



Centurion
UNIVERSITY
*Shaping Lives...
Empowering Communities...*

B.Sc. (Zoology) Syllabus

(Three Years Programme)

School of Applied Sciences

Centurion University of Technology & Management

2020

CHOICE BASED CREDIT SYSTEM IN B.Sc. (Honours)

Semester	Basket-1	Basket-2	Basket -3	Basket-4	Basket-5	Semester wise cumulative credits
Semester	Core	Ability Enhancement	Domain	Generic Elective	Skill	
I	C 1	Environmental Science (02 Credit)	Domain Courses of Minimum 26 credits upto maximum of 36 credits.	G - 1	At least 04 skill courses of 16 credits	Minimum 24 Credits
	C 2					
II	C 3	JOB Readiness (English) (06 Credit)		G - 2		Minimum 24 Credits
	C 4					
III	C 5			G - 3		Minimum 24 Credits
	C 6					
	C 7					
IV	C 8			G - 4		Minimum 24 Credits
	C 9					
	C 10					
V	C 11					Minimum 24 Credits
	C 12					
VI	C 13					Minimum 24 Credits
	C 14					
Total Credits						Minimum 140
* A student can opt more number of Domain /GE courses up to a maximum of 20 credits over the period of six semesters						Maximum 160

COURSE STRUCTURE

Semester – I

Sl.No.	Code	Subject Name	T-T-P	Credit
01	CUTM1016	Job Readiness	0-0-6	6
02	CUTM1010	Environmental Science	0-2-0	2
03	CUTM1497	Non-Chordates I	3-1-2	6
04	CUTM1499	Principles of Ecology	3-1-2	6
05	GE-1@	Inter Disciplinary Subject	3-1-2	6
TOTAL				26

Semester – II

Sl.No.	Code	Subject Name	T-T-P	Credit
01	CUTM1016	Job Readiness	0-0-6	6
02	CUTM1010	Environmental Science	0-2-0	2
03	CUTM1498	Non-Chordates II	3-1-2	6
04	CUTM1500	Cell Biology	3-1-2	6
05	GE-2@	Inter Disciplinary Subject	3-1-2	6
TOTAL				26

Note: @Generic Elective Subjects to be chosen from discipline other than Zoology

Semester – III

Sl.No.	Code	Subject Name	T-T-P	Credit
01	SEC-1#	Skill		4
02	CUTM1501	Diversity of Chordates	3-1-2	6
03	CUTM1502	Physiology: Controlling and Coordinating Systems	3-1-2	6
04	CUTM1503	Fundamentals of Biochemistry	3-1-2	6
05	GE-3@	Inter Disciplinary Subject	3-1-2	6
TOTAL				28

Semester – IV

Sl.No.	Code	Subject Name	T-T-P	Credit
01	SEC -2#	Skill		4
02	CUTM1504	Comparative Anatomy of Vertebrates	3-1-2	6
03	CUTM1505	Physiology: Life Sustaining Systems	3-1-2	6
04	CUTM1506	Biochemistry of Metabolic Processes	3-1-2	6
05	GE-4@	Inter Disciplinary Subject	3-1-2	6
TOTAL				28

Note: # Any two Skill Enhancement Courses to be chosen.

Semester –V

Sl.No.	Code	Subject Name	T-T-P	Credit
01	CUTM1507	Molecular Biology	3-1-2	6
02	CUTM1510	Evolutionary Biology	3-1-2	6
03	Domain			
04	Domain			
TOTAL				12

Semester –VI

Sl.No.	Code	Subject Name	T-T-P	Credit
01	CUTM1509	Developmental Biology	3-1-2	6
02	CUTM1508	Principle of Genetics	3-1-2	6
03	Domain			
04	Domain			
TOTAL				12

Course Structure for BSc Courses

NON CHORDATES-I:PROTISTS TO PSEUDOCOELOMATES

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1497	Non – Chordates-I_protists to pseudocoelomates	3-2-1	

Objective

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- To have in depth knowledge about invertebrates of different phyla.
- To understand the taxonomic position of Protozoa to Helminthes.
- To understand the body organization and general characteristics of animals belonging to different phylum ranging from unicellular to multicellular organization.

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students would be able to represent invertebrates of different categories which affects the ecosystem in various ways	PO1-3, PO7-3, PO9-2
CO2	Students will be able to describe the unique character of Protozoa ,Porifera, Coelenterata and Helminthes.	PO1-3, PO7-2, PO9-3
CO3	Students will understand the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.	PO1-3, PO9-1

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply.

- Students would be able to represent invertebrates of different categories which affects the ecosystem in various ways.
- Students will be able to describe the unique character of Protozoa, Porifera, Coelenterata and Helminthes.
- Students will understand the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.

Course content

Module- I - General characteristics and classification of kingdom Protista (06H)

Protista, Parazoa and Metazoa :General characteristics and Classification up to classes, Study of Euglena, Amoeba and Paramecium, Life cycle and pathogenicity of Plasmodium vivax and Entamoeba histolytica.

Module- II- General characteristics of Metazoa (05H)

Locomotion and Reproduction in Protista, Evolution of symmetry and segmentation of Metazoa.

Module- III- Porifera (6 H)

Porifera: General characteristics and Classification up to classes, Canal system and spicules in sponges.

Module- IV - Coelenterates (6 H)

Cnidaria: General characteristics and Classification up to classes, Metagenesis in Obelia Polymorphism in Cnidaria, Corals and coral reefs.

Module- V- Ctenophora (5 H)

Ctenophora: General characteristics and Evolutionary significance, General characteristics and Evolutionary significance.

Module- VI- Platyhelminthes (6H)

Platyhelminthes: General characteristics and Classification up to classes, Life cycle and pathogenicity of *Fasciola hepatica* and *Taenia solium*.

