



Ramakrishna Mission
Vivekananda Centenary College, Rahara

Department Of Zoology

**Syllabi for B.Sc. Honours in Zoology offered by the
Department Under
CHOICE BASED CREDIT SYSTEM**

Session 2017-2018

The course of B.Sc. Zoology is introduced under CBCS
syllabus, 2017 vide BOS resolution dated 5th August,
2017

Total Change= 88.30%

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Program Outcome:

After completion of the B.Sc. Degree program, the students will be able to

PO No.	Program Outcome	Cognitive Level
PO 1	Recognize the scientific tempers and attitudes, which in turn can prove to be beneficial for the society since the scientific developments can make a nation or society to grow at a rapid pace.	R
PO 2	Understand scientific knowledge and exchange ideas with other stakeholders; make people aware about sustainable utilization of resources with ethical approach.	U
PO 3	Understand and apply the issues of environmental contexts and sustainable development as a basic interdisciplinary concern.	U, Ap
PO 4	Create the ability to perform experiments and to analyse & interpret the obtained accurate results and thus gain the ability to solve problems, to involve in critical, independent, and creative thinking.	An, E, C
PO 5	Possess expertise to apply and formulate ideas which will provide them competitive advantage in pursuing higher studies from India or abroad; and seek jobs in academia, research or industries.	Ap, E
PO 6	Assemble the acquired in-depth knowledge of applied subjects towards the inculcation of professional and employment skills so that students can make a career and become an entrepreneur in diverse fields.	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Programme Specific Outcome:

After completion of the B.Sc. Zoology programme the students would be able to

PSO No.	Program Specific Outcome	Cognitive Level
PSO 1	Identify, classify and differentiate diverse nonchordates and chordates based on their morphological, anatomical and systemic organization, and understand their ecological and evolutionary significance, physiological adaptations, development, different behavioral aspects including reproduction.	R, U
PSO 2	Understand the relationship or synchronization among structure and function at molecular, cellular, morphological, anatomical, biochemical, physiological and genetical aspect of animals and apply the acquired skills in the fields of ecology, genetics, molecular biology, biotechnology, biostatistics, bioinformatics, qualitative and quantitative microscopy, enzymology and analytical biochemistry.	U
PSO 3	Understand and evaluate the physical features of environment to the structure of populations, communities, and ecosystems, environmental degradation and formulations for its protection, conservation of the species with reference to local importance.	U, E
PSO 4	Describe and analyse economic, ecological and medical significance of various animals in human life and thus apply in the entrepreneurship of their own on sericulture, apiculture, fisheries, poultry farming, environment monitoring and parasitic disease management.	R, Ap, An
PSO 5	Apply and implement the varied range of subject based skills to numerous fields that provide a foundation for future career in higher studies, government departments, environmental agencies, teaching, biotechnology, diagnostic, research laboratory, pharmaceutical, environmental and ecological fields.	Ap, C

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Credit Distribution across the Course				
Course Type	Total Papers	Credit		Total Credit
		Theory	Practical	
CC	14	14 × 4 = 56	14 × 2 = 28	56 + 28 = 84
DSE	4	4 × 4 = 16	4 × 2 = 8	16 + 8 = 24
GE	4	4 × 4 = 16	4 × 2 = 08	16 + 8 = 24
SEC	2	2X04=08		=08
AECC	2	2X04=08		=08
Grand Total Credit				=148
<p style="text-align: center;"><u>Abbreviations used:</u> CC = CORE COURSES DSE = DISCIPLINE SPECIFIC ELECTIVES GE = GENERIC ELECTIVES SEC = SKILL ENHANCEMENT COURSES AECC = ABILITY ENHANCEMENT COMPULSORY COURSES</p>				
<p style="text-align: center;">List of Core Courses (14 Papers for the Students of Zoology_Honours)</p>				Semester
UGZOOCC 01	NON-CHORDATES I : PROTISTS TO PSEUDOCOELOMATES			I
UGZOOCC 02	PRINCIPLES OF ECOLOGY			
UGZOOCC 03	NON-CHORDATES II : COELOMATES			II
UGZOOCC 04	CELL BIOLOGY			
UGZOOCC 05	DIVERSITY OF CHORDATES			III
UGZOOCC 06	ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS			
UGZOOCC 07	FUNDAMENTALS OF BIOCHEMISTRY			
UGZOOCC 08	COMPARATIVE ANATOMY OF VERTEBRATES			IV
UGZOOCC 09	ANIMAL PHYSIOLOGY: LIFE SUSTAINING SYSTEMS			

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UGZOOCC10	BIOCHEMISTRY OF METABOLIC PROCESSES	
UGZOOCC11	MOLECULAR BIOLOGY	V
UGZOOCC12	PRINCIPLES OF GENETICS	
UGZOOCC13	DEVELOPMENTAL BIOLOGY	VI
UGZOOCC14	EVOLUTIONARY BIOLOGY	
Choices for DSE (4 Papers to be selected by the Students of Zoology_Honours)		Semester
UGZOODSE01	IMMUNOLOGY	V
UGZOODSE02	ANIMAL BEHAVIOUR AND CHRONOBIOLOGY	V
UGZOODSE03	POLLINATION BIOLOGY	V
UGZOODSE04	PROJECT WORK	V
UGZOODSE05	BIODIVERSITY AND WILD LIFE CONSERVATION	VI
UGZOODSE06	COMPUTATIONAL BIOLOGY	VI
GE		
UGZOOGE 01	ANIMAL DIVERSITY AND SYSTEMS	
UGZOOGE 02	ECOLOGY, ECONOMIC AND MEDICAL ZOOLOGY	
UGZOOGE 03	BIOTECHNOLOGY: MICROBES TO ANIMALS	
UGZOOGE 04	INSECT, VECTORS AND DISEASES	
SEC		Semester
UGZOOSEC01	VALUE EDUCATION & INDIAN CULTURE	III
UGZOOSEC02	SPOKEN TUTORIAL FROM IIT BOMBAY	IV

Total Change= 90.14%

Question Pattern

Full Marks: 50

Q1. Choose the correct answer from the following options (any five): $5 \times 1 = 5$

Q2. Briefly state the following questions (any five): $5 \times 1 = 5$

Q3. Write down the following questions (any five): $5 \times 3 = 15$

Q4. Match the Column-A with Column-B (any one): 5

Q5. Describe briefly the following questions (any four): $4 \times 5 = 20$

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SEMESTER – I	
Course name	NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES
Course code	UGZOOCC01
Number of lectures	105
Credits	6
Marks	100
New addition: 73% (Pink) Modifications: 11% (Green) Total Change: 84%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands and apply the basic taxonomy, systematics and classification of Protozoa, Porifera, Cnidaria and Helminth groups, including Nematode- Plant interaction.
2	Understand and evaluate the life cycle of Protozoans, Platyhelminthes, Nematodes.
3	Understand and evaluate the host-parasite relationship and evolution of parasitism
4	Understand, apply and analyse the identification of invertebrate specimens and their life stages.

Core T1: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES

4 Credit

Unit 1: Protista and Metazoa

15 Class

- General characteristics and classification of Protozoa up to phylum (according to Levine *et. al.*, 1980).
- Locomotion in Protista (*Amoeba*, *Paramoecium* and *Euglena*).
- Reproduction in Protista (*Amoeba*, *Paramoecium* and *Euglena*).
- Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Plasmodium vivax*, *Entamoeba histolytica*, *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani*.
- Malaria –types (other than *P. vivax*), causative agents, mode of infection in human, major mode of treatment, major vector species in India and their control measures.
- Symmetry, origin and evolution of Metazoa.

Unit 2: Porifera

3 Class

- General characteristics and classification up to classes.
- Canal system and spicules in sponges.

Unit 3: Cnidaria

10 Class

- General characteristics and classification up to classes.
- Polymorphism in Cnidaria.
- Metagenesis in *Obelia*.
- Corals and coral reefs (including conservation).

Unit 4: Ctenophora

2 class

- General characteristics, evolutionary significance and classification up to classes.

Unit 5: Platyhelminthes

8 class

- General characteristics and classification up to classes.
- Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Fasciola hepatica* and *Taenia solium*.

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Unit 6: Nematoda**10 class**

- General characteristics and classification up to classes.
- Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity, Diagnosis, Prophylaxis and Treatment of *Ascaris lumbricoides* and *Wuchereria bancrofti*
- Nematode- Plant interaction; Gall formation.
- Myasis.
- Physiological and biochemical parasitic adaptations in helminthes

Unit 7: Concepts of Parasitism**4 class**

- Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical and biological vector).
- Host parasite relationship (including molecular aspects).
- Origin and evolution of parasitism.

Unit 8: Basics of Animal Classification**8 class**

- Systematics : definition, place and role in biology.
- Taxonomy : Definition, scope and different levels (alpha, beta and gamma taxonomy, micro and macrotaxonomy).
- ICZN and its important rules (Principle of nomenclature, authorship, priority, synonymy and homonymy).
- Type concept.
- Six kingdom and three domain concept of classification.

Core P1: NON-CHORDATES I: PROTISTS TO PSEUDOCOELOMATES Lab 2 credit**List of Practical**

1. Identification of *Amoeba*, *Euglena*, *Entamoeba*, *Opalina*, *Paramecium*, *Plasmodium* (from the prepared slides) [Name of specimen, name of phylum and two specimen characters].
2. Identification of *Sycon/Scypha*, Neptune's Cup, *Spongilla*, *Obelia*, *Physalia*, *Millepora*, *Aurelia*, *Tubipora*, *Corallium*, *Gorgonia*, sea anemone, *Pennatula*, *Fungia*, brain coral, *Acropora* [Name of specimen, systematic position upto class and two specimen characters].
3. One specimen/ slide of any ctenophore.
4. Staining/mounting of any protozoan/helminth from gut of cockroach.
5. Study of life stages of *Giardia intestinalis*, *Trypanosoma gambiense*, *Leishmania donovani* through permanent slides/micro photographs.
6. Study of adult and life stages of *Fasciola hepatica*, *Taenia solium* through permanent slides/micro-photographs.
7. Study of adult and life stages of *Ascaris lumbricoides*, *Ancylostoma duodenale* through permanent slides/micro-photographs.
8. Project Work: Power point presentation on study of any two non-chordate animals (from Protists to Pseudocoelomates) by student.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	PO Addressed	PSOs Addressed	Cognitive Level
CO 1:	Describe the protozoan reproduction, polymorphism in cnidarians, nervous system in molluscs	PO1	PSO 1	R
CO 2:	Apply and evaluate the biological and medicinal importance of various larvae and sponges respectively	PO 3	PSO 1,5	Ap, E
CO 3:	Understand the invertebrate defence and feeding mechanisms	PO 2	PSO 1	U
CO 4:	Analyse and discuss the adaptive radiation, evolution, affinities of a variety of invertebrates	PO 4	PSO 1	An, C

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CO 5:	Acquire skills in teaching the structural and functional features of invertebrate animal life's diversity	PO 6	PSO 5	Ap
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Reference Books

- Brusca, R.C. and Brusca, G.J. (2002). *Invertebrates*. 2nd edition, Sinauer Associates.
- Meglitsch, P.A. and Schram, F.R. (1991). *Invertebrate Zoology*. 3rd edition, Oxford University Press.
- Parker, T.J. and Haswell, W.A., ed. By Marshall, A.J. and Williams, W.D. (1995). *Text book of Zoology : Invertebrates*. Vol. 1, 7th edition, Indian edition, A.I.T.B.S. Publishers.
- Pechenik, J. A. (2015). *Biology of the Invertebrates*. 7th edition, McGraw Hill Education.
- Ruppert, E. E. and Barnes, R.D. (1994). *Invertebrate Zoology*. 6th edition, Harcourt Publishers.
- Ruppert, E. E., Fox, R.S. and Barnes, R.D. (2004). *Invertebrate Zoology. A functional Evolutionary Approach*. 7th edition, Indian edition, Cengage Learning.
- Ahmed, N., Dawson, M., Smith, C. and Wood, Ed. (2006). *Biology of Disease*. Taylor and Francis.
- Arora, D. R and Arora, B.B. (2012). *Medical Parasitology*. 3rd edition. CBS Publishers.
- Bose, M. (2016). *Parasitoses and Zoonoses*. New Central Book Agency.
- Chatterjee, K.D. (1952). *Human Parasites and Parasitic Diseases*. Published by author.
- Chatterjee, K.D. (2009). *Parasitology : Protozoology and Helminthology*. 13th edition, CBS Publishers and Distributors.
- Cheng, T.C. (1986). *General Parasitology*. 2nd edition, Elsevier.
- Dailey, M.D. (1996). Meyer, Olsen and Schmidt's *Essentials of Parasitology*. 6th edition, McGraw-Hill Science.
- Ichhpujani, R.L. and Bhatia, R. (2003). *Medical Parasitology*. 3rd edition, Jaypee Brothers.
- Loker, E.S. and Hofkin, B.V. (2015). *Parasitology : A Conceptual Approach*. Garland Science.
- Noble, E.R. and Noble, G.A. (1982). *Parasitology: The Biology of Animal Parasites*. 5th edition, Lippincott Williams and Wilkins.
- Parija, S. C. (2013). *Textbook of Medical Parasitology, Protozoology and Helminthology (Text and Colour Atlas)*. 4th edition, All India Publishers & Distributors.
- Roberts, L.S., Janovy, J. (Jr) and Nadler, S. (2013). *Gerald D. Schmidt and Larry S. Roberts' Foundations of Parasitology*. 9th edition, McGraw Hill.
- Bogitsh, B.J., Carter, C.E. and Oeltmann, T.N., 2013, *Human Parasitology*, 4th Edition, Elsevier Inc.
- Mayr, E. & Ashlock, P.D. (1991). *Principles of Systematic Zoology*. 2nd edition, McGraw-Hill, Inc.
- Simpson, G.G. (1961). *Principles of Animal Taxonomy*. Columbia University Press, New York.

Note: Classification (except Protozoa) to be followed from Rupert and Barnes (1994), *Invertebrate Zoology*, 6th Edition.

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SEMESTER – I		
Course name	PRINCIPLES OF ECOLOGY	
Course code	UGZOOCC02	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 72 (Pink)	Modifications: 19 (Green)	Change: 91%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers and understands the various features and aspects of population ecology, community ecology and ecosystem ecology.
2	Understand and evaluate the components of ecosystem, nutrient and biogeochemical cycles and impact of man on the ecological balance.
3	Understand and evaluate the importance of biodiversity and its conservation
4	Understand and analyse the causes, effects and control environmental pollution and degradation
5	Apply the acquired knowledge to solve the environmental and ecological problems

Core T2: PRINCIPLES OF ECOLOGY

4 Credit
2 class

Unit 1: Introduction to Ecology

- History of ecology.
- Autecology and synecology, Levels of organization; Laws of limiting factors, Study of physical factors.

Unit 2: Population

20 class

- Unitary and modular populations; unique and group attributes of population- density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, geometric, exponential and logistic growth equation and patterns; r and K life history strategies.
- Population regulation - density-dependent and independent factors; Population interactions - emergence of competition as a central theory experiments of Tansley, Gause and Park, competition exclusion principle, interspecific and intraspecific competitions, Lotka-Volterra model; concept of metapopulation (brief idea).

Unit 3: Community

16 class

- Community characteristics - species richness, dominance, diversity, abundance, vertical and horizontal stratifications;
- Animal's space and resource use, resource partitioning;
- Community and ecosystem: assemblage, guild and community concept, niche concept, ecotone and edge effect;
- Ecological succession - causes, types, hydrosere and concept of climax

Unit 4: Ecosystem

10 class

- Concept of an ecosystem: structure and function; producers, consumers and decomposers; energy flow through the ecosystem; Grazing and detritus food chain; Linear and Y-shaped food chains; food webs; ecological pyramids and ecological efficiencies;
- types of ecosystems (characteristic features, structure and function): forest, grassland, desert and aquatic ecosystems (lake, rivers, marine, estuary); nutrient and biogeochemical cycle with an example of nitrogen cycle; human modified ecosystems, wetland as an ecosystem service provider

Unit 5: Applied Ecology

1 class

- Ecology in Wildlife Conservation and Management

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Unit 6: Environmental Biology

5 class

- Environmental ethics :Issues and possible solutions.
- Climate change : global warming, acid rain, ozone layer depletion.
- Brief idea on El nino, La nina and their consequences.
- Carbon sequestration and vertical use of space for carbon assimilation.

Unit 7: Environmental Pollution / Degradation

6 class

- Definition, causes, effects and control measures of Air pollution, Water pollution, Soil pollution, Noise pollution, Thermal pollution, Nuclear hazards.
- Solid waste Management: causes, effects and control measures of urban and industrial wastes; bioremediation (brief idea).

