA extraction and the methods involved in DNA manipulation.
ii. Compare the conventional and modern methods of rDNA transfer into living cells.
iii. Design experiments involving gene cloning using vectors and compare the different vectors for bacteria, plants and animals.
iv. Evaluate different methods of gene analysis.
v. Apply gene cloning methods in recombinant vaccine and insulin production and stem cell therapy.

1. **Isolation, purification and manipulation of DNA:** Isolation of genomic DNA from bacteria, plant and animal cells – Purification of plasmid DNA and bacteriophage DNA – DNA manipulation - restriction endonucleases and other DNA manipulative enzymes – restriction digestion and ligation techniques – i*n vitro* mutagenesis.

2. **Introduction of rDNA into living cells:** Transformation of bacteria with rDNA – competent cell transformation – Methods of gene transfer in higher organisms - electroporation, biolistics, microinjection and liposome mediated gene transfer.

3. **Biology of cloning and expression vectors:** *E. coli* based vectors – λ and M13 based vectors – Cosmids – Phagemids – Yeast vectors – Ti and Ri plasmids – Plant and animal viral vectors – P element cloning vector – Cloning vectors for mammals - SV40 and adenoviruses – Expression vectors - types of promoters for expression vectors.

4. **Analysis of cloned gene:** Obtaining the clone of specific gene - direct selection and gene libraries – Studying gene location and structure - Southern transfer, *in situ* hybridization and FISH – Transcript and translation product analysis – DNA sequencing – PCR.

5. **Applications of gene cloning:** Transgenesis – production of recombinant proteins, vaccines, human insulin, diagnostic probes and other pharmaceutical compounds – Gene therapy and Stem cell therapy.

The laboratory component includes exercises as follows:

- Isolation and purification of Genomic DNA from *E.coli.*
- Isolation and purification of genomic DNA from plant and animal tissues.
- Purification of plasmids from *E. coli*.
- Restriction digestion of DNA.
- Ligation of DNA.
- Agarose gel electrophoresis of DNA samples.
- Competent cell preparation of bacteria.
- Transformation of competent cells using rDNA.

Text book

Brown, TA (2010) Gene Cloning and DNA Analysis – an Introduction. 6th Edition. Blackwell Science Publishers Ltd., Oxford, UK.

References

Primrose SB, Twyman RM and Old RW (2006) Principles of Gene Manipulation. 6th Edition. Blackwell Science Publishers Ltd., Oxford, UK.

Harisha, S (2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, New Delhi, India.

Sambrook J and Russell DW (2001) Molecular cloning: A Laboratory Manual. 3rd Edition. Cold Spring Harbor Press, Cold Spring Harbor, New York.

Becker JM, Caldwell GA and Zachgo EA (1996) Biotechnology – A Laboratory Course. 2nd Edition. Academic Press, San Diego, USA.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1				4		
CO2		2				
CO3						6
CO4					5	
CO5			3			

Mean = 4.0

ZOO 3543 Developmental Biology (3+2=5/h) (5cr)
(Theory cum Lab)

This course is designed to impart classical views and essential mechanisms regarding various aspects of development of animals with experimental approach. The course deals with gametogenesis, fertilization, cleavage patterns, embryonic stem cells, cleavage & gastrulation, and organogenesis in a mammal. Experimental embryological aspects such as embryonic induction, differentiation and nucleocytoplasmic interaction are discussed in detail.

Course Outcomes

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

i. Discuss the structures and functions of gonads, gametes, processes in fertilization & parthenogenesis.
ii. Outline the processes of cleavage, gastrulation and organogenesis.
iii. Analyze types, structure & functions of placenta, mechanism of regeneration and metamorphosis.
iv. Explain embryonic induction, organizers, differentiation and interactions of nucleus and cytoplasm.
v. Apply the knowledge of embryonic stem cells and embryo transplantation.

1. **Gametogenesis and fertilization:** Anatomy of testis and ovary - spermatogenesis and oogenesis - Types of eggs - Polarity - Mechanism of fertilization - Post fertilization changes - Parthenogenesis.