Module-VII - Nematelminthes (6H)

Nematelminthes: General characteristics and Classification up to classes, Life cycle, and pathogenicity of *Ascaris lumbricoides* and *Wuchereriabancrofti*, Parasitic adaptations in helminthes

PRACTICE :

1. Study of whole mount of Euglena, Amoeba and Paramecium.
2. Study of Permanent slides of Binary fission and Conjugation in Paramecium
3. Study of Obelia, Physalia, Millepora, Aurelia, Tubipora
4. Study of Corallium, Alcyonium, Gorgonia, Metridium
5. Study of Museum specimen of Pennatula, Fungia, Meandrina, Madrepora and ctenophore.
6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs).
8. Study of adult *Wuchereriabancroftii* and its life stages (Slides/micro-photographs).
9. To submit a Project Report on any related topic on life cycles/coral/ coral reefs.
10. Study of Sycon (T.S. and L.S.), Hyalonema, Euplectella, Spongilla

11. Examination of pond water collected from different places for diversity in protest.

Text Books:

- Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders

Reference Books:

- International Edition. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science
- Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson.

Non Chordates-II : Coelomates

Code	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1498	Non – Chordates-II: Coelomates	3-2-1	

Objective

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- To have in depth knowledge about invertebrates of different phyla.
- To understand the taxonomic position of Annelida to Echinodermata.
- To understand the body organization and general characteristics of animals belonging to different phylums .

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students would be able to represent invertebrates of different categories which affects the ecosystem in various ways	PO1-3, PO7-3, PO9-2
CO2	Students will be able to describe the unique characters of Annelida , Arthropoda, Mollusca and Echinodermata.	PO1-3, PO7-2, PO9-3
CO3	Students will understand the life functions and the ecological role of animals belonging to different phylums ranging from unicellular to multicellular organization.	PO1-3, PO9-1

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply.

- Students would be able to represent invertebrates of different categories which affect the ecosystem in various ways.
- Students will be able to describe the unique characters of Annelida , Arthropoda, Mollusca and Echinodermata.
- Students will understand the life functions and the ecological role of animals belonging to

different phylums ranging from unicellular to multicellular organization.

Course content

Module-I- Introduction to Coelomates- (3h)

Evolution of coelom and metamerism

Module-II- Annelida: (5h)

General characteristics and Classification up to classes, Excretion in Annelida

Module-III- Arthropoda: (4h)

General characteristics and Classification up to classes, Vision and Respiration in Arthropoda, Metamorphosis in Insects, Social life in bees and termites.

Module-IV- Onychophora:(3h)

General characteristics and Evolutionary significance of Onychophora.

Module-V - Mollusca:- (8 h)

General characteristics and Classification up to classes, Respiration in Mollusca, Torsion and detorsion in Gastropoda, Pearl formation in bivalves, Evolutionary significance of trochophore larva.

Module- VI-Echinodermata (4h)

General characteristics and Classification up to classes, Water-vascular system in Asteroidea

Module-VII -Developmental aspects of Echinoderms (4h)

Larval forms in Echinodermata, Affinities with Chordates.

Practice

1. Study of museum specimen belonging to phylum Annelida Earthworm, Nereis, Sabella , Leech and Aphrodite.
2. Study of digestive system of Earthworm.
3. Study of septal nephridia and pharyngeal nephridia of Earthworm
4. Study of museum specimen belonging to phylum Arthropoda Cockroach, Honeybee, Prawn Peripatus, Balanus
5. Study of mouth parts of Cockroach.
6. Study of digestive system of Cockroach (Dissection)
7. Study of nervous system of Cockroach (Dissection)
8. Study of whole mount of mouth parts of Cockroach
9. Study of museum specimen belonging to phylum Mollusca Snail , Octopus, Sepia , Chiton, Helix, Pila
10. Study of museum specimen belonging to phylum Echinodermata : Starfish, Antedon, Echinus, Ophiura

Text Books:

Ruppert and Barnes, R.D. (2006). Invertebrate Zoology, VIII Edition. Holt Saunders International Edition

Reference Books:

1. Barnes, R.S.K., Calow, P., Olive, P. J. W., Golding, D.W. and Spicer, J.I. (2002). The Invertebrates: A New Synthesis, III Edition, Blackwell Science

2. Barrington, E.J.W. (1979). Invertebrate Structure and Functions. II Edition, E.L.B.S. and Nelson

Developmental Biology

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1509	Developmental Biology	3-2-1	

Objective

Key points: Briefly explain why the course is to be studied. Specify who should study the course and requirement of prior knowledge and skill, if any.

- The course is so designed for acquiring knowledge to know the process of reproduction and the development of embryo.
- The objective of this course is to provide a comprehensive understanding of the concepts of early animal development.
- Students taking this course must develop a critical appreciation of methodologies specifically used to study the process of embryonic development in animals.

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students will get the knowledge about the reproductive and development processes and can apply the acquired knowledge for higher study.	PO1-3, PO7-1, PO9-2
CO2	This course will provide a comprehensive understanding of the concepts of early animal development	PO1-3, PO7-1, PO9-3
CO3	Students will be able to predict the lineage outcome of transplanting mesodermal cell populations from anterior heart to posterior presomatic tail bud.	PO1-3, PO4-1, PO9-3

Key points: State clearly what knowledge and skill a student is expected to learn at the end of the course and will be able to apply.

- Students will get the knowledge about the reproductive and development processes and can apply the acquired knowledge for higher study.
- This course will provide a comprehensive understanding of the concepts of early animal development.
- Students will be able to predict the lineage outcome of transplanting mesodermal cell populations from anterior heart posterior to presomatic tail bud.