CORE P2: PRINCIPLES OF ECOLOGY Lab

2 Credit

List of Practical

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical / real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Weiner diversity index for the same community.
3. Study of an aquatic ecosystem: phytoplankton and zooplankton, measurement of area, temperature, turbidity/penetration of light, determination of pH, and dissolved oxygen content (Winkler's method), Chemical Oxygen Demand and free CO₂.
4. Study of micro arthropods of water and soil samples.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the components and characteristics of population, community and the ecosystem	PO 1, 2	PSO 1, 3	R, U
CO 2:	Analyze, apply and evaluate the various concepts of population and community and relate the impact of man on the ecological balance	PO 4	PSO 3	An, Ap, E
CO 3:	Interpret and analyse the importance of biodiversity and its conservation management	PO 4	PSO 3	U, An
CO 4:	Demonstrate and evaluate the interactions among various environmental parameters	PO 2	PSO 3	U, E
CO 5:	Demonstrate and recommend environmental ethics related issues and management strategies.	PO 6	PSO 3	U, E

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Reference Books

- Bailey, R.A., Clark, H.M., Ferris, J.P., Krause, S. and Strong, R.L. (2002). *Chemistry of the Environment*. 2nd edition, Academic Press.
- Cain, M.L., Bowman, W.D. and Hacker, S.D. (2014). *Ecology*. 3rd edition. Sinauer associates.
- Chapman, J.L. and Reiss, M.J. (1999). *Ecology: Principles and Applications*. 2nd edition, Cambridge University Press.
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- Lindenmayer, D., Burns, E., Thurgate, N. and Lowe, A. (editors). (2014). *Biodiversity and Environmental Change: Monitoring, Challenges and Direction*. CSIRO Publishing.
- Michael, P.N. (2016). *Ecology*. CBS Publishers and Distributors.
- Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of Ecology*. 5th edition, Thomson Brooks/Cole.
- Rao, M.N. and Datta, A.K.(1987). *Waste Water Treatment*. Oxford and IBH Publishing Co. Pvt. Ltd. 345pgs.

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- Ricklefs, R.E. and Miller, G.L. (2000). *Ecology*. 4th edition, W.H. Freeman and Company.
- Smith, R.L. (2001). *Ecology and Field Biology*. Benjamin Cummings.
- Smith, T.M. and Smith, R.L. (2006). *Element of Ecology*. 6th edition, Pearson Education, Inc.
- Stilling, P. (2001). *Ecology: Theories & Application*. 4th Edition.
- Wetzel, R.G. (2001). *Limnology: Lake and River Ecosystems*. 3rd edition, Elsevier.

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SEMESTER – II		
Course name	NON-CHORDATES II: COELOMATES	
Course code	UGZOCC03	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 70% (Pink)	Modifications: 10% (Green)	Total Change: 80%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers and understands the classification of coelomate invertebrates and the structure, functional biology of these taxonomic categories.
2	Understand and evaluate different vector born diseases and the related life cycles, epidemiology, pathology, diagnosis, symptoms and treatments.
3	Understand and analyse the adaptive radiation, evolution and affinities of a variety of coelomates.
4	Understand and apply the basics of sericulture, apiculture, lac culture and pearl culture.

Core T3 – NON-CHORDATES II: COELOMATES**4 Credit****Unit 1: Introduction to Coelomates****3 class**

- Evolution of coelom and metamerism

Unit 2 : Annelida**8 class**

- General characteristics and classification up to classes.
- Excretion in Annelida.
- Larval form.

Unit 3 : Arthropoda**20 class**

- General characteristics and classification up to classes.
- Crustacean larvae.
- Respiration in Arthropoda : Gills in Prawn; trachea in cockroach; book lung in arachnids
- Vision in Arthropoda
- Metamorphosis in Insects
- Social life in bees and termites
- Parasitic Arthropods:
 - Biology, importance and control of Ticks (Soft tick and Hard tick), Mite, Lice, Flea and Bugs.
 - Mosquito as vectors of diseases : Malaria, Filaria, Dengue, DHF and Chikungunya ; causative agents, symptoms and treatment of Dengue, DHF and Chikungunya.
- Economically beneficial Arthropods:
 - Sericulture: Silks and silkworms; commonly cultivated species in India; economically important products from silkworm; biology & rearing of silkworms; problems- pests & diseases of silkworms as well as host plants; future prospects of sericulture in India.
 - Apiculture: Commonly cultivated species in India; economically important products of apiculture; methods of bee rearing; diseases of honeybee; future prospects of apiculture in India.
 - Lac culture: Types and composition of lac; lac insect and its life history; host plants & lac cultivation; pests and diseases of lac insect as well as host plants; lac extraction; uses of lac; future prospects of lac culture in India.

Unit 4: Onychophora**2 class**

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- General Characteristics and Evolutionary significance.

Unit 5: Mollusca**15 class**

- General characteristics and classification up to classes.
- Respiration in Mollusca
- Nervous system in Mollusca
- Torsion and detorsion in Gastropoda.
- Camouflage and inc sac in Cephalopoda.
- Pearl culture: commonly cultured species of pearl oysters in India, composition of pearl, culture methods, freshwater pearls, prospects & concerns of pearl cultivation in India.
- Larval forms in Mollusca: Trocophore, Glochidium, Velliger

Unit 6: Echinodermata**10 class**

- General characteristics and classification up to classes.
- Water vascular system in Echinodermata.
- Larval forms in Echinodermata.
- Affinities with chordates.

Unit 7: Hemichordata**2 class**

- General characteristics.
- Larval form
- Relationship with nonchordates and chordates.

Core P3: NON-CHORDATES II : COELOMATES Lab**2 credit****List of Practicals**

1. Identification of :
 - a. Annelids - *Aphrodita*, *Nereis*, *Sabella Arenicola*, *Chaetopterus*, *Pheretima*, *Hirudinaria*.
 - b. Arthropods – Horseshoe crab, *Penaeus*, *Macrobrachium*, *Daphnia*, *Balanus*, *Sacculina*, crab, *Eupagurus*, centiped, milliped, *Bombyx*, *Periplaneta*, termites and honey bees.
 - c. Onychophora – *Peripatus*.
 - d. Molluscs - *Cliton*, *Pila*, *Doris*, *Achatina*, *Lamellidens*, *Ostrea*, *Pinctada*, *Sepia*, *Octopus*, *Nautilus*.
 - e. Echinoderms - starfish, brittle star, sea urchin, sea cucumber, sea lily and feather star. [Name of specimen, systematic position upto class, and two specimen characters].
2. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm (Virtual demonstration).
3. T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm (virtual demonstration)
4. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta*.
5. Project Work : Power point presentation on study of any two nonchordate coelomate animals by the student.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Demonstrate and distinguish different coelomate invertebrates and the structural and functional biology of these taxonomic categories	PO 2	PSO 1	U, An
CO 2:	Illustrate different vector born diseases and the related life cycles, epidemiology, pathology, diagnosis, symptoms and treatments and take part in controlling these diseases .	PO 1, 2	PSO 4	U, Ap
CO 3:	Define, interpret and analyse the adaptive radiation, evolution and affinities of a variety of coelomates	PO 3,	PSO 1	R, U, An
CO 4:	Demonstrate and apply various techniques of sericulture, apiculture, lac culture and pearl culture. Thus create the enterprenureship.	PO 5, 6	PSO 4, 5	U, Ap, C

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CO 5:	Compare and apply the compound vision in arthropods	PO 3, 6	PSO 1, 5	An, Ap
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Reference Books

- Brusca, R.C. and Brusca, G.J. (2002). *Invertebrates*. 2nd edition, Sinauer Associates.
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Note: Classification to be followed from Rupert and Barnes (1994), Invertebrate Zoology, 6th Edition.

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SEMESTER – II		
Course name	CELL BIOLOGY	
Course code	UGZOCC04	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 83%(Pink)	Modifications: 7% (Green)	Total Change: 90%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Outline the structures and explain the functions of plasma membrane and all cellular organelles in details.
2	Acquire knowledge about chromosomes and cell divisions, both mitosis and meiosis.
3	Understand the mechanism of cell signalling and cancers.
4	Know how to measure and stain different cell types.

Core T4 – CELL BIOLOGY**Unit 1: Overview of Cells**

4 Credit
4 class

Basic structure of:

- * Prokaryotic and Eukaryotic cells.
- * Viruses, Viroid, Prion and Mycoplasma.

Unit 2: Plasma Membrane

10 class

- Various models and ultra-structure and composition of Plasma Membrane: Lipid Bilayer, Membrane Proteins and their types.
- Transport across membrane: Active and passive transport, Facilitated transport.
- Cell junctions: Tight junctions, Gap junctions, Desmosomes.
- Liposomes, Freeze-etching and freeze fracture technique for membrane study.

Unit 3: Endomembrane system

10 Class

- Structure and functions of : Endoplasmic Reticulum, Golgi Apparatus, Lysosomes and Ribosome.
- Protein sorting and mechanisms of vesicular transport.

Unit 4: Mitochondria, Peroxisome and Centrosome

10 class

- Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis, functions including Respiratory Chain and Oxidative Phosphorylation.
- Peroxisomes: Structure and functions.
- Centrosome: Structure and functions.

Unit 5: Cytoskeleton

6 class

- Type, structure and functions of cytoskeleton : microtubules, microfilaments, and intermediate filaments
- Accessory proteins of microfilament and microtubule.
- A brief idea about molecular motors.

Unit 6: Nucleus

8 class

- Structure of Nucleus: Nuclear envelope, nuclear pore complex, nucleolus and biogenesis of ribosome.
- Chromosome- structure and functions.
- Polytene and lampbrush chromosomes.
- Centromere and telomere.
- Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome).

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Unit 7: Cell Division

8 class

- Cell cycle and its regulation.
- Cancer (role of p53, Retinoblastoma and Ras).
- Cellular reproduction: Amitosis, Mitosis and Meiosis: Basic process and their significance.

4 class

Unit 8: Cell Signalling

- GPCR and Role of second messenger (cAMP)

2 Credit

Core P4 – CELL BIOLOGY Lab**List of Practicals**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
2. Study / preparation of various stages of meiosis from Grasshopper.
3. Drawing of ultrastructure of cell and different organelles (from photographs provided).
4. Demonstration and description of compound microscope.
5. Measurement of size (length/breadth) by micrometry of any cell / protozoan.
6. Diversity of eukaryotic cells – methylene blue staining of buccal epithelium (human); Leishman staining of mammalian blood cells ; Permeability of plasma membrane – effect of isotonic, hypotonic and hypertonic solutions on mammalian RBC.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the structures and functions of plasma membrane and all cellular organelles in details.	PO 1, 2	PSO 2	R, U
CO 2:	Illustrate the structure and functions of endomembrane system and cytoskeleton	PO 2	PSO 2	U
CO 3:	Demonstrate and identify the detail structure of nucleus and compare the functional mechanism of different parts of the nucleus.	PO 2	PSO 2	U, Ap
CO 4:	Elaborate the mechanism of cell signalling and cancers.	PO 2	PSO 2	C
CO 5:	Compare and apply the techniques to measure and stain different cell types.	PO 2, 6	PSO 2, 5	An, E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference books

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SEMESTER – III		
Course name	DIVERSITY OF CHORDATA	
Course code	UGZOOCC05	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 63% (Pink)	Modifications: 7% (Green)	Total Change: 70%

Course Objectives:

After completion of this course the student will be able to

Sl No.	Course Objectives:
1:	Understand the classification, structure, function and biology of chordates of different taxonomic classes.
2:	Outline the origin of chordates
3:	Explain some special topics like zoogeography, metamorphosis, snake bites, migration of birds, parental care of amphibian, echolocation of mammals.
4:	Apply the knowledge of poultry managements and different breeds of domestic animals.

Core T5: DIVERSITY OF CHORDATA**4 credit****Unit 1: Introduction to Chordates****2 class**

- General characteristics and outline classification of Phylum Chordata.

Unit 2: Protochordata**6 class**

- General characteristics and classification of subphylum Urochordata and Cephalochordata up to classes.
- Retrogressive metamorphosis in ascidians.
- Anatomical peculiarities and feeding in *Branchiostoma*.

Unit 3: Origin of Chordata**3 class**

- Dipleurula concept and the Echinoderm theory of origin of chordates.
- Advanced features of vertebrates over protochordates.

Unit 4: Agnatha**1 class**

- General characteristics and classification of cyclostomes up to order

Unit 5: Pisces**11 class**

- General characteristics and classification of Chondrichthyes and Osteichthyes up to order
- Gill respiration and accessory respiratory organs.
- Osmoregulation
- Swim bladder.
- Parental care
- Migration

Unit 6: Amphibia**6 class**

- General characteristics and classification up to living orders.
- Origin of Tetrapoda (Evolution of terrestrial ectotherm)
- Metamorphosis : Process and regulation.
- Parental care

Unit 7: Reptilia**7 class**

- General characteristics and classification up to living orders.
- Skull types.
- Venom apparatus and biting mechanism in snake.
- Anatomical peculiarities and affinities of *Sphenodon*.

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10 class

Unit 8: Aves

- General characteristics and classification up to living order
- *Archaeopteryx*- a connecting link
- Types of flight; principles and aerodynamics of flight.
- Respiration in bird.
- Migration in birds
- Poultry birds: Fowl & Duck - different breeds, their advantages & disadvantages; importance of indigenous breeds.

10 class

Unit 9: Mammalia

- General characteristics and classification up to living orders.
- Evolutionary peculiarities of Prototheria.
- Ruminant stomach.
- Echolocation in microbats.
- Adaptive radiation with special reference to locomotory appendages.
- Cattle, goats and lambs: different breeds, their advantages and disadvantages; importance of indigenous breeds.

4 class

Unit 10: Zoogeography

- Zoogeographical realms, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

Core P5 – DIVERSITY OF CHORDATA Lab

2 Credit

List of Practical

1. Identification of Protochordates :
Balanoglossus, ascidian, *Branchiostoma* (Name of specimen, systematic position up to class and two specimen characters).
2. Identification of Agnathans :
Petromyzon, *Myxine* (Name of specimen, systematic position up to class and two specimen characters).
3. Identification of Fishes :
Scoliodon, *Sphyrna*, *Pristis*, *Torpedo*, *Mystus*, *Heteropneustes*, *Labeo rohita* and *Labeo bata*, *Exocoetus*, *Echeneis*, *Anguilla*, *Hippocampus*, *Anabas*, Flat fish (Name of specimen, systematic position up to subclass and two specimen characters).
4. Identification of Amphibians:
Bufo, *Rana*, *Hyla*, *Necturus*, *Axolotl*, *Tylotriton*, *Ichthyophis/Uracotyphlus* (Name of Specimen, systematic position up to order and two specimen characters).
5. Identification of Reptilians:
Sea turtle, *Hemidactylus*, *Varanus*, *Uromastix*, *Chamaeleon*, *Draco*, *Vipera*, *Naja*, *Hydrophis*, *Crocodylus* (Name of specimen, systematic position up to order and two specimen characters). Key for Identification of poisonous and non-poisonous snakes.
6. Aves: Study of common birds from different orders.
7. Identification of Mammals: Bat (Insectivorous and Frugivorous), *Sorex*, *Funambulus*, *Loris*, *Herpestes*, *Erinaceus* (Name of specimen, systematic position up to order and two specimen characters).
8. Dissection of brain and pituitary of Tilapia.
9. Power point presentation on study of any two chordate animals by students.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and classify different class of chordates.	PO 1, 2	PSO 1	R, U
CO 2:	Demonstrate and compare the structure, function and biology of chordates of different taxonomic classes.	PO 2	PSO 1, 2	U, C
CO 3:	Outline and evaluate the origin of chordates	PO 1	PSO 1	U, E
CO 4:	Illustrate and analyse some special topics like	PO 2	PSO 1, 3	U, An

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	zoogeography, metamorphosis, snake bites, migration of birds, parental care of amphibian, echolocation of mammals.			
CO 5:	Apply the knowledge of poultry managements and different breeds of domestic animals to build animal husbandary.	PO 5	PSO 1, 4	Ap, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Banerjee, G.C. (1986). Poultry. 2nd edition, Oxford and IBH Publishing.
- Duellman, W.E. and Trueb, L. (1986). *Biology of Amphibians*. JHU Press.
- Jordan, E.L. and Verma, P.S. (2003). *Chordate Zoology*. S. Chand and Company.
- Nelson, J.S., (2006). *Fishes of the World*, 4th edition, Wiley.
- Parker, T. J. and Haswell, W. (1972). *Text Book of Zoology*, Volume II: Marshall and William (Editors). 7th edition, Macmillan Press, London.
- Pough, F.H., Janis, C.M. and Heiser, J.B. (2013). *Vertebrate life*, 9th edition, Pearson.
- Romer, A. S. and Parsons, T. S. (1986). *The vertebrate body*. 6th edition, Saunders College Publishing.
- Sinha, K. S., Adhikari, S., Ganguly, B. B. and Goswami, B. (2001). *Biology of Animals*. Vol. II. New Central Book Agency (p) Ltd.
- Young, J. Z. (1981). *The Life of Vertebrates*. 3rd edition, Oxford University Press.