2. **Cleavage, gastrulation and organogenesis:** Planes and patterns of cleavage - Types of blastula - Morphogenetic movements - Gastrulation process - Neurogenesis - Development of eye and kidney in chick.

3. **Embryonic and postembryonic adaptations:** Structure and types of plancentae - Placental physiology - Hormonal control - Patterns and mechanism of regeneration - Metamorphosis of frog.

4. **Experimental embryology-I:** Embryonic induction - Spemann's primary and secondary organizers - Types and process of differentiation - Nucleo-cytoplasmic interactions.

5. **Experimental embryology-II:** Nuclear transplantation experiments - Embryonic stem cells and pharmaceutical applications - Embryo transplantation techniques - *in vitro* fertilization - birth defects and teratology.

Laboratory component includes

- Microscopic observation on invertebrate larval forms and their adaptations.
- Role of thyroxin in metamorphosis of frog.
- Chick embryo developmental stages – organogenesis.
- Role of retinoic acid signals that control posterior-anterior axis patterning in zebra fish.
- Role of retinoic acid during limb regeneration.
- *In vitro* culture and differentiation of frog tadpole cells.

- Induced breeding in mice by using HCG
- Blastoderm mounting in chick embryo.

Text book

Balinsky, BI (2012) An introduction to Embryology. 5th Edition Thomson Asia Pvt. Ltd., Singapore

References

Laura RK, Evans JH and Keller, TCS (1999) Experimental Developmental Laboratory: A Laboratory Manual. Academic Press, UK

Jain, PC (1994) Elements of Developmental Biology. Vishal Publications, Jalandhar, New Delhi.

Verma, PS and Agarwal, VK (2006) Chordate Embryology. S. Chand & Company Ltd., New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4				4		
CO5				4		

Mean = 3.2

ZOO 3200 Environmental Studies (4h/wk) (2cr)

The course is designed to develop environmental awareness to under graduate ecology students in an extensive manner. It deals with the natural resources, ecosystems and the impact of human activity on them. The course also imparts the biodiversity and pollution in the present status and the suggestion for sustenance.

Course Outcomes

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

i. Identify renewable and non renewable resources and their proper usage and conservation.
ii. Explain the concept of ecosystem.
iii. Evaluate the human impact on environment and the measures to mitigate.
iv. Utilize ecotechnology to resolve environmental issues.
v. Analyze the consequences of environmental disasters and remedy.

1. **Renewable and non-renewable resources:** Definition, scope, awareness – Renewable and non renewable resources – Forest - use, overexploitation and deforestation – Water - use and over utilization of surface and ground water – Mineral - environmental effects of extracting and using mineral resources – Food - world food problems – Energy - growing energy needs – Land - land degradation – Conservation of natural resources.

2. **Ecosystems:** Concept, structure and function - Energy flow - Food chains and Food web - Ecological pyramids - Ecological succession – Ecosystems - aquatic, forest, grassland, desert and caves. Biogeochemical cycles.

3. **Environmental pollution:** Definition, causes, effects and control measures of air, water soil, noise and thermal pollution – Hazards of nuclear wastes and control.

4. **Sustainable environment issues**: Unsustainable and sustainable development - urban problems related to energy and water - Rain water harvesting - Watershed management - resettlements and rehabilitation problems - Environmental ethics.

5. **Environmental disasters:** Global warming - Green house gases - Ozone depletion – Case studies - Bhopal tragedy - Chernobyl disaster - Fukusima disaster - Prestige and deep horizon oil spill.

Text book

Thatheyus, AJ (2011) Text book of Environmental Studies. Alpha Science International Ltd., Oxford, U.K.

References

Bharucha E (2005) Text book of Environment studies. University Press Pvt. Ltd, Hyderabad.
Odum, EP (1971) Fundamental of ecology, WB Saunders, London
Sharma, PD (1999) Ecology and environment, Rastogi Publishers, Meerut.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4				4		
CO5					5	

Mean = 3.4

ZOO 3255 Medical Laboratory Technology (3h/wk) (2cr)
(Life skill course)

The objective of this course is to introduce various laboratory techniques involved in the analysis of the samples and the interpretation of the results. Further, students will be informed about the setting of a clinical laboratory. This course includes the collection and analysis of samples like urine, stool and sputum to test protein urea, glycemia and the presence of pus cells, parasite and various microorganisms. It also includes the examination of gastrointestinal contents, routine and special haematological tests, histopathology and serological tests.