Course Outline

Module -I- Historical perspective and basic concepts (4h)

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

Module-II- Various Developmental aspects (4h)

Early Embryonic Development, Gametogenesis, Spermatogenesis, Oogenesis and Types of egg, Egg Membranes.

Module-III- Fertilization (5 h)

Fertilization (External and Internal), Changes in gametes, Blocks to polyspermy, Planes and patterns of cleavage.

Module - IV- Fate Maps (4h)

Fate maps (including Techniques), Early development of frog up to gastrulation, Early development of chick up to gastrulation, Embryonic induction and Organisers.

Module -V- Embryonic development (5h)

Late Embryonic Development: Fate of Germ Layers, Extra-embryonic membranes in birds, Implantation of embryo in humans, Placenta (Structure, types and functions of placenta), Post Embryonic Development. Metamorphosis: Changes, hormonal regulations in amphibians and insects.

Module-VI- Regeneration (3h)

Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each).

Module- VII- Ageing (5h)

Ageing: Concepts and Theories, Implications of Developmental Biology Teratogenesis: Teratogenic agents and their effects on embryonic, development, In vitro fertilization ,Concept of Stem cell, Amniocentesis

PRACTICE

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula
2. Study of whole mounts and sections of developmental stages of frog through permanent slides: neurula, tail-bud stage, tadpole (external and internal gill stages).
3. Study of T.S of Testis , Semen sample , Graffian follicle(Mature follicle about to release an ovum) and corpus luteum through permanent slides.
4. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours).
5. Study of Whole mounts of chick embryo 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation.
6. Study of the developmental stages and life cycle of Drosophila from stock culture.
7. Study of different sections of placenta (photomicrograph/ slides)
8. Project report on Drosophila culture/chick embryo development

Text Books:

Verma, Agrawal, 2007, Embryology, Rostogi Publication

Reference Books:

- Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
- Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
- Carlson, R. F. Patten's Foundations of Embryology Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
- Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press CBCS

Principles of Genetics

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1508	Principles of Genetics	3-2-1	

Objective

<ul style="list-style-type: none"> • Genetics is offered as a core course that provides fundamental knowledge of inheritance and evolution of the concept of gene with study of genetic diseases. • This course provides an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like recombination, transposition, sex determination and mutations. • Describe the mechanisms governing Mendelian inheritance, gene interactions and gene expression.
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Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	The primary outcome of studying this course will be the gaining of knowledge of the basic principles of inheritance and knowledge of the principles of genetics is essential for a deeper understanding of the varied branches of the biological.	PO1-3, PO2-1, PO9-2
CO2	Knowledge of the mechanisms of mutations and the causative agents will lead to an increase in an awareness of the students about the harmful impact of various chemicals and drugs being used in day to day life.	PO1-3, PO7-2, PO9-2
CO3	Student will be able to make a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well being based on the techniques learned during this course.	PO1-3, PO2-2, PO9-2

- The primary outcome of studying this course will be the gaining of knowledge of the basic principles of inheritance and knowledge of the principles of genetics is essential for a deeper understanding of the varied branches of the biological.
- Knowledge of the mechanisms of mutations and the causative agents will lead to an increase in an awareness of the students about the harmful impact of various chemicals and drugs being used in day to day life.
- Student will be able to make a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well being based on the techniques learned during this course.

Course Outline

Module-I

Mendelian Genetics and its Extension: Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked, sex-influenced and sex-limited characters inheritance.

Module-II

Linkage, Crossing Over and Chromosomal Mapping: Linkage, Crossing Over and Chromosomal Mapping, Linkage and crossing over, Cytological basis of crossing over, 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.

Module- III

Mutations:Types of chromosomal aberrations (Classification, figures and with one suitable example of each), Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: CLB method, attached X method.

Module-IV

Sex Determination:Genetic and environmental basis of sex determination; Chromosomal mechanisms of sex determination in *Drosophila* and Man.

Module-V

Extra-chromosomal Inheritance. Criteria for extra-chromosomal inheritance, Antibiotic resistance in Chlamydomonas, Mitochondrial mutations in Saccharomyces, Infective heredity in Paramecium and Maternal effects.

Module-VI

Polygenic Inheritance: Polygenic inheritance with suitable examples; simple numericals based on it. Recombination in Bacteria and Viruses, Conjugation, Transformation, Bacteriophage, Transduction.

Module-VII

Transposons:Complementation Test in Transposable Genetic Elements: Transposons in bacteria, Ac-Ds elements in maize and P elements In *Drosophila*, Transposons in humans.

Principles of Genetics Lab Practice

Experiments:

1. To study the collection of *Drosophilla*.
2. Study of *Drosophilla* under compound microscope.
3. Chi-square analyses using seeds/beads/*Drosophila*.
4. Linkage maps based on data from conjugation, transformation and transduction.
5. Linkage maps based on data from *Drosophila* crosses.
6. Study of karyotype (*Human or Drosophilla*).
7. Pedigree analysis of some human inherited traits.
8. Study of genetics of mice.
9. Study of genetics of chicken
10. Linkage maps based on data from Trihybrid cross.
11. Morphological study of chromosome by squashing method.
12. Sex Determination: Genetic and environmental basis of sex determination

Text Books and Reference Books:

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India
- Snustad, D.P., Simmons, M.J. (2009). Principles of Genetics. V Edition. John Wiley and Sons Inc
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cummings
- Russell, P. J. (2009). Genetics- A Molecular Approach. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. Introduction to Genetic Analysis. IX Edition. W. H. Freeman and Co
- Fletcher H. and Hickey I. (2015). Genetics. IV Edition. GS, Taylor and Francis Group, New York and London. CBCS Undergraduate Program in Zoology 2015
- Pierce B. A. (2012). *Genetics-A conceptual approach*. IV Edition. W. H. Freeman and Company
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. (2007) *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.