Note: Classifications to be followed from Young, J.Z. (1981)

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SEMESTER – III	
Course name	ANIMAL PHYSIOLOGY : CONTROLLING AND COORDINATING SYSTEMS
Course code	UGZOOCC06
Number of lectures	105
Credits	6
Marks	100
New addition: 67% (Pink) Modifications:- Green 17% Total Change: 84%	

Course Objectives:

After completion of this course the students will be able to

Sl. No.	Course Objectives:
1	Remember and understand the basics of histology and functions of various tissues.
2	Understand the structure and physiology of muscles, nerves.
3	Explain the reproductive systems and distinguish the physiology of male and female reproduction.
4	Understand and evaluate the histology of endocrine glands and classify hormones, demonstrate their biosynthesis, receptors, mode of molecular actions, physiological function, feedback controls and related disorders.

CORE T6: ANIMAL PHYSIOLOGY : CONTROLLING AND COORDINATING SYSTEMS**4 Credit****Unit 1: Basics of Histology****4 class**

How to study tissues; preparation of histological slides : fixation, mordant, staining.

Unit 2: Tissues**6 class**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Unit 3: Bone and Cartilage**4 class**

Structure and types of bones and cartilages, Ossification, bone growth and resorption

Unit 4: Nervous System**10 class**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and Neuromuscular junction;

Reflex action and its types - reflex arc; Physiology of hearing and vision.

Unit 5: Muscle**8 class**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction;

Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 6: Reproductive System**8 class**

Histology of testis and ovary; Puberty, Physiology of male and female reproduction; Role of Pineal gland in reproduction; Estrous and Menstrual cycle, Prostate gland and its role in semen formation, Methods of contraception in male and female

Unit 7: Endocrine System**20 class**

- General idea of endocrine and exocrine systems.
- Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal ; Biosynthesis, mechanism of action , function and regulation of hormones secreted by them (including those of testis and ovary); Disorders of these glands;
- Classification of hormones; Types of hormone delivery system; Regulation of hormone secretion;

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- Mode of hormone action, Signal transduction pathways for steroidal and non-steroidal hormones; Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; General idea of feedback mechanism (both positive and negative); Hypothalamo – hypophysial axes – gonadal, adrenal and thyroidal axes.
- Placental hormones
- Role of hormones in homeostasis.
- Molecular Mechanism of Hormone Action:
 - Ligand – receptor concept, concept of signal transduction; Types of cell surface receptor mediated signaling as well as subcellular receptor-mediated signaling;
 - Signal transduction pathways of the hormones: Insulin, Glucagon, Adrenalin, T4.
 - General idea of apoptosis.
 - Hormone bioassays – RIA and ELISA.
 - Genomics of Hormone action.

CORE P6: ANIMAL PHYSIOLOGY: CONTROLLING AND COORDINATING SYSTEMS
Lab **2 Credit**

List of Practical

1. Recording of simple muscle twitch with electrical stimulation (or Virtual)
2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid
5. Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues (liver, thyroid, kidney, testis, ovary, adrenal and pancreas).

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the basics of histology and functions of various tissues.	PO 1, 2	PSO 2	R, U
CO 2:	Illustrate the structure and physiology of muscles, nerves.	PO 2	PSO 2	U
CO 3:	Explain the reproductive systems and distinguish the physiology of male and female reproduction.	PO 2, 4	PSO 2	U, An
CO 4:	Demonstrate and evaluate the histology of endocrine glands.	PO 2, 5	PSO 2, 5	U, E
CO 5:	Classify hormones and Explain their biosynthesis, receptors, mode of molecular actions, physiological function, feedback controls and related disorders.	PO 4, 5	PSO 2, 4, 5	An, Ap
CO 6:	Examine histology different tissues through preparation of temporary and permanent slides	PO 6	PSO 2, 4	An

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Barrett, K.E., Barman, S.M., Boritano, S. and Brooks, H.L. (2016). *Ganong's Review of Medical Physiology*. 25th edition, Indian edition, McGraw Hill Education.
- Hall, J.E. (2016). *Guyton and Hall Text book of Medical Physiology*. 13th edition, Elsevier.
- Marieb, E. (1998). *Human Anatomy and Physiology*. 4th edition, Addison-Wesley.
- Prakash, G. (2012). *Lab Manual on Blood Analysis and Medical Diagnostics*. S. Chand and Company.
- Randall, D., Burggren, W. and French, K. (2001). *Eckert Animal Physiology: Mechanisms and adaptations*. 5th edition, W. H. Freeman.

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- Silverthorn, D.U. (with Johnson, B.R. and Ober, W.C.) (2010). *Human Physiology :An Integrated Approach*. 5th edition, PHI Learning Pvt Ltd.
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- Norris, D. O. and Carr, J.A. (2013). *Vertebrate Endocrinology*. 5th edition, Academic Press.
- Ross, M.H., Kaye, G.I. and Pawlina, W. (2003). *Histology : A Text and Atlas*. 4th edition, Lippincott Williams and Wilkins.

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SEMESTER – III		
Course name	FUNDAMENTALS OF BIOCHEMISTRY	
Course code	UGZOCC07	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 63% (Pink)		Modifications: 25% (Green) Total Change: 88%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the basic and fundamental biochemistry of carbohydrates, proteins, lipids and nucleic acids.
2	Understand the nature, mechanism, and kinetics of enzyme action.
3	Learn some instrumentation such as microscopy, chromatography, electrophoresis, centrifugation, spectrophotometry etc.
4	Analyse pH, carbohydrates, proteins, lipids and chromatographic separation of amino acids

CORE T7: FUNDAMENTALS OF BIOCHEMISTRY**4 credit****Unit 1: Carbohydrates****8 class**

- Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Mutarotation, Epimers and Invert sugar.

Unit 2: Lipids**8 class**

- Classification and properties of Lipids.
- Structure and significance of physiologically important saturated and unsaturated fatty acids, triacylglycerol, Waxes, Phospholipids, Sphingolipid, Glycolipids, Steroids, Eicosanoids.
- Rancidity, Acid value, Iodine number, Reichert Meissl number, Acetyl number.
- Biological importance of Liposomes.

Unit 3: Proteins**14 class**

- **Amino acids:** Structure, Classification and General properties of α -amino acids; Physiological importance of essential and non-essential α -amino acids
- **Proteins:** Bonds stabilizing protein structure; Levels of organization in proteins; Denaturation; Classification of Proteins including simple and conjugate proteins; Ramachandran plot; Structure and function of Myoglobin, Haemoglobin, Collagen, Keratin and Elastin; Hill equation and plot of Myoglobin and Haemoglobin; Models of allosteric protein behavior; Protein folding and Ubiquitin mediated protein degradation; Protein sequencing.
- **Immunoglobulins:** Basic Structure, Classes and Function, Antigenic Determinants.

Unit 4: Nucleic Acids**12 class**

- Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids, Cot Curves: Base pairing, Denaturation, Renaturation and reassociation kinetics of DNA, Types of DNA (A, B and Z conformations) and RNA, Complementarity of DNA, Hypo-Hyperchromaticity of DNA.

Unit 5: Enzymes**18 class**

- Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of K_m and V_{max} , Lineweaver-Burk plot; Multi-substrate reactions; Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

Unit 6: Biophysical chemistry of biological systems**25 class**

- Introductory idea about the principles and applications of the following techniques :

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- a. Microscopy : Phase contrast, Dark field, Fluorescence, SEM & TEM.
- b. Chromatography : Paper chromatography, TLC, Affinity chromatography and Gel Filtration chromatography.
- c. Centrifugation : Density gradient, differential and ultracentrifugation.
- d. Electrophoresis : DNA and Protein including immunoelectrophoresis.
- e. X-ray crystallography.
- f. Spectrophotometry : UV-Visual and IR.
- Application of Radioisotopes in Biology.
- Viscosity and Surface Tension in Biological system.

Core P7: FUNDAMENTALS OF BIOCHEMISTRY Lab

2 Credit

List of Practical

1. Qualitative tests of carbohydrates, proteins and lipids.
2. Paper chromatography/Size-exclusion Chromatography of amino acids
3. Demonstration of pH meter and buffer preparation
4. Action of salivary amylase under optimum conditions
5. Effect of pH, temperature and inhibitors on the action of salivary amylase.
6. Demonstration of proteins separation by SDS-PAGE.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the basic and fundamental biochemistry of carbohydrates, proteins, lipids and nucleic acids.	PO 1, 2	PSO 2	R, U
CO 2:	Understand and apply the nature, mechanism, and kinetics of enzyme action.	PO 2, 4	PSO 2	U, Ap
CO 3:	Demonstrate, apply and evaluate some instrumentation such as microscopy, chromatography, electrophoresis, centrifugation, spectrophotometry etc.	PO 2, 4, 5	PSO 2	U, Ap, E
CO 4:	Analyse and estimate pH, carbohydrates, proteins, lipids and chromatographic separation of amino acids	PO 4, 6	PSO 2, 5	An, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, 6th edition, W.H. Freeman and Co., New York.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, 2nd edition, BIOS Scientific Publishers Ltd., U.K.
- Nelson, D.L. and Cox, M.M. (2017). *Lehninger Principles of Biochemistry*, 7th Edition, W.H. Freeman and Co.
- Rodwell, V., Bender, D., Botham, K.M., Kennelly, P.J. and Weil, P.A. (2015). *Harper's Illustrated Biochemistry*, 30th edition, McGrawHill Education.
- Voet, D., Voet, J.G. and Pratt, C.W. (2016). *Fundamentals of Biochemistry : Life at the molecular level*, 5th edition, Wiley.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, 6th edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- Zubay, G.L. (1998). *Biochemistry*, 4th Edition, Wm C. Brown Publishers.

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Rahara, Kol-700118

SEMESTER – IV	
Course name	COMPARATIVE ANATOMY OF VERTEBRATES
Course code	UGZOOCC08
Number of lectures	105
Credits	6
Marks	100
New addition: 65% (Pink) Modifications: 23% (Green) Total Change: 88%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Define and understand the structures of different systems such as, integumentary, skeletal, digestive, respiratory, circulatory, urinogenital, nervous and sensory organs in comparative way among the vertebrate groups.
2	Distinguish the disarticulated skeleton of many vertebrates.
3	Understand and evaluate the skeletal modifications in vertebrates.
4	Understand the evolution of urinogenital ducts, heart and aortic arches.

Core T8: COMPARATIVE ANATOMY OF VERTEBRATES**4 credit****Unit 1: Integumentary System****8 class**

- General structure & functions of integument; integumental derivatives (including scales of fishes; scales, scutes, carapace and plastron of reptiles; feathers of birds; hair, horn, antler, claw and nail of mammals).

Unit 2: Skeletal System**8 class**

- Overview of axial and appendicular skeleton, Jaw suspensorium, Visceral Arches,
- Comparative anatomy of vertebrae.

Unit 3: Digestive System**8 class**

- Alimentary canal and associated glands; dentition.

Unit 4: Respiratory System**8 class**

- Skin, gills, lungs and air sacs; Accessory respiratory organs.

Unit 5: Circulatory System**8 class**

- General plan of circulation; evolution of heart and aortic arches.

Unit 6: Urinogenital System**6 class**

- Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit 7: Nervous System**8 class**

- Comparative account of brain;
- Autonomic nervous system, Spinal cord, Cranial nerves in amphibians and mammals.

Unit 8: Sense Organs**6 class**

Classification of receptors; Brief account of visual and auditory receptors in man

2015

Core P8: COMPARATIVE ANATOMY OF VERTEBRATES lab**List of Practicals****2 credit**

- Study of placoid, cycloid and ctenoid scales through permanent slides / photographs
- Disarticulated skeleton of Frog, *Varanus/Calotes*, Fowl/Pigeon, Rabbit/Guineapig [including skull, atlas, axis, synsacrum (pigeon), pygostyle (pigeon), humerus, radio-ulna/radius and ulna, femur, tibio-fibula/tibia and fibula/tibio-tarsus and fibula, girdle bones, furcula (pigeon)].
- Carapace and plastron of turtle/tortoise (photographs)
- Mammalian skulls: One herbivorous and one carnivorous animal

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5. Dissection of white rat to study arterial and urinogenital system (subject to permission)
6. Study of structure of any two organs (heart, lung, kidney, eye and ear) from video recording (may be included if dissection not permitted)
7. Project on skeletal modifications in vertebrates (may be included if dissection not permitted)

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and compare the structures of different systems such as, integumentary, skeletal, digestive, respiratory, circulatory, urinogenital, nervous and sensory organs in the vertebrate groups.	PO 1, 2, 6	PSO 1, 2	R, U, E
CO 2:	Compare the disarticulated skeleton of many vertebrates.	PO 4	PSO 1, 2	An
CO 3:	Demonstrate and identify the skeletal modifications in vertebrates.	PO 2	PSO 1, 2	U, Ap
CO 4:	Discuss the evolution of urinogenital ducts, heart and aortic arches.	PO 2, 5	PSO 1, 5	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books:

- Kardong, K. V. (2015). *Vertebrates: Comparative Anatomy, Function, Evolution*. 7th edition, McGraw Hill Education.
- Kent, G. C. and Carr, R. K. (2001). *Comparative Anatomy of the Vertebrates*. 9th edition, McGraw Hill.
- Hildebrand, M and Goslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House
- Parker, T. J. and Haswell, W. (1972). *Text Book of Zoology*, Volume II: Marshall and William (Editors). 7th edition, Macmillan Press, London.
- Romer, A. S. and Parsons, T. S. (1986). *The vertebrate body*. 6th edition, Saunders College Publishing.
- Young, J. Z. (1981). *The Life of Vertebrates*. 3rd edition, Oxford University Press.

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SEMESTER – IV		
Course name	ANIMAL PHYSIOLOGY : LIFE SUSTAINING SYSTEMS	
Course code	UGZOOCC09	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 86% (Pink)	Modifications: 3% (Green)	Total Change: 89%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Learn the physiology of digestion, absorptions and hormonal control of enzyme secretion
2	Understand the histology and mechanism of respiratory system, circulation and excretion
3	Understand and analyse the adaptational Physiology.
4	Examine the histology of different tissue, ABO Blood group, red blood cells, white blood, haemoglobin and blood pressure

Core T9: ANIMAL PHYSIOLOGY : LIFE SUSTAINING SYSTEMS**4 Credit****Unit 1: Physiology of Digestion****10 class**

- Structural organization and functions of gastrointestinal tract and associated glands;
- Mechanical and chemical digestion of food;
- Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins;
- Hormonal control of secretion of enzymes in Gastrointestinal tract.

Unit 2: Physiology of Respiration**12 class**

- Histology of trachea and lung; Mechanism of respiration,
- Pulmonary ventilation; Respiratory volumes and capacities;
- Transport of oxygen and carbon dioxide in blood;
- Respiratory pigments,
- Dissociation curves and the factors influencing it;
- Carbon monoxide poisoning;
- Control of respiration

Unit 3: Renal Physiology**10 class**

- Structure of kidney and its functional unit;
- Mechanism of urine formation (including countercurrent mechanism, juxtaglomerular apparatus and vasa recta); Regulation of water balance;
- Regulation of acid-base balance

Unit 4: Blood**12 class**

- Components of blood and their functions;
- Structure and functions of haemoglobin;
- Haemostasis: Blood clotting system,
- Kallikrein-Kininogen system,
- Complement system & Fibrinolytic system,
- Haemopoiesis,
- Blood groups: Rh factor, ABO and MN

Unit 5: Physiology of Heart**12 class**

- Structure of mammalian heart;
- Coronary circulation; Structure and working of conducting myocardial fibers,
- Origin and conduction of cardiac impulses

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- Cardiac cycle;
- Cardiac output and its regulation,
- Frank-Starling Law of the heart, nervous and chemical regulation of heart rate.
- Electrocardiogram,
- Blood pressure and its regulation

Unit 5: Adaptational Physiology

- Acclimatization and Tolerance
- Thermoregulation in human

4 class

Core P 9: ANIMAL PHYSIOLOGY Lab

List of Practical

2 credit

1. Determination of ABO Blood group
2. Enumeration of red blood cells and white blood cells using haemocytometer
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of frog's heart beat under *in situ* and perfused conditions*
6. Recording of blood pressure using a sphygmomanometer
7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

*Subject to UGC Regulation

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and illustrate the physiology of digestion, absorptions and hormonal control of enzyme secretion	PO 1, 2	PSO 2	R, U
CO 2:	Demonstrate the respiratory system and its mechanism	PO 2	PSO 2	E
CO 3:	Explain the mechanisms of circulation and excretion	PO 4	PSO 5	E
CO 4:	Understand and analyse the adaptational Physiology.	PO 3, 5	PSO 2, 5	U, E
CO 5:	Compare and analyse the histology of different tissue, determine ABO Blood group, and examine red blood cells, white blood, haemoglobin and blood pressure	PO 4, 5	PSO 2, 5	An, E, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Barrett, K.E., Barman, S.M., Boitano, S. and Brooks, H.L. (2016). *Ganong's Review of Medical Physiology*. 25th edition, Indian edition, McGraw Hill Education.
- Hall, J.E. (2016). *Guyton and Hall Text book of Medical Physiology*. 13th edition, Elsevier.
- Marieb, E. (1998). *Human Anatomy and Physiology*. 4th edition, Addison-Wesley.
- Prakash, G. (2012). *Lab Manual on Blood Analysis and Medical Diagnostics*. S. Chand and Company.
- Randall, D., Burggren, W. and French, K. (2001). *Eckert Animal Physiology: Mechanisms and adaptations*. 5th edition, W. H. Freeman.
- Silverthorn, D.U. (with Johnson, B.R. and Ober, W.C.) (2010). *Human Physiology :An Integrated Approach*. 5th edition, PHI Learning Pvt Ltd.
- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*. 12th edition, John Wiley & sons.
- Vander A, Sherman J. and Luciano D. (2014). *Vander's Human Physiology: The Mechanism of Body Function*. 13th edition, McGraw Hills.