Course Outcomes

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

i. Identify human body conditions, medical instruments and their applications.
ii. Evaluate kidney disorders and analyze clinical samples.
iii. Assess the cell count, ESR, blood group, GTT and diabetic disorders.
iv. Identify the histopathological disorders.
v. Outline the procedures involved in fertility tests.

1. **Biomedical laboratory**: Normal and abnormal conditions of body - Symptoms – Samples to be collected for analysis and diagnosis – Instruments – Rules and regulations to be followed for hazardous chemicals – sterilization methods.

2. **Biosamples:** Urine - Collection and preservation, physical and chemical analysis for kidney diseases, proteinuria, glycemia and hereditary disorders – Stool - Types and collection, microscopic and culture methods, interpreting microbial diseases – Gastro-intestinal contents - digestive enzymes of liver pancreas – Sputum – Collection and staining for microscopic examination for respiratory disorders.

3. **Clinical haematology**: Phlebotomological methods - chemical analysis - cell counting (DC/TC) - estimation of ESR for pathological, physiological and hereditary disorders – Blood banking - Blood grouping and typing – Glucose tolerance test - Impaired glucose tolerance test - diabetic disorders.

4. **Histopathology**: Examination of cells from the body fluids for identifying disorders – Microtome and processing of tissues for tumors.

5. **Fertility test**: Semen analysis - Hormonal changes - Hormonal tests and pregnancy tests – factors affecting fertility.

Text book

Sood, R (1988) Medical Laboratory Technology. Jaypee Pub Ltd., New Delhi.

References

Mukherjee, KL (1989) Medical Laboratory Technology. Vol, I, II & III, Tata McGraw Hill Pub, Co, New Delhi.

Syrey MF, William JM and Elvyn GS (1978) Diagnostic microbiology. The C.V. Mosby Co.

ZOO 3255 Medical Laboratory Technology

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1			3	4		
CO2		2		4		
CO3				4		
CO4					5	
CO5					5	

Mean = 3.8

ZOO 3257 **Ornithology** **(3h/wk) (2cr)**
(Life skill course)

Learn about bird behavior, migration, ecology, conservation, and many other subjects. Each student will carry out documentation of local bird fauna which may results into a compilation of scientific publication. Students will develop expertise in bird studies which will be useful in taking up bigger challenges for studying birds with respect to their life history, behavior, ecology and also contribute to the ongoing Ornithological researches carried across the country.

Course Outcomes
Upon completion of this course, students will be able to:

i. Explain morphology, adaptations and economic importance of birds.
ii. Assess the importance and role of field ornithology techniques.
iii. Analyze field data applying statistics and pterological studies.
iv. Outline the various avian species in India, biodiversity hotspots and evaluate case studies.
v. Discuss the role of legislation, NGOs and sanctuaries in bird conservation.

1. **Bird Morphology, bird Communities, birds & Man:** Characteristics of birds - naming and classification - study of general bird morphology - morphological adaptations - Guilds - Stratification - Resource partitioning – Migration – Communication - Economic importance of birds - hazards of birds to aviation - effects of anthropogenic activity on birds.

2. **Field Ornithology:** Bird study techniques - Equipments - Areas of study - Field kit – Sampling - Bird photography - Bird ringing techniques - application - recording body measurements - usefulness of bird ringing data - ring recovery - Radio-telemetry - Use of gadgets like GPS, Camcorder, CCTV camera, night vision scope in bird study - Satellite pictures - Google Maps.

3. **Analysis of Field Data and Pterological Studies:** Analysis of field data - Applying statistics to evaluate data - Interpretation of data - Time budget analysis - Habitat utilization - Moulting pattern - Pellet and excreta analysis - Preparation of bird distribution maps - Role of birds in Ecosystem - Pollination, seed dispersal and insect control – Pterological studies - feather structure, types and its development.