Animal Physiology- Life sustaining system

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1505	Animal Physiology- Life sustaining system	3-2-1	

Objective

<ul style="list-style-type: none"> • To know the functioning of various organs and their inter relationship • To facilitate students about the various metabolic processes
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Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students would be able to know and compare the different anatomical aspect of various organisms	PO1-3, PO3-2, PO9-2
CO2	Students will acquire the knowledge of functioning of different body parts	PO1-3, PO4-2, PO9-2

CO3	The students can apply the acquired knowledge for higher study	PO1-3, PO2-2, PO9-2
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- Students would be able to know and compare the different anatomical aspect of various organisms
- Students will acquire the knowledge of functioning of different body parts
- The students can apply the acquired knowledge for higher study

Course Outline

Module- I

Physiology of Digestion: Structural organization 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

Module- II

Physiology of Respiration: Mechanism of respiration & Pulmonary ventilation, Respiratory volumes and capacities, Transport of oxygen and carbon dioxide in blood, Respiratory pigments and Control of respiration, Dissociation curves and the factors influencing it, Carbon monoxide poisoning

Module- III

Physiology of Heart: Structure of mammalian heart, Coronary circulation, Structure and working of conducting myocardial fibers, Origin and conduction of cardiac impulses

Module- IV

Physiology of Heart: 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

Module- V

Renal Physiology: Structure of kidney and its function, Structure and function of Nephron, Mechanism of urine formation, Regulation of water balance, Regulation of acid-base balance, Counter-Current theory

Module-VI

Adaptive physiology: Adaptive physiology, Adaptation of reptile and aves to water, space, land, Adaptation of other species to water, space, land

Module-VII

Reproductive System: Physiology of male reproduction, Physiology of female reproduction, Puberty and Methods of contraception in male and female

Physiology: Life sustaining system Lab (Practice)

Experiments

1. Histological study of gastrointestinal tract
2. Study of Histology of trachea and lung
3. Estimation of haemoglobin using Sahli's haemoglobinometer

4. Enumeration of R.B.C.& W.B.C. using haemocytometer
5. Determination of ABO Blood group
6. Preparation of haemin and haemochromogen crystals
7. Recording of blood pressure using sphygmomanometer
8. Histological study of kidney(Human)
9. Histological study of nephron
10. Histological study of testis(mammal)
11. Histological study of ovary(mammal)
12. Histological study of artery & vein

E-materials:

Online Source:

<https://www.udemy.com/course/humanphysiology/>,

<https://www.coursera.org/specializations/anatomy> ,

<https://www.edx.org/course/anatomy-cardiovascular-urinary-and-respiratory-sys>

Text Books:

1. Guyton's Physiology

Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.
4. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills

Diversity of Chordates

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1501	Diversity of Chordates	3-2-1	

Objective

- To understand about aware of higher organisms and their taxonomy to correlate the evolutionary trend in organisms.
- To know students about identify the diversification of species of chordate world

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Student should be able to describe unique characters of	PO1-3, PO2-1, PO9-2

	urochordates, cephalochordates and fishes.	
CO2	Student should be able to recognize life functions of urochordates to fishes.	PO1-3, PO2-3, PO9-2
CO3	Acquire in depth knowledge on the diversity of chordates and their systematic position	PO1-3, PO2-2, PO9-2

- Student should be able to describe unique characters of urochordates, cephalochordates and fishes.
- Student should be able to recognize life functions of urochordates to fishes.
- Acquire in depth knowledge on the diversity of chordates and their systematic position.

Course Outline

Module- I

Introduction to Chordates: General characteristics and classification of chordates, General characteristics of Protochordates and Hemichordata, General characteristics of Urochordata and Cephalochordata, Study of larval forms in Protochordates, Retrogressive metamorphosis in Urochordata

Module- II

Origin of Chordata: Origin of chordates-Dipleurula concept & Echinoderm theory, Advanced features of vertebrates over Protochordata

Agnantha: General characteristics and classification of cyclostomes, Classification of cyclostomes up to class, Characteristics of Petromyzon, Myxin

Module- III

Pisces: General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration, Osmoregulation in fishes, Parental care in fishes

Module- IV

Amphibia: Origin of Tetrapoda (Evolution of terrestrial ectotherms), General characteristics and classification of amphibia up to order, Parental care in Amphibians & Neoteny

Module- V

Reptilia: General characteristics and Classification of Reptilia, Affinities of *Sphenodon*, Poison apparatus and biting mechanism in snakes, Adaptive characteristics of crocodile

Module-VI

Aves: General characteristics and classification (up to order Archaeopteryx), Principles and aerodynamics of flight, Flight adaptations, Migration in birds

Module-VII

Mammals: Affinities of Prototheria, Adaptive radiate: Zoogeographical realm, Theories pertaining to distribution of animals, Plate tectonic and Continental drift theory, Distribution of vertebrates in different realms

Diversity of Chordates Lab (Practice)

Experiments:

1. Museum specimen on Protochordata- Balanoglossus, Herdmania, Branchiostoma
2. Sections of Balanoglossus through proboscis and branchio-genital regions
3. Museum specimen on Petromyzon, Myxine
4. Museum specimen on : Fishes-Scoliodon, Pristis, Torpedo, Chimaera
5. Museum specimen on Labeo, Exocoetus, Echineis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas
6. Museum specimen on-Amphibia: Ichthyophis/Ureotyphlus, Necturus
7. Bufo, Hyla, Alytes, Salamandra
8. Museum specimen on Reptilia Hemidactylus, Varanus, Uromastix, Chamaeleon, Draco
9. Draco, Vipera, Naja, Hydrophis (Identification of poisonous and non-poisonous snakes)
10. Aves :Study of two common birds from different orders
11. Aves :Study of types beaks and claws
12. Mammalia Sorex, Bat (Insectivorous and Frugivorous), Funambulus, Loris, Herpestes, Erinaceus