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SEMESTER – IV		
Course name	BIOCHEMISTRY OF METABOLIC PROCESSES	
Course code	UGZOCC10	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 72% (Pink)	Modifications: 20% (Green)	Total Change: 92%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remember and understand the basics mechanisms and pathway of Metabolism.
2	Remembers, understands the metabolism of carbohydrates, lipids and proteins in details.
3	Understand and evaluate about oxidative phosphorylation and redox reactions.
4	Estimate total protein and detect SGOT and SGPT or GST and GSH in serum/ tissue.
5	Understand and evaluate enzymatic activity.

Core T10: BIOCHEMISTRY OF METABOLIC PROCESSES**Unit 1: Overview of Metabolism**

4 credit
10 class

- Catabolism vs Anabolism, Stages of catabolism,
- Compartmentalization of metabolic pathways,
- Shuttle systems and membrane transporters;
- ATP as "Energy Currency of cell"; coupled reactions;
- Use of reducing equivalents and cofactors;
- Intermediary metabolism and regulatory mechanisms

Unit 2: Carbohydrate Metabolism

16 class

- Sequence of reactions and regulation of glycolysis,
- Citric acid cycle,
- Phosphate pentose pathway,
- Gluconeogenesis,
- Glycogenolysis and Glycogenesis

Unit 3: Lipid Metabolism

14

- β -oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms;
- Biosynthesis of palmitic acid;
- Ketogenesis

Unit 4: Protein Metabolism

10

- Catabolism of amino acids: Transamination, Deamination,
- Urea cycle;
- Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5: Oxidative Phosphorylation

10 class

- Redox systems;
- Review of mitochondrial respiratory chain,
- Inhibitors and un-couplers of Electron Transport System

Core P10 : BIOCHEMISTRY OF METABOLIC PROCESSES Lab

List of Practala

2 credit

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1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue
3. To study the enzymatic activity of Trypsin and Lipase.
4. Study of biological oxidation (SDH) [goat liver]
5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.
6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO₂ in the TCA cycle

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and explain the basic mechanisms and pathway of metabolism.	PO 1, 2	PSO 2	R, U
CO 2:	Demonstrate and compare the metabolism of carbohydrates, lipids and proteins in details.	PO 2, 5	PSO 2	U, E
CO 3:	Illustrate and experiment the oxidative phosphorylation and redox reactions.	PO 2, 6	PSO 2, 5	E, Ap
CO 4:	Estimate total protein and evaluate SGOT and SGPT or GST and GSH in serum/ tissue.	PO 2, 5	PSO 2, 5	E, C
CO 5:	Explain the enzymatic activity.	PO 5	PSO 2	U

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, 6th edition, W.H. Freeman and Co., New York.
- Hames, B.D. and Hooper, N.M. (2000). *Instant Notes in Biochemistry*, 2nd edition, BIOS Scientific Publishers Ltd., U.K.
- Nelson, D.L. and Cox, M.M. (2017). *Lehninger Principles of Biochemistry*, 7th Edition, W.H. Freeman and Co.
- Rodwell, V., Bender, D., Botham, K.M., Kennelly, P.J. and Weil, P.A. (2015). *Harper's Illustrated Biochemistry*, 30th edition, McGrawHill Education.
- Voet, D., Voet, J.G. and Pratt, C.W. (2016). *Fundamentals of Biochemistry : Life at the molecular level*, 5th edition, Wiley.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*, 6th edition, Cold Spring Harbor Lab. Press, Pearson Pub.
- Zubay, G.L. (1998). *Biochemistry*, 4th Edition, Wm C. Brown Publishers.

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SEMESTER – V		
Course name	MOLECULAR BIOLOGY	
Course code	UGZOCC11	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 66% (Pink)	Modifications: 27 (Green)	Total Change: 93%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Acquire knowledge about the replication, transcription, translation.
2	Understand the post transcriptional and post translational modifications, gene regulation, DNA repair mechanisms and
3	Elaborate various molecular tools and techniques like PCR, southern, northern and western blotting, recombinant DNA technology etc.
4	Learn various tools and techniques related to bacterial microbiology, some aspects of applied microbiology and diseases related to microbiology.

Core T11- MOLECULAR BIOLOGY

4 Credit

Unit 1: Nucleic Acids

3 class

- Salient features of DNA and RNA
- DNA structure: DNA double helix (Watson and Crick model)
- DNA and RNA as genetic material
- c-value paradox, Chargaff's rule

Unit 2: DNA Replication

7 class

- Mechanism of DNA replication in Prokaryotes and Eukaryotes and their differences; Semiconservative, bidirectional and discontinuous replication; RNA priming; replication of circular and linear ds-DNA; Replication of telomeres; replication slippage with reference to Huntington's disease.

Unit 3: Transcription

8 class

- RNA polymerase (I, II, III) and transcription Unit; Mechanism of Transcription in prokaryotes and eukaryotes and their differences; Transcription factors & Activators, Repressors, Motifs (only Basic helix loop helix [BHLH]; Leucine zipper - definition and example); synthesis of rRNA, tRNA and mRNA.

Unit 4: Post transcriptional Modifications and Processing of Eukaryotic RNA

5 class

- Capping and Poly A tail formation in mRNA; Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing; Processing of tRNA, Structure of globin mRNA

Unit 5: Translation

8 class

- Mechanism of protein synthesis in prokaryotes; Ribosome structure and assembly in prokaryotes, fidelity of protein synthesis, aminoacyl tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain.
- Genetic code, Degeneracy of the genetic code and Wobble Hypothesis; Inhibitors of protein synthesis; Differences between prokaryotic and eukaryotic translation.

Unit 6: Gene Regulation

6 class

- Regulation of transcription in prokaryotes: lac operon and trp operon;

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- Regulation of Transcription in eukaryotes: Activators, repressors, enhancers, silencer elements, miRNA mediated gene silencing, Genetic imprinting.
- Epigenetic regulation of gene expression: DNA methylation (CpG) and histone acetylation.

Unit 7: DNA Repair Mechanisms**3 class**

- Types of DNA repair mechanisms; RecBCD model in prokaryotes, nucleotide and base excision repair, SOS repair, Pyrimidine dimerization and mismatch repair.

Unit 8: Molecular Techniques**10 class**

i) Genome analysis:

- DNA sequencing: Principle of Dideoxy sequencing
- Restriction enzyme: Types and use in gene cloning
- Cloning vectors: Characteristic features, Plasmid vector (pBR322, pUC19), Cosmid, phage vector, Concept of expression and Shuttle vector
- Construction of genomic DNA and cDNA libraries
- PCR: Basic Principle; Use of Allele specific RT-PCR
- DNA fingerprinting: Principle of RFLP, mini-satellites, microsatellites, RAPD and its uses
- Blot Technique: Southern Blot and Northern Blot (principle and applications)

ii) Proteome Analysis:

- Principle and use of SDS PAGE
- Western blot (Principle and applications)

iii) Genetically Modified Organisms: Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection; Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice etc.

Unit 9: Regulatory RNAs**2 class**

- Ribo-switches, RNA interference, miRNA, siRNA

Unit 10: Diagnostic Microbiology and Bacteria Culture**3 class**

- Koch's postulates; Sensitivity and specificity of test results.
- Growth requirements and growth factors; Oxygen requirement
- Culture Media: Simple media, Complex media, Selective media and Enriched media.

Unit 11: Microbial Diseases**3 class**

- Virulent factors and toxins.
- Bacterial pathogenesis: Name of pathogen, symptoms, pathogenesis, mode of action & preventive measures of the diseases: Bacterial (Typhoid, Staphylococcal food poisoning), Viral (Polio, AIDS, Avian influenza).

Unit: 12 Applied Microbiology**2 class**

- Useful microbial products: Antibiotics, amino acids, biopesticides, Biodegradation.
- Industrial microbiology- Milk and alcohol.

Core P11 - MOLECULAR BIOLOGY Lab**2 Credit****List of Practical**

- Study of Polytene chromosomes from Chironomus / Drosophila larvae
- Preparation of liquid culture medium (LB) and raise culture of E. coli
- Estimation of the growth kinetics of E. coli by turbidity method
- Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking
- Demonstration of antibiotic sensitivity/resistance of E. coli to antibiotic pressure and interpretation of results
- Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter
- (Diphenylamine reagent) or spectrophotometer (A260 measurement)
- Agarose gel electrophoresis for DNA
- Quantitative estimation of RNA using Orcinol reaction
- Study and interpretation of electron micrographs/ photograph showing
 - DNA replication
 - Transcription
 - Split genes

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs	PSOs	Cognitive
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		Addressed	Addressed	Level
CO 1:	Define and illustrate the replication, transcription, translation.	PO 1, 2	PSO 2	R,U
CO 2:	Demonstrate the post transcriptional and post translational modifications, gene regulation, DNA repair mechanisms and	PO 2	PSO 2	U
CO 3:	Demonstrate and apply various molecular tools and techniques like PCR, southern, northern and western blotting, recombinant DNA technology etc.	PO 2, 4	PSO 2, 5	U, Ap
CO 4:	Elaborate various tools and techniques related to bacterial microbiology and apply some aspects of applied microbiology and diseases related to microbiology.	PO 4, 5	PSO 2, 5	Ap, C
CO 5:	Prepare bacterial culture and examine bacterial growth.	PO 4, 6	PSO 2, 5	An, C
CO 6:	Estimate of DNA and RNA	PO 4	PSO 2, 5	E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Brooker, R.J. (2012). Genetics : Analysis and Principles. 4th edition. , McGraw Hill Education.
- Brown, T. (2012). Introduction to Genetics : A molecular Approach. Garland Science.
- Brown, T.A. (2007). Genomes 3. Garland Science.
- Russell, P.J. (2010). iGenetics : A Molecular Approach. 3rd edition, Pearson Benjamin Cummings.
- Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics. 5th edition, International Student Version, John Wiley and Sons, Inc.
- Cox, M.M., Doudna, J.A and O'Donnell, M. (2012). Molecular Biology : Principles and Practice. 1st edition, Macmillan Higher Education, W.H. Freeman and Company, New York.
- Godbey, W.T. (2014). An Introduction to Biotechnology :TheScience, TechnologyandMedicalApplication. Elsevier.
- Krebs, J.E., Goldstein, E.S. and Kilpatrick, S.T. (2014). Lewin's Genes XI. Jones and Bartlett Learning.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A. and Scott, M.P. (2013). Molecular Cell Biology. 7th edition, W.H. Freeman and Company, New York.
- Nelson, D.L. and Cox, M.M. (2013). Lehninger Principles of Biochemistry. 6th edition, International edition, Macmillan Higher Education, W.H. Freeman and Company, New York.
- Russell, P.J. (2010). iGenetics : A Molecular Approach. 3rd edition, Pearson International Edition, Pearson Benjamin Cummings.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene. 6th edition, Pearson International Edition, Pearson Benjamin Cummings.

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SEMESTER – V		
Course name	PRINCIPLES OF GENETICS	
Course code	UGZOCC12	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 60% (Pink)	Modifications: 10% (Green)	Total Change: 70%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Learn the fundamental genetics like Mendelian and Non Mendelian inheritances, linkages, mutations.
2	Understand the sex determination of various animals, extrachromosomal inheritances, transposable genetic elements etc.
3	Understand various aspects of human genetics by covering chromosomal aberrations, gene mutation, etc..
4	Understand the various aspects of biostatistics such as central tendency, t-test, chi-square, ANOVA, correlations and regression.
5	Inspect the Mendelian laws and gene interactions, draw linkage maps and examine chromosomes.

Core T12 – PRINCIPLES OF GENETICS

4 Credit

Unit 1: Mendelian Genetics and its Extension

10 class

- Principles of inheritance, Principles of segregation and independent assortment and their chromosomal basis, Test cross, Application of laws of probability to Mendelian inheritance.
- Cis-trans test for allelism; Incomplete dominance and co-dominance; Epistasis; Multiple alleles; Isoallele: White eye locus in *Drosophila*; Complex locus: Lozenge locus in *Drosophila*; Lethal alleles, Pleiotropy, Penetrance and expressivity.
- Phenocopy, Sex-linked, sex- influenced and sex-limited inheritance; Polygenic inheritance with suitable examples; simple numericals.

Unit 2: Linkage, Crossing Over and Chromosomal mapping

10 class

- Linkage and Crossing Over, Complete and Incomplete linkage.
- Experiments by Bridges, molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity ; two factor and three factor crosses, Interference and coincidence.
- Somatic cell hybridization.
- Cytogenetic evidence of crossing over in *Drosophila* by Stern's experiment.

Unit 3: Mutations

7 class

- Types of gene mutations (Classification): transition, transversion, frameshift, nonsense, missense, silent, hypomorphic, null, lethal, forward, backward, suppressor, enhancer.
- Chromosomal aberrations in number and structure (classification with one suitable example of each); Nondisjunction.
- Molecular basis of mutations in relation to UV light and chemical mutagens (ionizing radiation, 5-BU, EMS.), Detection of mutations: CLB method, attached X method .

Unit 4: Sex Determination

8 class

- Sex chromosome systems: XX/XO, XX/XY, ZZ/ZW and haploidy/diploidy types.

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- Sex determination in *Drosophila*.
- Sex determination in human.
- Dosage compensation in :
 - a. *Drosophila*: Hyper activation of σX by *msl*, *mle* and *roX*RNA followed by histone *Ac16* Acetylation.
 - b. Human: Inactivation of σX by *XIST* RNA followed by DNA methylation
- Environmental sex determination in turtle, crocodile and limpet.

Unit 5: Human Genetics

5 class

- Karyotype, banding, nomenclature of chromosome subdivisions.
- Genetic disorders :
 - Chromosomal aneuploidy (Down, Turner and Klinefelter syndromes)
 - Chromosome translocation (chronic myeloid leukemia) and deletion (cat cry syndrome)
 - Gene mutation (cystic fibrosis).
 - Prader-Willi and Angelman syndrome.
 - Multifactorial (Diabetes mellitus).

Unit 6: Extra-chromosomal Inheritance

4 class

- Criteria for extra chromosomal inheritance,
- Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces*, Infective heredity in *Paramecium* and Maternal effects, Kappa particle in *Paramecium*, Shell spiralling in snail
- Mitochondrial inheritance and diseases (only brief)
- Cp-DNA and its mutation in leaf variegation.

Unit 7: Recombination in Bacteria and Viruses

5 class

- Conjugation, Transformation, Transduction, Complementation test in Bacteriophage.

Unit 8: Transposable Genetic Elements

5 class

- Transposons (DNA and Retro-transposons).
- Ac-Ds elements in maize
- P and copia elements in *Drosophila*,
- Transposons in humans: LINE, SINE, Alu

Unit 9 : Biostatistics

6 class

- 1. Importance of Statistics in Biology.
- 2. Graphical representation of data - Bar chart, Histograms, Scatter plots, Pie charts; Frequency polygon.
- 3. Grouped, ungrouped, Discrete and Continuous variables – examples.
- 4. Mean, Mode and Median.
- 5. Standard deviation, Variance and Standard error.
- 6. Simple Correlations and Regression analysis.
- 7. Analysis of Variance (one way).
- 8. Chi-square test.
- 9. Student's t-test (paired and unpaired).

Core P12 – GENETICS Lab

2 credit

List of Practical

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.
7. Identification of various stages of mitosis from permanent slides (onion root tip).
8. Study / preparation of various stages of meiosis from Grasshopper.