4. **Birds of India:** An overview of the history of Ornithology in India - Birds in folklore and Indian culture - Grassland - desert - wetland - forest - Himalayan birds - Bird biodiversity hotspots in India.

5. **Conservation of Birds:** Endangered bird species - Threatened birds - Red Data Book - IUCN criteria - Artificial breeding and release of endangered birds - Recent conservation issues - Decline of vultures - Role of NGO’s in conservation of birds - Legal protective measures - Bird sanctuaries.

Text book
Ali, S (2002) The Book of Indian Birds. Bombay Natural History Society, Mumbai, India.

References

Ali S and Ripley, SD (2002) Handbook of the Birds of India and Pakistan. Vol 1-10, 2nd Edition, Oxford University Press, India.

Grimmett R, Inskipp C and Inskipp, T (2012) Pocket Guide to the Birds of the Indian Subcontinent (Helm Field Guides). 2nd Edition. Christopher Helm Publishing Company Ltd., UK.

Kazmierczak K and van Perlo BA (2000) Field Guide to the Birds of the Indian Subcontinent. Yale University Press, New Haven.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2	1	2			5	
CO3		2	3	4	5	
CO4	1	2		4	5	
CO5		2		4	5	6

Mean = 3.3

ZOO 3838 **Biotechnology** **(5+3h/wk) (8cr)**
(Theory cum Lab)

Students will be trained in various aspects of biotechnology such as animal, plant, microbial and environmental biotechnology. The course also imparts biosafety, bioethics and intellectual property rights, issues related to biotechnology. The laboratory course integrates theory with extensive practical training on plant and animal cell culture, fermentation technology, vermicomposting, biodecolourization, and environmental monitoring.

Course Outcomes

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

i. Apply various aspects of animal biotechnology including media preparations and cell culture.
ii. Assess the history, scope and basics of plant biotechnology and transgenic plants.
iii. Explain the history, scope and basics of microbial biotechnology including various methods employed.
iv. Analyze the various aspects of environmental biotechnology including bioremediation, biosensor and biomarkers.
v. Evaluate the biostafety, bioethics and intellectual property rights.

1. **Animal Biotechnology**: Animal cell and Tissue culture - Media - Suspension culture - Fibroblast culture - Development and maintenance of cell line - Hybridoma technology - Monoclonal antibody production - Application of animal cell and tissue culture - Transgenic animals – Cloning - Cell banking - Downstream processing.

2. **Plant Biotechnology:** History and scope of plant biotechnology - *in vitro* culture techniques of explants - Organogenesis and micropropagation - single cell culture - protoplast culture - Plant genetic engineering using *Agrobacterium* - Transgenic plants and Bt based genetically modified crops.

3. **Microbial Biotechnology:** History and scope of microbial technology – microbial biomass – microbial metabolites – range of fermentation products – aerobic and anaerobic fermentation – culture media – immobilization – scale up of bioprocess – primary and secondary screening of production strains – fermentation economics.

4. **Environmental Biotechnology:** Environmental monitoring - Sampling analysis - Biosensor - Bioindicators - Biomarker - water quality criteria - Alternative energy sources - Renewable sources of energy - Oil recovery - Biofuels - Bioremediation - Biocontrol - Biofertilizer.

5. **Biosafety and Bioethics:** Definition - Requirement - Biosafety - Bioethics - social issues, Bioweapons and Patent laws - Patent rights – Case studies - Biopiracy – Ice minus bacteria - Monsanto

Laboratory component includes the following exercises:

- Initiation of embryonic cell culture of frog.
- Mouse embryo Fibroblasts mono layer culture.
- Chick embryo Fibroblasts mono layer culture.

- Surface sterilization of explants.
- Initiation of callus on MS medium.
- Formation of shoot and roots of *Oryza sativum*.
- Formation of callus by phytohormones.
- Screening of microbes for metabolites.
- Aerobic and anaerobic fermentations of grape wine.
- Factors affecting fermentations.
- Biogas production.
- Role of vermicompost on plant growth.
- Decolourisation of dyes employing microbes.
- Field/ Industrial visits.