References

Text Books:

- Kotpal.R.L, (2007)Modern Text Book of Zoology,Rastogi Publication

Reference Books:

- Young, J. Z.(2004). The Life of Vertebrates. III Edition. Oxford University press. Pough H. Vertebrate life, VIII Edition, Pearson International.
- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub Co.Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

Biochemistry of Metabolic Processes

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1506	Biochemistry of Metabolic Processes	3-2-1	

Objective

- To know the functioning of various organs and their inter relationship
- To understand about the various metabolic processes

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the significance of Biochemistry	PO1-3, PO3-1, PO9-2



CO2	Describe the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins	PO1-3, PO3-2, PO2-1
CO3	Describe the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites	PO1-3, PO2-2, PO9-2

- Understand the significance of Biochemistry
- Describe the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins
- Describe the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites

Module- I

Overview of Metabolism: Stages of Metabolism (Catabolism vs Anabolism), Compartmentalization of metabolic pathways, ATP as "Energy Currency of cell" & use of reducing equivalents and cofactors, Intermediary metabolism and regulatory mechanisms.

Module- II

Carbohydrate Metabolism: Sequence of reactions and regulation of glycolysis & Gluconeogenesis, Citric acid cycle and significance, Phosphate Pentose Pathway (Role and significance), Glycogenesis, Glycogenolysis.

Module- III

Lipid Metabolism: β -oxidation of saturated fatty acids with even & odd number of carbon atoms, Omega -oxidation of even & odd number of saturated fatty acids, Biosynthesis of palmitic acid, Metabolism of unsaturated fatty acid, Ketogenesis, Metabolic Fuel Utilization & Regulation of fatty acid

Module- IV

Protein Metabolism: Catabolism of amino acids, Transamination, Deamination, Protein Metabolism

Module- V

Fate of carbon skeleton: Urea cycle, Fate of C-skeleton of Glucogenic & Ketogenic amino acids, Regulation of Urea cycle, Role of mitochondria

Module- VI

Oxidative Phosphorylation: Oxidative Phosphorylation, Redox systems & Coupled reactions, Review of mitochondrial respiratory chain, Shuttle systems & Membrane transporters

Module- VII

Inhibitors and Uncouplers: Inhibitors of Electron Transport System, Uncouplers of Electron Transport System, Activity of Enzyme

Biochemistry of Metabolic Process Lab (Practice)

Experiments:

1. To demonstrate the effect of temperature on enzyme activity
2. To estimate the carbohydrate content of supplied tissue by Spectrophotometry method
3. To estimate the glycogen content of supplied tissue by colorimeter method
4. To estimate the lipid content from the given sample
5. To estimate the protein content of supplied tissue by colorimeter method
6. Estimation of total protein content in the given sample by Lowry's /Barfoed's Method
7. To estimate amino acids from a mixture by using chromatography (paper/Thin layer)
8. To estimate amino acids from a mixture by using chromatography (paper/Thin layer)
9. Determination of SGPT in given sample by using available kit.(Chick/Goat Serum)
10. Estimation of known and unknown protein
11. Preparation of Standard Curve of Bovine serum Albumin
12. Study the enzymatic activity of Trypsin and Lipase

1. Reference

Text Books:

1. Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.

Reference Books:

1. Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. W.H. Freeman and Co., New York.
3. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.rs
4. Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

Principles of Ecology

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1499	Principles of Ecology	3-2-1	

2. Objective

Obtain knowledge about the Ecosystem and their functioning, so that they will be crusader of environmental sustainability.

3. Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Describe the different components of ecosystem, the types of biogeochemical cycles and importance of energy as drivers of ecosystem	PO1-3, PO4-2, PO9-2
CO3	distinguish among allied scientific disciplines (environmental science, conservation biology, restoration ecology, and environmental engineering) and compare their purposes with that of ecology	PO1-3, PO4-2, PO9-2
CO7	describe the application of the scientific method to ecological experimentation.	PO1-3, PO2-2, PO9-3

- Describe the different components of ecosystem, the types of biogeochemical cycles and importance of energy as drivers of ecosystem
- distinguish among allied scientific disciplines (environmental science, conservation biology, restoration ecology, and environmental engineering) and compare their purposes with that of ecology
- describe the application of the scientific method to ecological experimentation.

Course Outline

Module- I(10Hrs)

Introduction to Ecology: History of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors.

Module- II (7Hrs)

Population: Unitary and Modular populations Unique and group attributes of population: Density, nasality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Exponential and logistic growth, equation and patterns, r and K strategies .

Module-III (8Hrs)

Population regulation - density-dependent and independent factors Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical Responses.

Module-IV (8Hrs)

Community: Community characteristics: species richness, dominance, diversity, abundance, vertical stratification, Ecotone and edge effect; Ecological succession with one Example, Theories pertaining to climax community.

Module- V (5Hrs)

Ecosystem: Types of ecosystems with one example in detail, Food chain: Detritus and Grazing food chains, Linear and Y-shaped food chains, Food web. B.Sc. (Zoology) Curriculum School of Applied Sciences

Module- VI (5Hrs)

Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies .

Module- VII (5Hrs)

Nutrient and biogeochemical cycle with one example of Nitrogen cycle, Human modified ecosystem
Applied Ecology: Ecology in Wildlife Conservation and Management Principles of Ecology

PRACTICE

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.
4. (Winkler's method), Chemical Oxygen Demand and free CO₂.
5. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

Text Books :

Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole

Reference Books:

- Colinvax, P. A. (1993). Ecology. II Edition.
- Wiley, John and Sons, Inc. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
- Robert Leo Smith Ecology and field biology(2000) Harper and Row publisher Ricklefs, R.E.