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Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and explain fundamental genetics like Mendelian and Non Mendelian inheritances, linkages, mutations.	PO 1, 2	PSO 2, 5	R, U
CO 2:	Demonstrate sex determination of various animals, extrachromosomal inheritances, transposable genetic elements etc.	PO 2	PSO 2	Ap
CO 3:	Illustrate and compare various aspects of human genetics by covering chromosomal aberrations, gene mutation, etc..	PO 2,4	PSO 2, 5	U, An
CO 4:	Apply and evaluate various aspects of biostatistics such as central tendency, t-test, chi-square, ANOVA, correlations and regression.	PO 5,6	PSO 4, 5	Ap, E
CO 5:	Test the Mendelian laws and gene interactions, draw linkage maps and examine chromosomes.	PO 4, 6	PSO 5	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Brooker, R.J. (2012). *Genetics : Analysis and Principles*. 4th edition. , McGraw Hill Education.
- Brown, T. (2012). *Introduction to Genetics : A molecular Approach*. Garland Science.
- Brown, T.A. (2007). *Genomes 3*. Garland Science.
- Gilbert, S.F. (2014). *Developmental Biology*. 10th edition, Sinauer Associates.
- Hartl, D.L. and Ruvoilo, M. (2012). *Genetics : Analysis of Genes and Genomes*. 8th edition, Jones and Bartlett.
- Klug, W.S., Cummings, M.R., Spencer, C.A. and Palladino, M.A. (2012). *Concepts of Genetics*. 10th edition, International edition, Pearson Benjamin Cummings.
- Russell, P.J. (2010). *iGenetics : A Molecular Approach*. 3rd edition, Pearson Benjamin Cummings.
- Snustad, D.P. and Simmons, M.J. (2010). *Principles of Genetics*. 5th edition, International Student Version, John Wiley and Sons, Inc.
- Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). *Molecular Biology of the Gene*. 6th edition, Pearson International Edition, Pearson Benjamin Cummings.
- Antonisamy, B., Christopher, S. and Samuel, P.P. (2010). *Biostatistics : Principles and Practice*. Tata McGraw Hill Education.
- Banerjee, P.K. (2011). *Introduction to Biostatistics*. S. Chand Publishing
- Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics*. Duxberry Press.
- Zar, J.H. (2010). *Biostatistical Analysis*. 5th edition, Pearson Education.

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SEMESTER – VI	
Course name	DEVELOPMENTAL BIOLOGY
Course code	UGZOOCC13
Number of lectures	105
Credits	6
Marks	100
New addition: 69% (Pink) Modifications: 9% (Green) Total Change: 78%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Understand the historical perspective and basic concepts of developmental biology
2	Learn the different aspects of early, late and post embryonic developments.
3	Acquire knowledge about implications of developmental biology in various fields, such as in teratogenesis, stem cell biology, in vitro fertilization, cryopreservation, cord blood transfusion etc.
4	Inspect the developmental stages, different sections of placenta.

Core T13 –DEVELOPMENTAL BIOLOGY

4 credit

Unit 1: Introduction

3 class

- Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division.

Unit 2 : Early Embryonic Development

22 class

- Gametogenesis: Spermatogenesis & Oogenesis.
- Ultra structure of sperm and ovum in sea urchin and mammals.
- Types of eggs and egg membranes
- Fertilization in Sea urchin (external) and mammals (internal).
- Cleavage: Cleavage plane, types, role of yolk in cleavage; cleavage process in *C. elegans*, and frog (*Xenopus*) and chick ; Types of Blastula.
- Fate maps (including techniques)
- Morphogenetic movements: Types and examples.
- Gastrulation: Process in *C. elegans*, frog (*Xenopus*) and chick.
- Embryonic induction and organizers (with Speman-Mangold experiment).

Unit 2 : Late Embryonic Development

15 class

- Fate of germ layers
- Formation and function of Extra-embryonic membranes in birds (chick).
- Implantation of embryo in human
- Placenta: Structure (Rabbit), types, examples and functions.

Unit 3 : Post Embryonic Development

10 class

- Metamorphosis: Changes, hormonal regulations in amphibians and insects;
- Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each);
- Ageing: Concepts and Theories
- Development of eye in chick.

Unit 4 : Implications of Developmental Biology

10 class

- Teratogenesis: Teratogenic agents and their effects on embryonic development;

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- Embryonic Stem Cells (ESC) and Adult Stem Cells (ASC)
- Cryopreservation of gametes and embryo.
- In vitro fertilization,
- Amniocentesis
- Umbilical Cord Blood: present importance and future prospects.

Core P13 : DEVELOPMENTAL BIOLOGY Lab

2 credit

List of Practical

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages).
2. Study of whole mounts of developmental stages of chick through permanent slides: 24, 48, 72, and 96 hours of incubation.
3. Study of the developmental stages and life cycle of butterfly from stock culture.
4. Study of eggs and tadpoles of frog from collected or preserved material.
5. Study of different sections of placenta (photomicrograph/ slides).
6. Study of the developmental stages and life cycle of *Drosophila* from stock culture.
7. Project report on *Drosophila* culture/chick embryo development.
8. Egg.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the historical perspective and basic concepts of developmental biology	PO 1, 2	PSO 2	R, U
CO 2:	Explain and compare the different aspects of early, late and post embryonic developments.	PO 2, 5	PSO 2	An, E
CO 3:	Apply and adapt the knowledge of developmental biology in various fields, such as in teratogenesis, stem cell biology, in vitro fertilization, cryopreservation, cord blood transfusion etc.	PO 4, 5	PSO 2, 5	Ap, C
CO 4:	Inspect the developmental stages, different sections of placenta, .	PO 5	PSO 2	An
CO 5:	Compose study report on <i>Drosophila</i> culture and chick embryonic development	PO 4, 6	PSO 5	C

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Reference Books

- Balinsky, B.I. (1981). *An Introduction to Embriology*. 5th edition, Thomson Learning.
- Carlson, R. F. Patten's Foundations of Embryology
- Gilbert, S.F. (2014). *Developmental Biology*. 10th edition, Sinauer Associates.
- Slack, J.M.W. (2012). *Essential Developmental Biology*. 3rd edition, Wiley-Blackwell.
- Wolpert, L. and Tickle, C. (2011). *Principles of Development*. 4th edition, Oxford University Press.

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SEMESTER – VI		
Course name	EVOLUTIONARY BIOLOGY	
Course code	UGZOOCC14	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 52% (Pink)	Modifications: 32% (Green)	Total Change: 84%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Learn various evolutionary concepts and historical perspective about evolution.
2	Understand the importance and implication of the evidences of evolution.
3	Understand the population genetics and evaluate the evolutionary forces and its impact.
4	Understand the origin and evolution of man and draw phylogenetic trees

Core T14 – EVOLUTIONARY BIOLOGY

4 Credit

Unit 1: Introduction

2 class

- Life's Beginnings: Chemogeny, RNA world, Biogeny
- Evolution of eukaryotes

Unit 2 : Theories of Evolution

4 class

- Historical review of Evolutionary concepts: Lamarckism, Darwinism and Neo Darwinism

Unit 3: Evidences of Evolution

10 class

- Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse,
- Molecular universality of genetic code and protein synthesising machinery, three domains of life, neutral theory of molecular evolution, molecular clock, example of globin gene family, rRNA/cyt c
- Punctuationism and gradualism mode of evolutionary changes
- Adaptationism versus Pleuralism

Unit 4: Variations

4 class

- Sources of variations: Heritable variations and their role in evolution

Unit 5: Population Genetics and Evolutionary Forces

18 class

- Population genetics: Hardy-Weinberg Law (statement and derivation of equation, application of law to biallelic population); Evolutionary forces upsetting H-W equilibrium
- Natural selection: concept of fitness, selection coefficient, derivation of one unit of selection for a dominant allele, genetic load, mechanism of working, types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection.
- Genetic Drift : mechanism, Founder's effect and bottleneck phenomenon
- Role of Migration and Mutation in changing allele frequencies.

Unit 6: Product of evolution

10 class

- Micro evolutionary changes (inter-population variations, clines, races)
- Species concept (Biological species concept, subspecies, Polytypic species, Sibling species and Ring species), Isolating mechanisms, modes of speciation—allopatric, sympatric,
- Adaptive radiation / macroevolution (exemplified by Galapagos finches)

Unit 7: Extinctions

2 class

- Extinctions, Back ground and mass extinctions (causes and effects), detailed example of K-T extinction.

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Unit 8: Human Evolution**6 class**

- Origin and evolution of man; Unique hominin characteristics contrasted with primate
- Characteristics; primate phylogeny from *Dryopithecus* leading to *Homo sapiens*;
- Molecular analysis of human origin.

Unit 9: Phylogenetic trees**4 class**

- Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees.

Core P14 – EVOLUTIONARY BIOLOGY Lab**2 Credit****List of Practical**

1. Study of fossils from models/pictures.
2. Study of homology and analogy from suitable specimens.
3. Study and verification of Hardy-Weinberg Law by chi square analysis.
4. Study of evolution of ecosystem from models/pictures.
1. 5.Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies
5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Learn various evolutionary concepts and historical perspective about evolution.	PO 1	PSO 2,	R
CO 2:	Demonstrate the importance and implication of the evidences of evolution.	PO 2, 3	PSO 2, 3	Ap
CO 3:	Explain the population genetics and evaluate the evolutionary forces and its impact.	PO 2, 5	PSO 2, 3	U
CO 4:	Illustrate the origin and evolution of man and draw phylogenetic trees	PO 2, 6	PSO 2, 4	An, C
CO 5:	Recall various evolutionary concepts and historical perspective about evolution.	PO 1, 2	PSO 2, 3, 6	E, Ap
CO 6:	Summerise the importance and implication of the evidences of evolution.	PO 2, 6	PSO 6	Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Campbell, N.A. and Reece J.B. (2011). *Biology*. 9th edition. Pearson Benjamin Cummings.
- Futuyma, D.J. (2013). *Evolution*. 3rd edition, Sinauer Associates.
- Hall, B.K. and Hallgrímsson, B. (2008). *Strickberger's Evolution*. 4th edition, Jones and Bartlett Publishers.
- Herron, J.C. and Freeman, S. (2013). *Evolutionary Analysis*. 5th edition, Pearson.
- Ridley, M. (2004). *Evolution*. 3rd edition, Blackwell Publishing.
- Russell, P.J. (2010). *iGenetics : A Molecular Approach*. 3rd edition, Pearson Benjamin Cummings.
- Ghosh, Z. and Mallick, B. (2008). *Bioinformatics : Principles and Applications*. Oxford University Press.
- Pevsner, J. (2009). *Bioinformatics and Functional Genomics*. 2nd edition, Wiley Blackwell.
- Zvelebil, M. and Baum, J.O. (2007). *Understanding Bioinformatics*. Garland Science.

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DISCIPLINE SPECIFIC ELECTIVES (DSE)

SEMESTER – V		
Course name	IMMUNOLOGY	
Course code	UGZOODSE01	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 60% (Pink)	Modifications: 27% (Green)	Total Change: 87%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the structures and function of immune cells, immunoglobulins, antigens and their interactions with antibodies.
2	Understand the MHC molecules, cytokines, hyper sensitivity reactions and cellular mode of immunity development.
3	Understand the immune diffusion technique and ELISA
4	Understand the histology of spleen, thymus and lymph nodes and analyse the bloodcells, blood groups and immune reactions

SEM V : DSE 1 - IMMUNOLOGY**DSE1 T : IMMUNOLOGY****4 credit****Unit 1: Overview and Basics****8 Class**

- Historical perspective of Immunology.
- Evolution of immune system.
- Cells and organs of immune system.
- Primary and secondary lymphoid organs.
- Innate and adaptive immune system : Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity; Adaptive immunity (Cell mediated and humoral); Passive : Artificial and natural immunity; Active : Artificial and natural immunity; Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid arthritis and tolerance, AIDS).
- Immunity of invertebrates.

Unit 2: Antigens**3 class**

- Antigens, Immunogens, Antigenicity, Antigen processing and presentation; haptens, adjuvants, epitopes.

Unit 3: Immunoglobulins**14 class**

- Basic structure of immunoglobulins, classes and functions.
- Antigen – antibody interactions
- Immunoassays (ELISA and RIA), Polyclonal sera.
- Isotype, idiotype and allotype of antibodies.
- VDJ recombination and allied process for generating antibody diversity (brief idea).
- Hybridoma technology - use in monoclonal antibody production.

Unit 4: Major Histocompatibility Complex**5 class**

- Structure and function of MHC molecules with special reference to class I and class II.
- Endogenous and exogenous pathways of antigen processing and presentation.

Unit 5: Complement System, Cytokines and Hypersensitivity**15 class**

- Soluble mediators and effectors of immune response.

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- Complement systems – classical, alternative and lectin pathway; process of complement mediated damage evasion; complement system diseases.
- Sources, targets and functions of Cytokines with reference to IL1 to IL14; Interferon α, β, γ ; TNF α and TGF β ; Therapeutics cytokines.
- Hypersensitivity –types, classification, mode of damage, opsonization.

Unit 6: Cellular immune response

15 class

- B cells : differentiations, activation, proliferation and response; structure of B cell receptors.
- T cells: types and functions; differentiation, activation, proliferation and response; Structure and function of T cell receptor complex.
- T cell – B cell interactions.
- Various types of vaccines.
- Autoimmune diseases.

DSE1 P: IMMUNOLOGY Lab

2 credit

List of Practical

1. Histological study of spleen, thymus and lymph nodes from slide/photograph.
2. Staining and study of mammalian blood film for immunocompetent cell.
3. Demonstration of Antigen – antibody reaction by immunodiffusion and sheep RBC – WBC reaction.
4. ABO blood group determination.
5. Demonstration of ELISA.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the structures and function of immune cells, immunoglobulins, antigens and their interactions with antibodies.	PO 2	PSO 2	R,U
CO 2:	Demonstrate and explain the MHC molecules, cytokines, hyper sensitivity reactions and cellular mode of immunity development.	PO 2	PSO 2	U, E
CO 3:	Compare and elaborate the cellular immune response	PO 2, 5, 6	PSO 2, 5	An, C
CO 4:	Understand and identify the histology of spleen, thymus and lymph nodes and analyse the bloodcells, blood groups and immune reactions	PO 2, 4	PSO 2, 5	U, Ap, An
CO 5:	Demonstrate and apply immune diffusion technique and ELISA	PO 2, 3	PSO 2, 5	U, Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Abbas, A.K., Lichtman, A.H. and Pillai, S. (2017). *Cellular and Molecular Biology*. 9th edition, Elsevier.
- David, M., Jonathan, B., David, R.B. and Ivan, R. (2012). *Immunology*. 8th edition, Elsevier
- Kindt, T.J., Goldsby, R.A. and Osborne, B.A. (2007). *Kuby Immunology*. 6th edition, W.H. Freeman and company.
- Kuby, J. (1992). *Immunology*. 3rd edition, W.H. Freeman and Company.
- Owen, J.A., Punt, J., Stranford, S.A. and Jones, P.P. (2009). *Kuby Immunology*. 7th edition, Macmillan Higher Education.

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SEMESTER – V	
Course name	Animal Behavior and Chronobiology
Course code	UGZOODSE02
Number of lectures	105
Credits	6
Marks	100
New addition: 50% (Pink) Modifications: 38% (Green) Total Change: 88%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the details about patterns of behaviours, survival strategies, social and cooperative behaviours.
2	Understand the design of signals and its application in ecology and evolution
3	Understand and evaluate the chronobiology
4	Understand nesting habits of animals, analyse the ethogram and prepare a short report on behavioural activities of animals

SEM V: DSE-2A - ANIMAL BEHAVIOR AND CHRONOBIOLOGY**DSE 2 T – ANIMAL BEHAVIOUR AND CHRONOBIOLOGY****Unit 1: Introduction to Animal Behaviour****4 credit****4 Class**

- Origin and history of Ethology
- Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen
- Tinbergen's 4 questions of animal behavior (Proximate and Ultimate Causes)

Unit 2: Patterns of Behaviour**6 Class**

- Stereotyped Behaviours (Orientation, Reflexes); Individual behavioural patterns
- FAP and Code breaking
- Instinct versus Learned Behaviour; Associative learning
- Classical and operant conditioning
- Habituation, Imprinting.