Text book

Satyanarayana, U (2005) Biotechnology. Books and Allied Pvt. Ltd., Kolkata.

References

Ignacimuthu, SJ (2001) Methods in Biotechnology, Phoenix Publishing House Pvt., New Delhi.

Primrose, S.B (2001) Molecular Biotechnology. 2nd Edition, Panima Publishing Corporation, New Delhi.

Gupta, PK (1996) Elements of Biotechnology. Rastogi and Co., Meerut.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4				4		
CO5					5	

Mean = 3.2

ZOO 3642 **Biodiversity** **(4+2=6/h) (6cr)**
(Theory cum Lab)

The course aims to provide students a broad foundation in Biodiversity and Conservation Biology with the ability to acquire extensive subject knowledge in the discipline. It will enable the students to understand biodiversity in the context of ecosystem dynamics, ecosystem functioning and provision of ecosystem services. Students will know how to assess biodiversity with different methodologies and they will be able to conduct a critical analysis of measures to manage biodiversity. Students will understand and apply relevant scientific principles in the area of Conservation Biology and retrieve and present information about biodiversity and Conservation Biology effectively. Students will identify variation in species and perform biodiversity sampling methods and analysis utilizing data from real collections of surveys.

Course Outcomes

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

i. Revise the concepts of biodiversity and its measurement.
ii. Explain the values and significance of biodiversity.
iii. Discuss threats to biodiversity and wild life conservation.
iv. Assess the role of various institutions and agencies in biodiversity conservation.
v. Analyze the role of NGOs and various environmental movements in biodiversity conservation.

1. **Basics of Biodiversity:** Introduction - Concept and Definition - Scope of biodiveristy - Constraints of biodiversity - Genetic, Species, Ecosystem biodiversity - Measuring biodiversity – Alpha, Beta and Gamma Diversity - Species richness – Evenness-Dominance - Approaches to estimating diversity and dominance - Shannon and Simpson's index - India as a mega-diversity nation - Hotspots of Biodiversity.

2. **Value and significance of biodiversity:** Tangible benefits - food, fiber, fodder, medicines, and construction material - Intangibles - pollination, pest control, soil development and maintenance of soil fertility - soil and water conservation - nutrient cycling - Human-animal conflicts - existing conservation projects - Tiger, Rhino, Elephant, Turtles, Crocodiles, Birds, Coral reefs and Mangroves.

3. **Threats to biodiversity:** Loss of Biodiversity and its causes - Patterns of losses - Causes and factors of mass extinction - Listing of Threatened biodiversity including vulnerable, rare, threatened, Endangered and extinct plant and animal species - Wildlife Trade and Laws - Wildlife protection Act of India - CITES - TRAFFIC - RED Data Book - IUCN - Measures to control poaching and wildlife trade.

4. **Conservation of biodiversity:** Aim for conservation - Current practices - Conservation of Genetic, Species and Ecosystem biodiversity - International conventions on conservation - Treaties on nature & conservation - *Ex situ* & *In situ* conservation - Vavilovin seed bank - Institutions and their role in conservation – Zoos - Natural history museums & collections - Zoological survey of India - Botanical survey of India - Forest research Institutes - Central Marine Fisheries research Institutes.

5. **Role of NGOs in conservation:** International NGOs - UNEP, GEF, WCS, Bird Life International - Important NGOs in India and their contributions - WWF, ATREE, BNHS, WTI and Kalpavriksha - Important NGO movements - Chipko movement - Silent valley - Narmada Bachao Aandholan - Pani Panchayats - Seed Movement.