Cell Biology

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1500	Cell Biology	3-2-1	

Objective

- To make the student understand all type of cells and cellular components, and how cell works in healthy and diseased states

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells.	PO1-3, PO4-2, PO9-2
CO2	To understand the organization of cellular components and their specific functions.	PO1-3, PO4-2, PO9-2
CO3	Basic knowledge on mitotic and meiotic cell division, cellular communication and signal transduction taking place in cells	PO1-3, PO2-2, PO9-3

Students will understand

- Understand the structures and purposes of basic components of prokaryotic and eukaryotic cells.
- To understand the organization of cellular components and their specific functions.
- Basic knowledge on mitotic and meiotic cell division, cellular communication and signal transduction taking place in cells

Course outline

Module- 1 (11 Hrs)

Overview of Cells; Cell theory; Prokaryotic and Eukaryotic cells; Virus; Viroids; Mycoplasma; Prions
Assignment 1: Prions and associated diseases

Module- 2 (10 Hrs)

Plasma Membrane: Various models of plasma membrane structure; Transport across membranes: Active and Passive transport, Facilitated Transport; Cell junctions: Tight junctions, Gap junctions, Desmosomes, Hemidesmosomes

Module- 3 (6 Hrs)

Endomembrane System: Structure and Functions of Endoplasmic Reticulum, Golgi Apparatus, Lysosomes

Module- 4 (8 Hrs)

Mitochondria: Structure and function, Semi-autonomous nature, Endosymbiotic hypothesis, Chemiosmotic hypothesis, Mitochondrial electron transport chain; Peroxisomes: structure and function.

Module- 5 (10 Hrs)

Cytoskeleton: Structure and Functions: Microtubules, Microfilaments and Intermediate filaments;
Nucleus: Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin:
Euchromatin and Hetrochromatin and packaging (nucleosome)

Module- 6 (10 Hrs)

Cell Division and Cell cycle: Mitosis, Meiosis; Regulation of cell cycle

Module- 7 (10 Hrs)

Cell Signaling: Overview of cell signaling, signaling molecules and receptors, GPCR, Second messengers, Role of second messenger (cAMP) in cell signaling, Activation of gene transcription by GPCR

PRACTICE

1. Cell Organization and Sub Cellular Structure Studies
2. Gram's staining technique for visualization of prokaryotic cells
3. Counting of cells using Hemocytometer
4. Study of cell attachment
5. Study of cell proliferation
6. Isolation of Endoplasmic Reticulum
7. Isolation and microscopic study of mitochondria
8. Study the presence of Barr body in human female blood cells/cheek cell
9. Study of Actin Assembly
10. Study various stages of mitosis using permanent slides
11. Study various stages of meiosis using permanent slides
12. Maintenance of mammalian cell lines.

Text Books:

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins

Reference Books:

1. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San

3. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Roberts Keith and Watson James (2008).
Molecular Biology of the Cell, V Edition, Garland publishing Inc., New York and London

Fundamentals of Biochemistry

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1503	Fundamentals of Biochemistry	3-2-1	

Objective

This course will make students to know about the biochemical features in organisms and self.

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Understand the significance of Biochemistry	PO1-3, PO3-1, PO9-2
CO2	Describe the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins	PO1-3, PO3-2, PO2-1
CO3	Describe the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites	PO1-3, PO2-2, PO9-2

- Understand the significance of Biochemistry
- Describe the chemistry of carbohydrates, lipids, proteins and amino acids the classification and structural organization of proteins
- Describe the catabolic reactions of carbohydrates, lipids and amino acids and to Identify the class and functions of secondary metabolites

Course outline

Module-I

Carbohydrates: Structure and Biological importance of :Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates

Module-II

Lipids: Structure and Significance: Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids

Module-III

Proteins: 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 and Denaturation; Levels of organization in proteins; Introduction to simple and conjugate proteins

Module-IV

Immunoglobulins: Basic Structure, Classes and Function, Antigenic Determinants.

Nucleic Acids: Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids; Cot Curves: Base pairing, Denaturation and Renaturation of DNA; Types of DNA and RNA; Complementarity of DNA; Hypo-Hyperchromaticity of DNA.

Module-V

Enzymes: Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action.

Module-VI

Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation; Concept of K_m and V_{max} , and Lineweaver-Burk plot; Multi- substrate reactions.

Module-VII

Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme action.

PRACTICE

1. Qualitative tests of functional groups in carbohydrates
2. Qualitative tests of functional groups in lipids.
3. Qualitative tests of functional groups in protein
4. Separation of amino acid using Paper Chromatography.
5. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A_{260} measurement)
6. Action of salivary amylase under optimum conditions.
7. Effect of different pH on salivary amylase activity.
8. Demonstration of proteins separation by SDS-PAGE.
9. Effect of different Temperature on salivary amylase activity.
10. Effect of inhibitor on salivary amylase activity

Text Books:

Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.

Reference Books:

1. Cox, M.M and NelsoEXT n, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.rs
3. Sources of Environmental hazards, hazard identification and accounting, fate of toxic and persistent substances in the environment, dose Response Evaluation, exposure Assessment.

Animal Physiology: Controlling and Coordinating System

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1502	Animal Physiology : Controlling and Coordinating System	3-2-1	

Objective

To obtain Knowledge about the functioning of various system of organisms and their interrelationship for well-coordinated function.