Unit 3: Social and Sexual Behaviour**14 Class**

- Social Behaviour: Concept of Society; Altruism; Kin Selection and Hamilton's Rule, Social Organization in lion, langur, naked mole rat, honey bee, termite and army ants. Roosting, Lek and choruses behavior
- Sexual Behaviour: Asymmetry of sex; Sexual dimorphism; Mate choice and mating system (polyandry and polygyny), Intrasexual selection and conflict (male rivalry); Intersexual selection and conflict (female choice); Handicap Hypothesis; Sexual conflict in parental care,

Unit 4: Animal Survival Strategies**10 Class**

- Optimal Model Behaviour.
- Predator versus prey: Evolutionary Arm's race
- Living in groups (advantages and disadvantages)
- Mutualism, Reciprocity (Spawning in black helmet fish, Regurgitation in vampire bat and Alliances in primates)
- Prisoner's Dilemma, Selfish genes
- Optimality model and ESS, Group Selection
- Pseudopregnancies, Use of Mating plug strategy
- Multiple mating

Unit 5: Cooperation and Helping in Birds, Mammals and Fishes**8 Class**

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- Genetic predisposition and ecological constraints
- Helping in birds (Florida Scrub Jays, bee eater, pied kingfisher)
- Helping in mammals (Belding's ground squirrel, lion)
- Helping in fishes: (Anemone fish)

Unit 6: Design of Signals: Ecology and Evolution

10 Class

- Ecological constraints and communication
- Communication in ants, birds and primate calls, pheromones
- Signals modified during evolution (ritualization- manipulation, honesty)
- Honest signaling: Thomson's gazelles
- Manipulative signaling: mantis, shrimps
- Biological Colouration, Mimicry,

Unit 7: Chronobiology

8 Class

- Types and characteristics of biological rhythms: Short- and Long term rhythms
- Circadian rhythms; circatidal rhythms, circalunar rhythms and circannual rhythms.
- Concept of synchronization and masking.
- Photic and non-photic zeitgebers; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

DSE 2 P – ANIMAL BEHAVIOUR AND CHRONOBIOLOGY Lab

2 credit

List of Practical

1. To study nests and nesting habits of the birds and social insects, roosting behavior.
2. Preparation of ethogram from local animal watching, Ad-libitum study of animals.
3. Rearing of butterflies to document the life cycle of the species.
4. To study the geotaxis behavior in earthworm.
5. Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study behavioural activities of animals and prepare a short report.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the details about patterns of behaviours, survival strategies, social and identify the cooperative behaviours.	PO 1, 2, 3	PSO 1, 3	R, U, Ap
CO 2:	Explain the design of signals and analyse its application in ecology and evolution	PO 2, 3, 5	PSO 1, 3	U, An
CO 3:	Illustrate and evaluate the chronobiology	PO 3, 5	PSO 1, 3	U, E
CO 4:	Compare nesting habits of animals, analyse the ethogram and prepare a short report on behavioural activities of animals	PO 5, 6	PSO 1, 5	An, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books :

- Alcock, J. (2013). *Animal Behavior : An Evolutionary Approach*, 10th edition, Sinauer Associates Inc.
- Davies, N.B., Krebs, J.R. and West, S.A. (2012). *An Introduction to Behavioural Ecology*. 4th edition, Wiley-Blackwell.
- Drickamer, L.C., Vessey, S.H. and Jacob, E.M. (2002). *Animal Behaviour: Mechanisms, Ecology and Evolution*. 5th edition, McGraw Hill.
- Dugatkin, L.A. (2014). *Principles of Animal Behaviour*. 3rd edition, W.W. Norton and Company.
- Dunlap, J.C., Loros, J.J. and Patricia, J. DeCoursey (editors). (2004). *Chronobiology Biological Timekeeping*. Sinauer Associates, Inc. Publishers.
- Kumar, V. (2002). *Biological Rhythms*. Springer.

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- Manning, A. and Dawkins, M.S. (2016). *An Introduction to Animal Behaviour*. 6th edition, Cambridge University Press.
- Saunders, D.S., editors : Steel, C.G.H., Vafopoulou, X. and Lewis, R.D. (2002). *Insect Clocks*. 3rd edition, Elsevier Science.
- Sherman, P.W. and Alcock, J. (Editors) (2013). *Exploring Animal Behaviour : Readings from American Scientist*. 6th edition, Sinauer Associate Inc.

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SEMESTER – V		
Course name	POLLINATION BIOLOGY	
Course code	UGZOODSE03	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 100% (Pink)	Modifications: 0% (Green)	Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands and apply the knowledge about flowering of plants in natural environment and its relation with pollination, and above all ecological impact.
2	Understand and evaluate know about the basic principle and modes of pollination, types and identification of flower visitors, pollinator diseases, colour vision capabilities of insect pollinators.
3	Understand and evaluate the Importance of Pollination and threats to Pollinators and conservation of pollinators
4	Understand and analyse Gymnosperms & Angiosperms pollination systems
5	Dissect, identify and draw the flowering plants and mouthparts of the pollinating insects

DSE 3 T: POLLINATION BIOLOGY

4 credit

Basic principle of Pollination or Pollination in general

- Introduction with examples

History of Pollination

- Fossil evidence, First evidence of Man's involvement in Pollination, Indian scenario
- **Necessity / Significance / Importance of Pollination** – Asexual / Vegetative Reproduction vs. Sexual Reproduction – transformation from Mitosis to Meiosis – importance of Meiosis – Haploid to Diploid cycle with Recombination DNA.

Evolution of Pollination

- Transition from Gymnosperm to Angiosperm

Pollinating Agents (P A) in brief –

- Pollinating agents (Wind, air, insects & Other animals) Insect pollinators (Morphology of a typical insects, classification, distinguishing characters, specialized structures for carrying pollen)

Pollination in Gymnosperms –

- Characteristics and modalities – mostly air pollinated but Entomophily also.

Pollination in Angiosperms –

- Characteristics, Unisexual / Bi-sexual Flowers – their adaptations.

Pollination Types – Self Pollination

- **Autogamy and Geitonogamy** – What it is - Characteristics of Self Pollinated flowers, with examples – Merits and De-merits of Self pollination

Cross Pollination (Xenogamy) –

- What it is – Characteristics of Cross Pollinated flowers, with examples – Merits and De-merits of Cross Pollination.

Co-evolution of Angiosperms and Entomofauna –

- History and Diversity.

Plant Pollinator Specificity - Case Studies –

- Pollination in *Rafflesia*, Pollination in *Ophrys*, Pollination in *Ficus* (Fig).

Pollinator threats & Conservation:

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- Pollinator diseases, Habitat Loss & Others

The Plants & Flowers

- Gymnosperm & Angiosperm, Functional floral morphology and phenology, Pollen morphology and NPC classification, Flower and floral parts, *Plant Reproduction*. Reproductive strategies and innovations. Mechanisms of pollen dispersal. Major plant lineages and the origin of the Angiosperms. *Floral Evolution*. The evolution of the flower and floral diversity. Floral Advertisement: Visual, Odorant. *Nectar, Pollen, and other floral rewards*.
- Dispersal of fruit and seed, Application of palynology: Melissopalynology & Aeropalynology.

DSE 3 P – POLLINATION BIOLOGY Lab

2 credit

- Dissection, identification and drawing of reproductive organs of the flowering plants (Entomophilous, Ornithophilous etc.)
- Dissection, identification and drawing of mouthparts of the pollinating insects (Coleoptera, Lepidoptera, Diptera, Hymenoptera & Hemiptera).
- Basic Study of pollen morphology (Shape, type of aperture, polar outline, surface pattern etc.)
- Review work on the pollination biology

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and apply the knowledge about flowering of plants in natural environment and its relation with pollination, and above all ecological impact.	PO 1, 2, 3	PSO 1, 3	R, U, Ap
CO 2:	Illustrate and evaluate the basic principle and modes of pollination, types and identification of flower visitors, pollinator diseases, colour vision capabilities of insect pollinators.	PO 3	PSO 1,3, 5	U, E
CO 3:	Explain and analyse the importance of pollination and threats to pollinators and conservation of pollinators	PO 5, 6	PSO 1, 3, 4	U, An
CO 4:	Demonstrate and analyse Gymnosperms & Angiosperms pollination systems	PO 3	PSO 5	U, An
CO 5:	Evaluate and prepare report on the relationship between the flowering plants and mouthparts of the pollinating insects	PO 3, 6	PSO 1, 5	E, C

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SEMESTER – V		
Course name	PROJECT WORK (BIOINFORMATICS AND MOLECULAR BIOLOGY)	
Course code	UGZOODSE04	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 100% (Pink)	Modifications: 0% (Green)	Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remember and understand the basic concepts in bioinformatics and molecular biology.
2	Apply various bioinformatics tools to analyse various biological data.
3	Identify research questions and design insilico experiments.
4	Solve research problems.

DSE 4 T – PROJECT WORK (BIOINFORMATICS AND MOLECULAR BIOLOGY) 4 credit

Design and perform in silico experiments include but are not limited to the following topics

1. Cloning and restriction studies, PCR and Primer Design
2. Structure Prediction or Modeling of Proteins, Structural analysis
3. Comparative Genomics, Genome analysis and annotation
4. Nucleotide sequence and analysis, SNP Analysis, Gene Silencing
5. Aligning Pairs of Sequences, Phylogenetic analysis, Measure Evolutionary Distance
6. Protein Sequence Analysis
7. Data mining for microarrays, RNA Analysis, Gene Ontology Enrichment in Microarray Data
8. Docking and Drug Design, Drug Target Identification
9. Identifying Biomolecular Subgroups Using Attractor Metagenes
10. Predicting Protein Secondary Structure Using a Neural Network
11. Exploring Genome-wide Differences in DNA Methylation Profiles
12. Identifying Differentially Expressed Genes from RNA-Seq Data
13. Exploring Protein-DNA Binding Sites
14. Next-Generation Sequencing data analysis, Working with Illumina Solexa Next-Generation Sequencing Data
15. Performing a Metagenomic Analysis
16. Working with Whole Genome Data, Comparing Whole Genomes
17. Analysis of a Protein Family
18. Analyzing Synonymous and Nonsynonymous Substitution Rates
19. Investigating the virus strains: Reconstructing the Origin and the Diffusion
20. Predicting and Visualizing the Secondary Structure of RNA Sequences

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21. Analyzing Gene Expression Data, Gene Expression Profile Analysis

DSE 4 P –BIOINFORMATICS AND MOLECULAR BIOLOGY Lab **2 credit**

1. Review work on the bioinformatics and molecular biology

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the basic concepts in bioinformatics and molecular biology.	PO 1, 2	PSO 2	R, U
CO 2:	Apply various bioinformatics tools, analyse and interpret various biological data.	PO 2, 4	PSO 2	Ap, An
CO 3:	Identify research questions and design insilico experiments	PO 4, 5	PSO 2,4	Ap, C
CO 4:	Perform and solve the research problems.	PO 5, 6	PSO 2, 5	Ap, C
CO 5:	Discuss the results and prepare scientific reports.	PO 6	PSO 2, 5	E, Ap

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books:

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SEMESTER – VI	
Course name	BIODIVERSITY AND WILD LIFE CONSERVATION
Course code	UGZOODSE05
Number of lectures	105
Credits	6
Marks	100
New addition: 100% (Pink) Modifications: 0% (Green) Total Change: 100%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the various issues related to biodiversity loss and conservation as well as status, conditions and conservation of forests and wildlife.
2	Understand and apply the various tools used in field biology
3	Compare and evaluate the pitfall/ trail / transect monitoring for abundance and diversity estimation.
4	Prepare on complete report on excursion or field visit.

DSE 5 T: Biodiversity and Wild life Conservation**4 credit**

- Types of biodiversity, biodiversity and human welfare, mega diversity zones and biodiversity hot spots with special reference to India, problems and scales of biodiversity extinctions in time and space. **8 class**
- Diversity in bio-geographical regions of earth, fresh water and marine zones. **4 class**
- Biodiversity indicators : Surrogate species. **1 class**
- Concept of wildlife, values of wildlife, conservation ethics, importance of conservation, wildlife heritage of India, reasons for wildlife depletion in Indian context, Wild life strength, WPA (1972). **5 class**
- Protected area concept – Sanctuary, National Park, Biosphere reserve, Core Zone, Buffer Zone, Corridor concept, Extended corridor, Conflicted Zones, Conservation reserves. Animals on the basis of smallest, largest, types, distribution. **4 class**
- Habitat, Distribution, Habits, Status, Threats and Conservation strategies (King cobra, White rumped vulture, Great Indian bustard, Sanghai deer, Nilgiri Tahr, Musk deer, Red panda, Snow leopard, Lion tailed macaca, Hollock gibbon). **5 class**
- Concept of threatened fauna – IUCN categories, types, nature and consequences of threats to species diversity. **5 class**
- Man-animal conflict (man-leopard, man-elephant and man-snake) – causes, examples and mitigation measures. **6 class**
- Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve. Elephant Conservation and Gangetic Dolphin Conservation. **4 class**
- JFM & Arabari model for conservation – key stone, flagship and umbrella species. Environmental and conservation movements in India (Chipko movement, Silent Valley etc.) **4 class**
- Role of NGO's in wildlife conservation in India. Mode of conservation action to be adopted. **2 class**

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DSE 5 P: BIODIVERSITY AND WILDLIFE CONSERVATION PRACTICAL (DSE P3)**List of practicals****2 credit**

1. Collection of water samples to identify zooplanktons to relate with major potential habitat of gangetic dolphin.
2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Binoculars, Global Positioning System, Various types of Cameras and lenses).
3. Familiarization and study of animal evidences in the field; Indirect evidences for identification of animals through pug marks/ hoof marks/ scats/ pellet groups/ nest/ antlers etc. (in field trip / excursion).
4. Identification of skulls of mammals.
5. Pitfall/ Trail / transect monitoring for abundance and diversity estimation of mammals/ bird/ arthropods (in field trip / excursion).
6. Laboratory notebook submission.
7. Submission of a complete report on excursion /field trip in any National forest/ Wild life sanctuary/ Reserve forest/ Biosphere reserve.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and understand the various issues related to biodiversity loss and conservation as well as status, conditions and conservation of forests and wildlife.	PO	PSO 3	R, U
CO 2:	Understand and apply the various tools used in field biology	PO	PSO 3, 5	U, Ap
CO 3:	Compare and evaluate the pitfall/ trail / transect monitoring for abundance and diversity estimation	PO	PSO 3, 5	An, E
CO 4:	Prepare complete report on excursion or field visit.	PO	PSO 3, 5	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Ananthakrishnan, T.N. (1989). *Bioresources Ecology*. Oxford and IBH Publishing.
- Balakrishnan, M. (2016). *Wildlife Ecology and Conservation*. The Scientific Publishers.
- Gaston, K.J. and Spicer, J.I. (2004). *Biodiversity : An Introduction*. 2nd edition, Wiley.
- Jeffries, M.J. (2006). *Biodiversity and Conservation*. 2nd edition, Routledge.
- Joshi, P.C. (2004). *Biodiversity and Conesevation*. Aph Publishing Corporation.
- Kumar, U. and Asija, M. (2004). *Biodiversity : Principles and Conservation*. 2nd edition, Agrobios (India).
- Spicer, J.I. (2009). *Biodiversity*. The Rosen Publishing Group.

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SEMESTER – VI	
Course name	COMPUTATIONAL BIOLOGY
Course code	UGZOODSE06
Number of lectures	105
Credits	6
Marks	100
New addition: 100% (Pink)	Modifications: 0% (Green)
Total Change: 100%	

Course Objectives:

After completion of this course the students will be able to

Sl. No.	Course Objectives:
1	Remember, understand the importance, Goal and Scope of bioinformatics
2	Understand, evaluate and use the biological databases to retrieve biological data
3	Understand the basic concept of sequence alignment
4	Understand and apply the Bioinformatics and biostatistics

DSE 6 T: COMPUTATIONAL BIOLOGY**4 credit****Unit 1: Introduction to Bioinformatics****5 class**

- Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics

Unit 2: Biological Databases**10 class**

- Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

Unit 3: Data Generation and Data Retrieval**14 class**

- Generation of data (Gene sequencing, Protein sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin, Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal, Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez)

Unit 3: Basic Concepts of Sequence Alignment**14 class**

- Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences, GAPS and INDELS.

Unit 4: Applications of Bioinformatics**7 class**

- Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts)

Unit 5: Biostatistics**10 class**

- Introduction, Measures of Central Tendency, calculation of standard deviation, standard error, Co-efficient of Variance, Chi-square test, Z test, t-Test

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DSE 6 P : COMPUTATIONAL BIOLOGY Lab**2 credit**

- Accessing biological databases
- Retrieval of nucleotide and protein sequences from the databases.
- To perform pair-wise alignment of sequences (BLAST) and interpret the output
- Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences
- Predict the structure of protein from its amino acid sequence.
- To perform a "two-sample t- test" for a given set of data
- To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and explain the importance, goal and scope of bioinformatics	PO	PSO 2	R, U
CO 2:	Illustrate, inspect and apply the biological databases to retrieve biological data	PO	PSO 2	U, Ap, An
CO 3:	Demonstrate and apply the basic concept of sequence alignment.	PO	PSO 2	U, Ap
CO 4:	Demonstrate and apply the tools in bioinformatics and biostatistics	PO	PSO 2	U, Ap
CO 5:	Construct the graphical representations of statistical data.	PO	PSO 2	C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

SUGGESTED READINGS

- Bagchi, A. (2018). *Introduction to Bioinformatics*, Narosa Publishing House
- Ghosh Z and Mallick B. (2008). *Bioinformatics: Principles and Applications*, Oxford University Press.
- Pevsner J. (2009). *Bioinformatics and Functional Genomics*, II Edition, Wiley Blackwell.
- Zvelebil, Marketa and Baum O. Jeremy (2008). *Understanding Bioinformatics*, Garland Science, Taylor and Francis Group, USA.
- Zar, Jerrold H. (1999). *Biostatistical Analysis*, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA
- Antonisamy, B., Christopher S. and Samuel, P. P. (2010). *Biostatistics: Principles and Practice*. Tata McGraw Hill Education Private Limited, India.
- Pagana, M. and Gavreau, K. (2000). *Principles of Biostatistics*, Duxberry Press, USA

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GENERIC ELECTIVES

SEMESTER – I/II		
Course name	ANIMAL DIVERSITY AND SYSTEMS	
Course code	UGZOOGE01	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 52% (Pink)	Modifications: 32% (Green)	Total Change: 84%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers the general characters and special features in different animal groups.
2	Understands and apply the taxonomy and classifications of animals.
3	Remember and understand the basic endocrinology and histology of animals.
4	Remember and understand the basics of developmental biology in animals.