Laboratory component includes the following exercises:

- Understanding the concept of sampling: Random sampling, sample size, quadrat, transect and point method for the study of community structure.
- Determination of frequency, density and abundance of different species present in the community.
- Determination of species richness and evenness.
- Study the dispersion of the species by calculating mean and variance of species.
- Estimating Alpha (α), Beta (β) and Gamma (γ) diversity.
- Estimating species diversity by Shannon and Simpson's Index
- Preparation of field data sheet.
- Identification of butterflies, amphibians and reptiles (up to the species), bats and birds up to genus.
- Documentation of Avifauna within the college campus and adjoining areas.
- Visit to Zoos, Sanctuaries and National park.
- GPS field data collection and import to computer.

Text book

Krishnamurthy KV (2009) An Advanced Textbook on Biodiversity Principles and practice. Oxford & IBH publishing Co Pvt. Ltd., New Delhi.

References

Ghosh, A (2009) Biodiversity Conservation, APH Publications, New Delhi.
Sharma, PD (2005) Ecology and Environment. Rastogi Publication, New Delhi
Dutta, A (2001) Biodiversity and Ecosystem Conservation. Kalpaz Publications, New Delhi.
Negi ,SS (1993) Biodiversity and its Conservation in India. Indus Publications, New Delhi.
Ladle, RJ (2009) Biodiversity and Conservation: Response to biodiversity loss. Taylor and Francis, UK.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3			3			
CO4					5	
CO5				4		

Mean = 3.2

ZOO 3544 **Bioinformatics** **(3+2=5h/wk) (5cr)**
(Theory cum Lab)

This course is designed to introduce future biologists and physicians to bioinformatics tools and analysis methods. Upon completion of the course, students should be more comfortable working with the vast amounts of biomedical and genomic data and online tools that will be relevant to their work in the coming decades.

Course Outcomes
Upon completion of this course, students will be able to:

i. Discuss the basic concepts of computer, hardware and software.
ii. Outline WWW, HTML, URL, browsers, search engines, bibliographic databases and retrieval.
iii. Use various bioinformatics tools to analyze molecular biological data.
iv. Explain the types of data and biological databases.
v. Outline various algorithms for sequence alignments and presenting large biological data.

1. **Operating systems and Internet:** Operating System concept - Windows 98/XP, Windows server NT/2000, UNIX/LINUX - Internet evolution - Working of Internet - Use of Internet - Working with E-mail - An overview of Computer viruses - General Precautions.

2. **Search Engine:** Overview of World Wide Web (Web Server and Client) - Introduction to Search engine and Searching the Web - Searches on MEDLINE, PUBMED and bibliographic databases - Downloading files - Introduction to Web Browsers - Understanding HTML and URL, Domain name, IP Address – Blogging - Overview of available Bioinformatics resource in web.

3. **Bioinformatics and data generation:** Bioinformatics and its relation with molecular biology - Examples of related tools (FASTA, BLAST, BLAT, RASMOL), databases (GENBANK, Pubmed, PDB) and software (RASMOL, Ligand Explorer) - Data generation - Generation of large scale molecular biology data - Applications of Bioinformatics.

4. **Biological Database:** Introduction to data types and Source - Population and sample - Classification and Presentation of Data - Quality of data, private and public data sources - Biological Databases - Nucleic acid databases (NCBI, DDBJ, and EMBL) - Protein databases (Primary, Composite, and Secondary) - Specialized Genome databases (SGD, TIGR, and ACeDB) - Structure databases (CATH and SCOP).

5. **Sequence Alignments:** Introduction to Sequences, alignments and Dynamic Programming - Local alignment and Global alignment (algorithm and example) - Pairwise alignment (BLAST and FASTA Algorithm) and multiple sequence alignment (Clustal W algorithm) - Methods for presenting large quantities of biological data.

Laboratory component includes exercises as follows:

- Types of biological databases and using it - Genbank, Protein Data Bank, Uniprot.
- Sequence Analysis Tools: BLAST, FASTA (Nucleic acids & Proteins), Clustal W and EMBOSS.

- Sequence Comparisons (Pairwise Sequence Alignments).
- To identify an unknown nucleotide sequence using the NCBI search tool BLAST
- Phylogenetic Analysis - Phyllip.
- Molecular Modeling: Homology Modeling – Swissmodeller.

Text book

Ignacimuthu, S (2005) Basic Bioinformatics.2nd Edition, Narosa Publishing House**,** New Delhi.