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students would be able to know and compare the different anatomical aspect of various organisms	PO1-3, PO3-2, PO9-2
CO2	Students will acquire the knowledge of functioning of different body parts	PO1-3, PO4-2, PO9-2
CO3	The students can apply the acquired knowledge for higher study	PO1-3, PO2-2, PO9-2

- Students would be able to know and compare the different anatomical aspect of various organisms
- Students will acquire the knowledge of functioning of different body parts
- The students can apply the acquired knowledge for higher study

Course outline

Module-I Tissues

Structure, location, classification and functions of epithelial tissue, Structure, location, classification and functions of connective tissue, Structure, location, classification and functions of muscular tissue, Structure, location, classification and functions of nervous tissue & Structure and types of bones and cartilages.

Module-II Bone and Cartilage & Muscle:

Ossification, bone growth and resorption, Histology of different types of muscle, Ultra structure of skeletal muscle, Chemical basis of muscle contraction;

Module-III Blood:

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

Module-IV Nervous System :

Organization of the Brain, 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.

Module-V Endocrine System I:

Classification of hormones, Histology & mechanism of action of pituitary gland, Histology & mechanism of action of thyroid gland, Histology & mechanism of action of parathyroid gland.

Module-VI Endocrine System II:

Histology & mechanism of action of pancreas, Histology & mechanism of action of pineal gland, Histology & mechanism of action of gonadal hormone, Regulation of their secretion; Mode of hormone action.

Module-VII Neuroendocrine gland

Hypothalamus (neuroendocrine gland), Principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system, Role of hormone in growth.

PRACTICE

1. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells
2. Preparation of permanent slide of liver/skeletal muscle/any other tissue of given specimen.
3. Determination of blood groups
4. Preparation of blood smear from blood cells.
5. Estimation of haemoglobin using Sahli's haemoglobinometer
6. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)
7. Anatomical model of eye .
8. Anatomical model of ear .
9. Study of permanent slides of various Mammalian tissues
10. Study of slides of endocrine glands
11. Identification of histological slides of lymphoid tissue
12. Preparation of permanent slide of any five mammalian (goat/chick) tissues by microtomy

.Text Books:

1. Agrawal, V.K, Textbook of Animal Physiology, S.Chand Publication
2. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition.
3. Herculat Asia PTE Ltd. /W.B. Saunders Company.

Reference Books:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

Comparative Anatomy of Vertebrates

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1504	Comparative Anatomy of Vertebrates	3-2-1	

Objective

<ul style="list-style-type: none"> • To make a comparative study of the anatomy of an organ in different groups of vertebrates • To derive the evolutionary significance from it • Tto understand as to why an organ evolved the way it is present now.
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Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students recognize vertebrate structural principles by studying all body systems of vertebrates in an evolutionary perspective.	PO1-3, PO7-1, PO9-2
CO2	Compare and contrast the anatomical systems of different vertebrates and identify common traits across species and groups.	PO1-3, PO4-2, PO9-2
CO3	Compare and contrast the anatomical systems of different vertebrates and identify common traits across species and groups.	PO1-3, PO2-2, PO9-2

<ul style="list-style-type: none"> • Students recognize vertebrate structural principles by studying all body systems of vertebrates in an evolutionary perspective. • Compare and contrast the anatomical systems of different vertebrates and identify common traits across species and groups.

- Demonstrate an understanding of the characteristics of vertebrates and what makes both chordates and vertebrates unique among animals

Course outline

Module-I :Integumentary System

Introduction to integuments, General features of integuments Dermis and Epidermis, Derivatives of integuments scales nails hooves , Horn antles baleen dermal armour , Dermal derivatives

Module-IISkeletal System

Introduction to skeletolsystem, Axial Skeleton, Appendicular skeleton, Jaw suspensorium , Visceral arches

Module-III: Digestive System

Introduction to digestive system, Alimentary canal, Associate glands , Dentition

Module-IV Respiratory System

Introduction to Respiratory system, Brief account of Gills , Brief account of lungs , Brief account of air sac , Brief account of swim bladders

Module-V Circulatory System

Introduction to Circulatory system, General plan of circulation, Evolution of heart , aortic arches

Module-VI: Urinogenital System

Introduction to Urinogenital system , Succession of kidney , Evolution of urinogenital duct , Types of mammalian urinogenital system

Module-VII Nervous System

Introduction to Nervous system ,Comparative account of brain, Autonomic nervous system, Spinal cord, Types of receptors

PRACTICE

1. Temporary mount of external scales in fishes (cycloid, placoid, ganoid, ctenoid)
2. Study of disarticulated skeleton of Amphibia/Reptilia/Aves/Mammal
3. Demonstration of Chick to study arterial system
4. Demonstration of Specimen
5. Demonstration of heart through video
6. Mini project & Powerpoint presentation

Text Books:

- Jordan, E. L. and Verma, P. S. (2013) Chordate Zoology (14th edition).
- Saxena, R. K. and Saxena, S. (2015) Comparative Anatomy of Vertebrates (2nd edition).

Reference Books:

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.

Online Source: https://www.youtube.com/playlist?list=PLdNTrjqdXm_T7DzT1AO_b5_6G8zEF2al

Evolutionary Biology

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1510	Evolutionary Biology	3-2-1	

Objective

<ul style="list-style-type: none"> • To provide comprehensive overview of Concept of Evolution. • To explain Origin of Life especially Prokaryotes as well as Eukaryotes in detail. • To provide adequate information about Geological Time Scale • To give detailed outline of Extinctions and its types. • To impart descriptive knowledge regarding Origin and Evolution of Man

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Students understand and explain the main forces of evolution (natural selection, sexual selection, genetic drift). and the interplay among them, both over ecological and evolutionary time.	PO1-3, PO7-1, PO9-2
CO3	Students understand the history of life; the evolution of humans	PO1-3, PO4-2, PO9-2

<ul style="list-style-type: none"> • Students understand and explain the main forces of evolution (natural selection, sexual selection, genetic drift). and the interplay among them, both over ecological and evolutionary time. • Students understand the history of life; the evolution of humans
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Course outline