UNIT I: Taxonomy, Classification, General Account on Animals**40 class**

1. History of Taxonomy, Rules and schemes for classifying animals as laid by ICZN (brief idea).
Type concept : names of Primary and Secondary types, their definitions and applications.
2. General characters and classification of Protozoa up to Phylum; Conjugation in *Paramecium*.
3. General characters and classification of Porifera up to classes; Canal System in *Sycon/Scypha*.
4. General characters and classification of Cnidaria up to classes; Polymorphism in Siphonophora.
5. General characters and classification of Platyhelminthes up to classes; Life history of *Taenia solium*.
6. General characters and classification of Annelida up to classes; Metamerism in Annelida.
7. General characters and classification of Arthropoda up to classes; Peculiarities of respiration in Prawn and Cockroach.
8. General characters and classification of Mollusca up to classes; Torsion in Gastropoda.
9. General characters and classification of Echinodermata up to classes; Water vascular system in starfish.
10. General features, Classification and Phylogeny of Protochordata, Mechanism of feeding in Urochordata.
11. General features of Agnatha and classification of cyclostomes up to classes.
12. General features and classification of fishes up to orders; Osmoregulation in Fishes.
13. General features and classification of Amphibia up to orders; Parental care in Amphibia.
14. General features and classification of Reptilia up to orders; Poisonous and non-poisonous snakes; Biting mechanism in venomous snakes.
15. General features and classification of Aves up to orders; Exoskeletal structures in birds.
16. General features and classification of Mammalia up to orders; ruminant stomach.

Note: Classification of Point 1 to be followed from Levine *et al.* (1980); Points 3 to 9 from Ruppert and Barnes (1994), Invertebrate Zoology, 6th edition; Points 10 to 16 from Young (1981).

UNIT II: Endocrinology and Histology**10 class**

1. General characters of hormones; Naming and function of hormones secreted from Pituitary, Thyroid and Pancreas.

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2. Insects endocrine glands (in brief) and their role in metamorphosis.
3. Histology of pituitary, thyroid and pancreas.

UNIT III: Developmental Biology

10 class

1. Spermatogenesis and Oogenesis; Fertilization in sea urchin.
2. Types of Eggs & Cleavages.
3. Process of Cleavage and Gastrulation in chick.
4. Extra-embryonic membranes in chick.
5. Concept of Protostomia & Deuterostomia.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the general characters and special structures in different animal groups.	PO 1	PSO 2	R, U
CO 2:	Demonstrate and apply the taxonomy and classifications of animals.	PO 2	PSO 2, 3	U, Ap
CO 3:	Define, demonstrate and illustrate the basic endocrinology and histology of animals.	PO 5	PSO 2	R, U, E
CO 4:	Define, demonstrate and illustrate the basics of developmental biology in animals.	PO 2, 3	PSO 2	R, U, E

Reference Books

- Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, 3rd edition, Blackwell Science.
- Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.
- Chapman, R.F. (2012). *The Insects: Structure and function*. 5th edition, Cambridge University Press.
- Copenhaver, W.M., Kelly, D.E. and Wood, R.L. (1978). *Bailey's Textbook of Histology*. 17th edition, Williams and Wilkins Company.
- Gilbert, S. F. (2006). *Developmental Biology*, 8th edition, Sinauer Associates, Inc., Publishers.
- Hadley, M. and Levine, J. (2007). *Endocrinology*. 6th edition, Pearson Education.
- Hall, J.E. (2016). *Guyton and Hall Text book of Medical Physiology*. 13th edition, Elsevier.
- Kardong, K. V. (2015). *Vertebrates: Comparative Anatomy, Function, Evolution*. 7th edition, McGraw Hill Education.
- Pechenik, J. A. (2015). *Biology of the Invertebrates*. 7th edition, McGraw Hill Education.
- Pough, F.H., Janis, C.M. and Heiser, J.B. (2013). *Vertebrate life*, 9th edition, Pearson.
- Ross, M.H., Kaye, G.I. and Pawlina, W. (2003). *Histology : A Text and Atlas*. 4th edition, Lippincott Williams and Wilkins.
- Ruppert, E.E. and Barnes, R.D. (1994). *Invertebrate Zoology*, 6th edition, Harcourt Publishers.
- Young, J. Z. (1981). *The Life of Vertebrates*. 3rd edition, Oxford University Press.

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SEMESTER – I/II	
Course name	ECOLOGY, ECONOMIC AND MEDICAL ZOOLOGY
Course code	UGZOOGE02
Number of lectures	105
Credits	6
Marks	100
New addition: 52% (Pink) Modifications:- 32% (Green) Total Change: 84%	

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands and apply the definition, principle and scope of fisheries and aquaculture, lac culture and pest management
2	Understand and evaluate the concept of ecology, biodiversity and wildlife conservation.
3	Remember, understand the concept of parasitism and evaluate the life history, pathogenicity and clinical features of selected parasites.
4	Remember, Understand the basic principles of biotechnology and immunology.

GE T2: Ecology, Economic and Medical Zoology

4 credit
20 class

UNIT I: Economic Zoology

1. Fisheries and Aquaculture : Principles, definitions and scope; Fisheries resource of India (inland and off-shore); Exotic fishes – their merits and demerits; Induced breeding and its importance; Basic principles of different Aquaculture system (Polyculture and Integrated farming); Marine pearl culture; Culture of prawn and shrimps.
2. Lac Culture : Types of Lac insects and host plants; Methods of lac cultivation; Products and uses; Problems and prospects.
3. Pest and Pest management : Definition and types of pests; life history, damage and control of i) *Scirpophaga* ii) *Sitophilus* iii) *Bandicota*; Concept on IPM.

UNIT II: Ecology, Biodiversity and Wildlife Conservation

25 class

4. Ecology and Ecosystem : Definition, components, energy flow, food chain, food web, ecological pyramids.
5. Population : Definition and growth form.
6. Community : Definition and types.
7. Basic concept of Biodiversity; Biodiversity hotspots. Conservation of wild life - Purpose and method; importance and strategies of wildlife conservation; concept of Wildlife Sanctuary, National Park and Biosphere Reserve; conservation act and application. Animal cruelty and prevention act.
8. Scheduled I of wild life protection Act, 1972 and importance of schedules in conservation.

UNIT III: Parasitology

7 class

9. Parasitism : Definition and types; an outline idea of other interspecific interactions (symbiosis, commensalism and mutualism).
10. Life history, pathogenicity and clinical features of
a. i) *Entamoeba histolytica* ii) *Plasmodium vivax* iii) *Ascaris lumbricoides*.

UNIT III: Biotechnology and Immunology

8 class

11. Basic concept of genetic engineering and cloning.
12. Concepts of immunity – innate and adaptive.
13. Outline structure and classification of immunoglobulin, Antigen – Antibody reaction.
14. Basic principles of vaccination.

GE P2: Ecology, Economic and Medical Zoology Lab

2 credit

List of Practical

1. Estimation of dissolved O₂ content of water.

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2. Estimation of dissolved free CO₂ content of water.
3. Measurement of pH of water.
4. Sampling of zooplanktons and extraction of soil microarthropods.
5. Determination of ABO blood group and Rh factor.
6. Identification (Scientific name, two specimen characters, and economic importance) – *Entamoeba histolytica*, *Plasmodium vivax*, *Ascaris lumbricoides*, *Taenia solium*, *Scirpophaga insertulas*, *Sitophilus oryzae*, *Bandicota bengalensis*, *Labeo rohita*, *Labeo bata*, *Cirrhinus mrigala*, *Hypophthalmichthys molitrix*, *Cyprinus carpio*, *Lates calcarifer*, *Teniolosa ilisha*, *Penaeus monodon*, *Macrobrachium rosenbergii*.
7. Field Excursion – submit report on field excursion at anyone place from below –
 - i) Estuarine / Fresh water fish farm.
 - ii) Agricultural farms for pest study and idea of IPM practices.
 - iii) Species diversity studies in forest ecosystems / coastal regions.
 - iv) Places of wild life interests – Reserve Forest, Sanctuary, National park, Biosphere reserve.
8. Viva voce
9. Laboratory Note Book

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and apply the definition, principle and scope of fisheries and aquaculture, lac culture and pest management	PO 1, 6	PSO 2, 5	R, U, Ap
CO 2:	Illustrate, analyse and evaluate the concept of ecology, biodiversity and wildlife conservation.	PO 1, 3	PSO 2, 3	U, E
CO 3:	Define, demonstrate and apply the concept of parasitism and evaluate the life history, pathogenicity and clinical features of selected parasites.	PO 6	PSO 4, 5	R, U, Ap
CO 4:	Define and understand the basic principles of biotechnology and immunology.	PO 1, 5	PSO 2	R, U

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

- Abbas, A.K., Lichtman, A.H. and Pillai, S. (2017). *Cellular and Molecular Biology*. 9th edition, Elsevier
- Ananthakrishnan, T.N. (1989). *Bioresources Ecology*. 3rd edition, Oxford and IBH Publishing.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. 2nd edition, CBS Publications and Distributors.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Balakrishnan, M. (2016). *Wildlife Ecology and Conservation*. The Scientific Publishers.
- Cain, M.L., Bowman, W.D. and Hacker, S.D. (2014). *Ecology*. 3rd edition. Sinauer associates.
- Chapman, J.L. and Reiss, M.J. (1999). *Ecology: Principles and Applications*. 2nd edition, Cambridge University Press.
- Chatterjee, K.D. (1952). *Human Parasites and Parasitic Diseases*. Published by author.
- Chatterjee, K.D. (2009). *Parasitology : Protozoology and Helminthology*. 13th edition, CBS Publishers and Distributors.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, 7th Edition, Mosby, Elsevier Publication.
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI publications, U.K.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. 4th edition, ASM press, Washington, USA.
- Hill, D.S. (2009). *Agricultural Entomology*. Timber Press.

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- Khanna, S.S. and Singh, H.R. (2009). *A text Book of Fish Biology and Fisheries*. Narendra Publishing House.
- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, 6th edition. W.H. Freeman and Company.
- Kumar, U. and Asija, M. (2004). *Biodiversity : Principles and Conservation*. 2nd edition, Agrobios (India).
- Odum, E.P. and Barrett, G.W. (2005). *Fundamentals of Ecology*. 5th edition, Thomson Brooks/Cole.
- Owen, J.A., Punt, J., Stranford, S.A. and Jones, P.P. (2009). *Kuby Immunology*. 7th edition,
- Pedigo, L.P. and Rice, M.E. (2009). *Entomology and Pest Management*, 6th edition, Pearson Prentice Hall.
- Srivastava, C.B.L. (1999). *Fish Biology*. Narendra publishing House.

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SEMESTER – II		
Course name	BIOTECHNOLOGY: MICROBES TO ANIMALS	
Course code	UGZOOGE03	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 100%(Pink)	Modifications: 00% (Green)	Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the concept of biotechnology.
2	Understand and evaluate the techniques in gene manipulation.
3	Understand and evaluate the application of microbes in biotechnology.
4	Remember, understand and analyse the method of transgenic animal production.
5	Remember and extend the basic concept in biotechnology and human welfare.

GE T2: Ecology, Economic and Medical Zoology**4 credit****Unit 1: Introduction**

Concept and scope of Biotechnology

Unit 2: Techniques in Gene Manipulation

Restriction and modifying enzymes, Cloning vectors and Expression vectors, Transformation techniques, Identification of recombinants, Construction and screening of DNA libraries; Molecular analysis of DNA, RNA and proteins (i.e. Southern, Northern and Western blotting), DNA sequencing (Sanger's method and automation), Polymerase Chain Reaction, Microarrays, DNA fingerprinting: RAPD

Unit 3: Microbes in Biotechnology

Growth kinetics of microbes, Applications of microbes in industry (Concept of primary and secondary metabolites, Fermentation/Bioreactors, Downstream processing), Bioremediation and Biosensing

Unit 4: Transgenic Animal

Production of transgenic animals: Retroviral method, DNA microinjection method, embryonic stem cell method, nuclear transplantation; Applications of transgenic animals; Knockout mice; Transgenic livestock; Transgenic fish.

Unit 5: Biotechnology and Human Welfare

Animal cell technology: Concept of expressing cloned genes in mammalian cells, Recombinant DNA in health (Recombinant insulin and human growth hormone), Production of recombinant vaccines, Gene therapy: in vitro, in-vivo and ex-vivo, Ethical issues concerning: Transgenesis, Biosafety and Intellectual Property Rights

PRACTICAL

1. Isolation of genomic DNA from *E. coli* and analyze it using agarose gel electrophoresis
2. Isolation of plasmid DNA (pUC 18/19) and analyse it using agarose gel electrophoresis.
3. Transformation of *E. coli* (pUC 18//19) and calculation of transformation efficiency.

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4. Restriction digestion of lambda (λ) DNA using EcoRI and Hind III.
5. DNA ligation (lambda DNA EcoRI/Hind III digested).
6. Construction of restriction digestion maps from data provided.
7. Study of Southern blot hybridization and PCR; Analysis of DNA fingerprinting (Dry Lab)

Project on Animal Cell Culture

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate and apply the concept of biotechnology.	PO 1	PSO 2	R, U, Ap
CO 2:	Demonstrate and analysing the techniques in gene manipulation	PO 2	PSO 2	U, An
CO 3:	Demonstrate and evaluate the application of microbes in biotechnology	PO 2	PSO 2	U, E
CO 4:	Define, demonstrate and evaluate the method of transgenic animal production.	PO 2, 3	PSO 2	R, U, E
CO 5:	Extend the basic concept in biotechnology and human welfare and perform experiments.	PO 3, 5	PSO 2, 3	U, C

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

Reference Books

1. Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). An Introduction to Genetic Analysis. IX Edition. Freeman and Co., N.Y., USA.
4. Snustad, D.P. and Simmons, M.J. (2009). Principles of Genetics. V Edition, John Wiley and Sons Inc.
5. Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y., USA.
6. Beauchamp, T.I. and Childress, J.F. (2008). Principles of Biomedical Ethics. VI Edition, Oxford University Press.

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SEMESTER – II		
Course name	INSECT, VECTORS AND DISEASES	
Course code	UGZOOGE04	
Number of lectures	105	
Credits	6	
Marks	100	
New addition: 100%(Pink)		Modifications: 00% (Green) Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Remembers, understands the characteristic and morphological features of Insects.
2	Understand and evaluate the insects as vectors.
3	Understand and analyse different vectors of different orders.
4	Understand, identify and analyse different vectors and their associated diseases.