References

Teresa K, David A and Parry-Smith (2001) Introduction to Bioinformatics. 1st Edition, Pearson Education, New Delhi.

Lesk, AM (2002) Introduction to Bioinformatics.1st Edition, Oxford University Press, USA

Claverie JM and Notredame C (2006) Bioinformatics for Dummies. 2nd Edition, John Wiley & Sons, Inc., USA.

Xiong**,** J (2006) Essential Bioinformatics. Cambridge University Press, New York.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2			3			
CO3			3			
CO4			3	4		
CO5				4		

Mean = 3.8

ZOO 3446 **Project** **(4h/wk) (4cr)**

The research project aims to help students to develop research aptitude and skills for solving research problems. This will help them to learn appropriate research methodologies, develop new ideas, interpret and understand research concepts. The course is intended to instill scientific temper and to take up careers in research.

Course Outcomes

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

i. Identify appropriate research methodology
ii. Formulate hypothesis, design and conduct experiments
iii. Analyze data and interpret the results
iv. Compile research findings in written and verbal forms
v. Create applications using research findings to advance education theory and practice

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2						6
CO3			3	4	5	
CO4			3			
CO5			3			

Mean = 3.7

ZOO 3258 Human Reproduction and Conception Control (3h/wk) (2cr)
(Life Skill Course)

The course on Human Reproduction and Conception Control includes female and male sexual anatomy and physiology, patterns of sexual behavior, conception, pregnancy, child birth, contraceptive methods, sexually transmitted diseases, reproductive disorders and therapy.

Course Outcomes

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

i. Outline the anatomy of male and female reproductive organs.
ii. Explain the physiology of reproduction.
iii. Analyze the types of love, sexual behavior patterns, conception, pregnancy, fetal development and parturition.
iv. Utilize the methods of contraception and birth control.
v. Assess the causes of sexually transmitted diseases, common sexual disorders and their prevention.

1. **Anatomy and physiology of female reproductive system:** External genitalia and internal structures - breasts – menstruation - ovulation - hormonal control.

2. **Anatomy and physiology of male reproductive system**: External genitalia and internal structures – male sexual function - erection - ejaculation - circumcision.

3. **Sexual behavior pattern, conception and pregnancy**: Love - types - celibacy - erotic dreams - fantasy - masturbation - homosexuality - atypical sexual behavior – Sexual arousal - role of hormones, brain, senses, food and chemicals – Sexual response - three stage and four phase model – Conceiving - pregnancy - fetal development - stages of child birth - breast feeding.

4. **Contraceptive methods and fertility control:** Contraceptive methods - hormone based oral and non-oral contraceptives - barrier methods - intrauterine devices - methods based on menstrual cycle - post-coital contraceptive methods - abortion - choice of contraception at different ages – Fertility control - male and female sterilization - vaccines for fertility control.

5. **Sexual diseases and disorders of reproductive system:** Common vaginal infections - Sexually transmitted diseases - gonorrhea - syphilis - AIDS - prevention – Disorders - hypoactive sexual desire, erectile, dyspareunia and orgasmic disorders - chronic illnesses and disabilities - menstrual cycle problems – Basics of sexual enhancement and sex therapy – Specific suggestions for men and women.

Text book

Crooks, R and Baur, K (1996) Our sexuality. VI Edition, Brook /Cole publishing company, California, USA.

References

Shapiro, HI (1988) The birth control book. Prentice Hall Press, New York.
Chaudhuri, SK (1999) Practice of fertility control - A comprehensive text book. IV Edition, B.I. Churchill Livingstone Pvt. Ltd., New Delhi.

Vander, AJ, Sherman, JH and Luciano DS (2001) Human Physiology: The Mechanism of Body Function.VIII Edition, McGraw Hill Inc. New Delhi.

	K1: Remembering	K2: Understanding	K3: Applying	K4: Analyzing	K5: Evaluating	K6: Creating
CO1		2				
CO2		2				
CO3				4		
CO4			3		5	
CO5				4	5	

Mean = 3.5