Module-I :Major Events in History of Life

Major Events in History of Life ,Lamarckism , Darwinism , Neo-Darwinism

Module II : Fossils

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Module III :Organic variations

Isolating Mechanisms ,Natural selection (Example: Industrial melanism) , Types of natural selection(Directional, Stabilizing, Disruptive) , 3.5Artificial selection

Module IV

Genetic Drift , Micro evolution , Biological species concept (Advantages and Limitations) , Modes of speciation (Allopatric, Sympatric)

Module V

Macro-evolutionary Principle , Darwin's Finches , Causes and effects of extinction , Biological species concept (Advantages and Limitations) , Modes of speciation (Allopatric, Sympatric)

Module VI : Extinction

Mass extinction , K-T extinction , Role of extinction in evolution , Origin and evolution of man, Homonid characteristics

Module VII

Phylogenetic trees , Multiple sequence alignment , constructions of phylogenetic trees

PRACTICE

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

Reference and Text books

- B.S. Tomar& S.P. Singh, 2000. Evolutionary biology. (Rastogi Publ.).
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing

- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings. Douglas,
- J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

Molecular Biology

	Course Title	T-P-Pj (Credit)	Prerequisite
CUTM1507	Molecular Biology	3-2-1	

Objective

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|---|
| <ul style="list-style-type: none"> • This course covers the structure function, and makeup of the molecular building blocks of prokaryotic and eukaryotic organisms. • It focuses on the interactions and interrelationship of DNA, RNA and protein synthesis and how these interactions are regulated. |
|---|

Course Outcome

COs	Course Outcomes	Mapping COs with POs (High-3, Medium-2, Low-1)
CO1	Student would understand and apply general concepts of molecular biology to specific problems	PO1-3, PO7-1, PO9-2
CO2	Student would understand the biological processes such as DNA replication, transcription and translation.	PO1-3, PO4-2, PO9-2
CO3 & CO8	Student would understand the consequences of dysfunctioning of these processes and develop ideas for possible solutions.	PO1-3, PO4-2, PO9-2, PO5-2

- Student would understand and apply general concepts of molecular biology to specific problems
- Student would understand the biological processes such as DNA replication, transcription and translation.
- Student would understand the consequences of dysfunctioning of these processes and develop ideas for possible solutions.

Course outline

Module-I: Nucleic acids

Introduction to nucleic acids: Nucleotide and Nucleoside, Types of nucleic acids: DNA & RNA

DNA: Watson & Crick model of DNA, Different forms of DNA (A, B and Z forms). RNA: Different forms of RNA, Protein coding RNA (mRNA), Functional RNA (rRNA and tRNA), Regulatory RNA (si RNA, mi RNA, sn RNA)

Module II: DNA replication

Overview of DNA replication: Different models of DNA replication, Semi-conservative mode of DNA replication, rolling circle mode of DNA replication, Theta mode of DNA replication. Enzymes involved in DNA replication and their roles: DNA polymerases, DNA gyrase, DNA helicase, DNA ligase, Primase. Replication process: DNA replication in prokaryotes and eukaryotes

Module III: DNA mutation

Mutation: Causes of mutation and effects of mutation. Types of mutation: missense mutation, Nonsense mutation, Insertion or Deletion, Duplication, Frameshift mutation, Repeat expansion

Module IV: DNA Repair

DNA Repair: Direct repair, Excision repair, Mismatch repair, Nonhomologous end-joining, SOS response. DNA repair errors: Defects in DNA repair and its consequences.

Module V: Transcription and post transcriptional processing

Transcriptional machinery: The transcription Unit, Enzymes and transcription factors. Transcription process: Process of transcription in prokaryotes and eukaryotes. Post transcriptional processing: Processing of mRNA, Synthesis and processing of functional RNA (rRNA & tRNA). Reverse transcription: The process of synthesis of cDNA.

Module VI: Regulation of gene transcription

Transcription regulation in prokaryotes: The operon concept: The lac operon, The trp operon.
Transcription regulation in eukaryotes: Activators, repressors, enhancers, silencer elements. Gene silencing: Transcriptional and post-transcriptional gene silencing

Module VII: Translation and post translational processing

Component of translation and their roles: mRNA: The precursor of molecule of translation, Ribosomes: The site of protein synthesis, tRNA: the carrier molecule of translation. Translation: Process of translation in prokaryotes and eukaryotes. Post translational modifications: Co- and post-translational modifications of proteins

Molecular Biology Lab (Practice)

Experiments:

1. Isolation and spectrophotometric estimation of DNA
2. Isolation and spectrophotometric estimation of RNA
3. Visualization of DNA/RNA using agarose gel electrophoresis
4. Preparation of equilibrated phenol
5. Quantitative estimation of RNA using Orcinol reaction
6. Demonstration of DNA & RNA by MGP
7. Preparation of liquid culture medium (LB) and raise culture of E. coli
8. Preparation of solid agarose medium (LB) and raise colonies of E. coli
9. Demonstration of DNA replication, transcription and translation using Photograph, slides and/or videos.
10. Application of *in silico* tools (BIOVIA's DISCOVERY STUDIO) to study the three dimensional structure of proteins.

Text Books:

1. Watson, J. D., Baker, T. A., Bell, S. P., Gann, A., Levine, M., & Losick, R. (2004). *Molecular Biology of the Gene* (International Ed.).

Reference Books:

1. Brown, T. A. (2006). *Genomes 3*. Garland Science
1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: *Molecular Biology of the Cell*, IV Edition.

2. Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates.
3. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
4. Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
5. Lewin B. (2008). Gene XI, Jones and Bartlett

Online Source:

- *ePathsala*
- *NPTEL*