Theory**Credits 4****Unit-1 Introduction to Insects****6 class**

General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts with respect to feeding habit

Unit-2 Concept of Vectors**6 class**

Brief introduction to Vectors (mechanical and biological), Reservoirs, Host-vector relationship, Adaptations as vectors, Host specificity

Unit-3 Insects as Vectors**8class**

Detailed features of insect orders as vectors – Diptera, Siphonoptera, Siphunculata, Hemiptera

Unit-4 Dipteran as Disease Vectors**14 class**

Study of important Dipteran vectors – Mosquitoes, Sand fly, Houseflies Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis Control of mosquitoes

Unit-5 Siphonaptera as Disease Vectors**6 class**

Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit-6 Siphunculata as Disease Vectors**4 class**

Human louse (Head, Body and Pubic louse) as important insect vectors; Control of human louse

Unit-7 Hemiptera as Disease Vectors**6 class**

Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures

ZOOGCOR03P: Insect Vectors and Diseases Lab**(Credits 2)****List of Practical**

1. Mounting and Study of different kinds of mouth parts of insects
2. Spot identification of following insect vectors through permanent slides/photographs: Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus

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humanus corporis, Phthirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica

3. Study of different diseases transmitted by above insect vectors
4. Submission of a project report on any one of the insect vectors and disease transmitted

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, demonstrate the characteristic and morphological features of Insects.	PO 1	PSO 1	R, U
CO 2:	Illustrate and evaluate the insects as vectors.	PO 2, 3	PSO 3, 4	U, E
CO 3:	Demonstrate and analyse different vectors of different orders.	PO 4	PSO 4,	U, An
CO 4:	Demonstrate, identify and prepare report on different vectors and their associated diseases.	PO 6	PSO 1, 5	U, Ap, C

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Reference Books

1. Anathakrishnan : Bio resources Ecology 3rd Edition
2. Goldman : Limnology, 2nd Edition
3. Odum and Barrett : Fundamentals of Ecology, 5th Edition
4. Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
5. Trivedi and Goyal : Chemical and biological methods for water pollution studies
6. Welch : Limnology Vols. I-II
7. Wetzel : Limnology, 3rd edition
8. Bose, M. (2017). Parasitoses and Zoonoses, New Central Book Agency

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SKILL ENHANCEMENT COURSE (SEC)

SEMESTER – III		
Course name	Value Education and Indian Culture	
Course code	UGZOOSEC01	
Number of lectures	30	
Credits	2	
Marks	50	
New addition: 100%(Pink)		Modifications: 00% (Green) Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Attain awareness about daily routine, self-evaluation & Integral Personality Development
2	Understand the educational needs, the Power of thoughts and the Science of Peace
3	Understand the relation: Values and enlightened citizenship
4	Attain awareness about the Indian Practice and Culture
5	Demonstrate the importance of Four Yogas
6	Acquire idea about Modern India: her hopes, challenges and Swami Vivekananda

PGZOOSOC 3: Value Education and Indian Culture

Class: 60 hrs

Unit1: Daily Routine:

2 class

- A suggested daily routine
- The daily routine & the concept of Biological clock: key to a healthy and productive life
- Necessity for an all-round daily routine
- Combining Rest and Activity, Hardships and Joy in a daily routine
- The scope of developing the power of concentration and detachment through a daily routine
- Daily Routine disciplines the system but confers conviction on oneself

Unit2: Self Evaluation & Integral Personality Development:

2 classes

- Why is Self-Evaluation important? Because if you win yourself, you win the world
- Quantitative Self Evaluation for a qualitative change: A method
- Traits to track Personality Development: Academic Excellence, Social Compatibility, Participation in Group events, Sense of Responsibility, Role as a Consumer, Scientific Temperament, Aesthetic taste and creativity, Leisure time Activities, Concern for others, Spiritual values.
- Close and Constant Self Evaluation : a stitch in time saves nine
- The world *is* as we *are* : A minor inner change may nullify a major outer perturbation

Unit3: Our Educational Needs

2 classes

- The need of a correct blend of inner and outer well-being in education
- Man-making, Character building education : growing from within , a surer foundation of progress
- The outer crust and the inner core of our personality: "What you are shouts so loudly in my ears that I cannot hear what you say."

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- A 5-point training in Discipline, Cleanliness, Behaviour, Manners and Ambition
- Sharpening the sword of will: controlling its expression, a basic educational need
- How to study effectively?

Unit4: The Power of thoughts and the Science of Peace

3 class

- Shanti Mantras: Peace can be radiated from and reflected back upon ourselves
- You can create an ambience and others can enjoy it, can be benefitted by it.
- How to create a positive, peaceful and inspiring ambience?- the aggressive exertion and the unquestioning sacrifice involved in it

Unit5: Subhashita: The Well said

2 class

- Bringing home high thoughts in nuggets of wisdom
- Pearls of Wisdom and flames of fire: simple parables and anecdotes from the great ones.

Unit6: Values and Enlightened Citizenship

2 classes

- Intrinsic and Instrumental Values
- What makes a man great? A powerful will to do good born out of self-control and self-sacrifice
- Learning the art of inter-personal relations: Not I but You
- The combination of the Head, Heart and Hand: a valuable value for Enlightened Citizenship

Unit7: Indian Practice and Culture

2 classes

- The idea of sacredness & its necessity
- Every aspect of life is sacred in India
- Renunciation and service the twin ideals for India
- My freedom from Nature helps me to serve nature and the world better
- I never say I am the body, I always say this body is mine : I as a master of the body-mind complex
- Weakness is death: in search of real strength of self-knowledge, reliance on God and unselfish service
- Meditation, Concentration and the silent Indian path for becoming a dynamo of power
- The Indian concept of Unity in diversity: Harmony of Religions

Unit8: Four Yogas

3 classes

- The Real and Apparent Man, the science of knowing myself: Jnana Yoga
- Taming the mighty current of emotions and giving them their right food: Bhakti Yoga
- The Science of working wisely: Karma Yoga
- The Process of making my mind mine: Raja Yoga
- Selected portions from Swami Vivekananda's Karma Yoga
- Harmony of 4 Yogas: a needed balance for the modern man

Unit9: Modern India: her hopes, challenges and Swami Vivekananda

2 classes

- Swami Vivekananda's method of combining the best of the East & the West: where Indian values and Western workmanship join hands
- Invigorating rationality in the field of the Indian search for the supreme joy : erasing the misconception of dogmatism

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- Rousing a sense of pride in the age-long Indian discoveries in the field of inner truths as opposed to an inferiority complex posed by Western material supremacy.
- Do you feel: Service, Swami Vivekananda's acid test for modern science and traditional spirituality.

Unit10: Students' Presentations/Project: (may be in groups)
10 hrs

Project on Service, Teaching and Cleanliness

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	PO Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define, understand and apply the daily routine, self-evaluation & Integral Personality Development	PO1	PSO - 5	R, U, Ap
CO 2:	Learn, and apply the Power of thoughts & the Science of Peace	PO 3	PSO - 5	U, Ap
CO 3:	Understand the relation: Values and enlightened citizenship	PO 2	PSO - 5	U
CO 4:	Discuss the awareness about the Indian Practice and Culture	PO 4	PSO - 5	C
CO 5:	Demonstrate and practice the Four Yogas	PO 6	PSO - 5	U, Ap
CO 6:	Explain and analyse the idea about Modern India: her hopes, challenges and Swami Vivekananda	PO 6	PSO - 5	U, An

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Books for Reference:

- 1) Jivan Sopan, Published by Ramakrishna Mission Vivekananda Centenary College, Rahara, Kolkata
- 2) Swami Vivekananda : His Call to the Nation, Advaita Ashrama
- 3) Thoughts of Power: Swami Vivekananda, Advaita Ashrama
- 4) Swami Vivekananda, The Friend of all, Ramakrishna Mission Institute of Culture, Golpark, Kolkata
- 5) Gems, Ramakrishna Mission Institute of Culture, Golpark, Kolkata

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SEMESTER – IV		
Course name	Spoken Tutorial on CellDesigner	
Course code	UGZOOSEC02	
Number of lectures	30	
Credits	2	
Marks	50	
New addition: 100%(Pink)		Modifications: 00% (Green)
Total Change: 100%		

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Install and start the CellDesigner program
2	Understand various aspects of CellDesigner system
3	Create a new model
4	Running the simulation
5	Viewing a Model and connect to Database

UGZOOSEC II: Spoken Tutorial on CellDesigner

Class: 30 hrs

Installation of CellDesigner 4.3

CellDesigner series- based on version 4.3, Startup guide for first-time users of CellDesigner, Software requirement, Download & Installation of CellDesigner, On Windows OS, Adding a protein species,

Getting Started with CellDesigner

General view of CellDesigner, The Menu & Tool Bar, Components, Species & Reaction, Creating a simple network: Name & Size of the network, Grid Visible, Grid Snap, Change size of network, Select a component, Move/Delete a component, Undo/Redo, Change the size of the component, Save the Network, Zoom.

Create and Edit Components

Open an already saved .xml file, Change the following in a Compartment- Size, shape, color and thickness of the border, Create multiple files in CellDesigner, Learn about Start-point and End-point of a Species, Change identity of Species and Reaction

Creating a new Model

Species, Add a Protein on the Canvas, Add Protein Residues, Change the Residue/Region Status, Create Reaction, Tidy up your diagram layout, Export Images / Print Images, Customizing Properties, Add Notes (e.g. literature references) and MIRIAM to Proteins/Reactions, Refer to the databases

Build and Modify Process Diagram

Use Macros, Move all components to another side of the draw area, Align a Reaction line, Extend a Reaction line, Build a Process diagram using CellDesigner

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Customizing Diagram Layout

To change color, shape and width of a Reaction line, Add Anchor points to a Reaction line, Align Components, Show/hide Reaction ids, Adding notes to Components, Editing Protein or Gene, Editing information, And to get a bird's eye view of the diagram.

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Recall how to install and use the CellDesigner programme	PO 5	PSO 2, 5	R
CO 2:	Build gene-regulatory and biochemical networks by CellDesigner, a structured diagram editor.	PO 5	PSO 2, 5	Ap
CO 3:	Design models of biochemical reaction networks in Computer-readable format.	PO 5, 6	PSO 2, 5	AP
CO 4:	Analyze simulation and other analysis packages.	PO 5, 6	PSO 2, 5	An
CO 5:	Relate data representation with various pictorial representations.	PO 5, 6	PSO 2, 5	U
CO 6:	Browse and modify existing SBML models with references to existing databases, simulate and view the dynamics through an intuitive graphical interface.	PO 5, 6	PSO 2, 5	E, C

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Books for Reference:

https://www.celldesigner.org/help/CDH_QT.html

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AECC

SEMESTER – I		
Course name	English Communication	
Course code	UGZOOAECC01	
Number of lectures	30	
Credits	2	
Marks	50	
New addition: 100% (Pink)	Modifications: 00% (Green)	Total Change: 100%

Course Objectives:

After completion of this course the student will be able to

Sl. No.	Course Objectives:
1	Demonstrate mastery of the discipline by detailing the development and current practices of Listening, Speaking, Reading and Writing as Language skills.
2	Conduct research that engages and responds to diverse audiences of scholars, students, and community members.
3	Demonstrate values and ethics in all activities

Course Content**Unit I: Introduction to Communication****10 classes**

- ❖ Process of Communication
- ❖ Levels of Communication
- ❖ Flow of Communication
- ❖ Verbal and Non-Verbal Communication
- ❖ Barriers to Communication

Unit II: Listening and Speaking Skills**10 classes**

Listening and its types.

- ❖ Barriers to effective listening,
- ❖ Traits of a good listener.
- ❖ Introduction to English Phonetic Symbols: Consonants and Vowels with illustrations in use.
- ❖ Dialogue
- ❖ Group Discussion
- ❖ Presentation
- ❖ Interview Technique.

Unit III: Reading and Writing Skills**10 classes**

- ❖ Techniques of Reading
- ❖ Types of Reading
- ❖ Reading Comprehension (unseen passage)
- ❖ Paragraph Writing
- ❖ Letter Writing
- ❖ Email Writing
- ❖ Report Writing
- ❖ Proposal writing
- ❖ Book Review
- ❖ Poster Making

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Course Outcome

After completion of this course the student will be able to

CO No.	Course Outcomes:	POs Addressed	PSOs Addressed	Cognitive Level
CO 1:	Enhance their English language proficiency in the aspects of reading, writing, listening and speaking.	PO1, PO2, PO3	PSO - 5	U, A
CO 2:	Develop academic literacy required for undergraduate learning, further studies and research	PO1, PO2, PO3	PSO - 5	C
CO 3:	Apply the requisite communicative skills and strategies to future careers	PO1, PO2, PO3	PSO - 5	Ap,
CO 4:	Gain an insight into cultural literacy and cross-cultural awareness and engage in self-directed English language learning	PO3, PO5	PSO - 5	Ap, C
CO 5:	Be responsible and ethical English users	PO3, PO5	PSO - 5	Ap

Question Pattern for End Semester Examination (Course Code: AECC)

COMPONENT	NATURE OF THE QUESTION	MAXIMUM MARKS
Part A	Short answers	5 X 1 = 5 Marks
Part B	Listening	1 X 5 = 5 Marks
Part C	Speaking (Presentation and Project submission)	1 X 15 = 15 Marks
Part C	Reading Comprehension	1 X 5 = 5 Marks
Part C	Writing	2 X 5 = 10 Marks 1 X 10 = 10 Marks

Prescribed Books:

1. Vibrant English (New Delhi: Orient Black Swan)
2. Speak Well (New Delhi: Orient Black Swan) a compulsory supplementary Work Book for exercises on Interactions, dialogue, presentation skills, Group discussions, debates and Interviews.

Recommended Readings for advanced learning:

1. Advanced Skills in English. eds E Suresh Kumar et al.,
2. Practising Writing Skills, Work Book
3. Enhancing English and Employability Skills
4. Business Communication,
5. English for Fluency
6. English Language Practice
7. Basics of Academic English- 1 and 2
8. Practising English- all these are Orient Black Swan publications

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SEMESTER – II		
Course name	ENVIRONMENTAL SCIENCE (ENVS)	
Course code	UGAECC02	
Number of lectures	30	
Credits	2	
Marks	50	
New addition: 100%(Pink)	Modifications: 00% (Green)	Total Change: 35%

Course Objectives:

After completion of this course the student will be able to

CO No.	Course Objectives:
CO 1:	Remembers and understands the concept, components and function of natural resources and ecosystems.
CO 2:	Understand and evaluate the Cause, effects and control measures of various environmental pollutants.
CO 3:	Understand the basic idea about the disasters and its management.
CO 4:	Understand and apply the knowledge about the social, environmental issues and environmental legislation.

- 1. Definition**, scope and importance. Need for public awareness. **1 classes**
- 2. Natural Resources: Renewable and non-renewable:** Forest, Water, Mineral, Food, Energy & Land resources – Use and associated problems. **4 classes**
- 3. Ecosystems:** Concept, Structure and function, Energy flow, Ecological succession, Food chains, food webs and ecological pyramids. Types – Forest, Grassland, Desert & Aquatic (ponds, streams, lakes, rivers, oceans, estuaries) ecosystems. **6 classes**
- 4. Environmental Pollution:** Definition, Cause, effects and control measures of - Air, Water, Soil, Noise pollution and Nuclear hazards. Solid waste Management. Role of an individual in prevention of pollution. **5 classes**
- 5. Disasters and management:** Floods, Earthquake, Cyclone and Landslides. **4 classes**
- 6. Social Issues and the Environment:** Water conservation, rain water harvesting, watershed management. Resettlement and rehabilitation of people; its problems and concerns. Environmental ethics: Issues and possible solutions. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust. Wasteland reclamation. Consumerism and waste products. Urban problems related to energy. **5 classes**
- 7. Environmental legislation:** Environment Protection Act. Air (Prevention and Control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife Protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Public awareness. **4 classes**
- 8. Human Population and the Environment:** Population growth, variation among nations; Population explosion – Family Welfare Programme; Environment and human health (including

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HIV/AIDS); Human Rights; Role of Information Technology in Environment and human health.

3 classes

Course Outcomes:

After completion of this course the student will be able to

CO No.	Course Outcomes:	PO Addressed	PSOs Addressed	Cognitive Level
CO 1:	Define and demonstrate the concept, components and function of natural resources and ecosystems.	PO1	PSO 3	R, U
CO 2:	Define, illustrate and analyse the cause, effects and control measures of various environmental pollutants.	PO 3	PSO 3	R, U, An
CO 3:	Demonstrate the basic idea about the disasters and its management.	PO 3	PSO 3	U
CO 4:	Illustrate and apply the knowledge about the social, environmental issues and environmental legislation.	PO 4	PSO 3	U, Ap
CO 5:	Define, demonstrate and evaluate the impact of human population on the Environment	PO 6	PSO 3, 5	R, U, E

R= remembering, U = understanding, Ap = applying, An = analysing, E = evaluating, and C = creating

References:

1. Agarwal KC, 2001. Environmental Biology, Nidi Publishers Ltd. Bikaner.
2. Bharucha Erach, 2003. The Biodiversity of India, Mapin Publishing Pvt. Ltd, Ahmedabad – 380013, India. Email: mapin@icenet.net
3. Brunner RC, 1989, Hazardous Waste Incineration, McGraw Hill Inc. 480pgs.
4. Clark RS, Marine Pollution, Clanderson Press, Oxofrd (TB).
5. Cunningham WP, Cooper TH, Gorhani E & Hepworth MT, 2001. Environmental Encyclopaedia, Jaico Publishing House, Mumbai, 1196pgs.
6. De AK, Environmental Chemistry, Wiley Eastern Ltd.
7. Down to Earth, Center for Science and Environment (R)
8. Hawkins RE, Encyclopaedia of Indian Natural History, Bombay Natural History Society, Bombay (R)
9. Heywood V H and Watson R T, 1995. Global Biodiversity Assessment. Cambridge University Press 1140pgs.
10. Jadhav H and Bhosale VM, 1995. Environmental Protection and Laws. Himalaya Publishing House, Delhi 284pgs.
11. Mckinney ML and Schoch RM, 1996. Environmental Science Systems and Solutions. Web enhanced edition, 639pgs.
12. Mhaskar AK, Matter Hazardous, Techno-Science Publications (TB)
13. Miller TG, Jr. Environmental Science, Wadsworth Publishing CO. (TB)
14. Odum EP, 1971. Fundamentals of Ecology. WB Saunders Co. USA, 574pgs.
15. Rao MN and Datta AK, 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd. 345pgs.

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