

Deccan Education Society's

**Kirti M. Doongursee College of
Arts, Science and Commerce
(AUTONOMOUS)**



Affiliated to

UNIVERSITY OF MUMBAI

Syllabus for
Program: Bachelor of Science
Course: T.Y.B.SC.
Subject: ZOOLOGY

Choice Based Credit System (CBCS)
with effect from
Academic Year 2024-2025

Course Code	SEM – V-Invertebrates and type study	Credits	Lectures/Week
KUSZO23501	Paper I-Taxonomy - Invertebrates and Type Study	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animals*
- *Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects..*
- *Learners will get an idea of general characteristics and details of invertebrate animal systems*

Unit	Topics	No of Lectures
I	Principles of Taxonomy	15
II	Kingdom Animalia I	15
III	Kingdom Animalia II	15
IV	Type study: <i>Sepia</i>	15

Unit I: Principles of Taxonomy (15L).

1.1: Levels of Organization:

1.1.1: Unicellularity, colonization of cells, multicellularity

1.1.2: Levels of Organization: Acellular, Cellular, Tissue level, Organ level and 'Organ-system' level

1.2: Symmetry

1.2.1: Basic concept and definition

1.2.2: Types:

a. Asymmetry: e.g. *Amoeba*

- b. Radial symmetry: e.g. Starfish
- c. Bi-lateral symmetry: e.g. Invertebrate - Planaria
Vertebrate - Man

1.2.3: Evolutionary significance of symmetry

1.3: Coelom

1.3.1: Basic concept and definition

1.3.2: Formation of coelom

1.3.3: Types:

- a. Acoelomate: Platyhelminthes e.g. Liverfluke
- b. Pseudocoelomate: Nematoda e.g. Roundworm
- c. Coelomate: e.g. Frog

1.3.4: Evolutionary significance of coelom

1.4: Metamerism

1.4.1: Basic concept and definition

1.4.2: Types:

- a. Pseudometamerism: e.g. Tapeworm

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b. True metamerism:

- i. Homonomous - Annelida e.g. *Nereis*
- ii. Heteronomous - Cephalization - Insecta e.g. Dragonfly
Cephalothorax - Crustacean e.g. Lobster

1.4.3: Evolutionary significance of metamerism

1.5: Taxonomy

1.5.1: Basic concept, definition and objectives

1.5.2: Linnaean Hierarchy, Binomial Nomenclature

1.5.3: Six Kingdom classification:

General characters of each Kingdom with examples:

Kingdom Archaeobacteria

Kingdom Eubacteria

Kingdom Protista

Kingdom Fungi

Kingdom Plantae

Kingdom Animalia

1.6: Kingdom Protista: Animal like Protists: Protozoa

1.6.1: General characters of Protozoa

1.6.2: Classification of Protozoa with distinguishing features and suitable examples:

Phylum Sarcomastigophora

Class Sarcodina e.g. *Amoeba*

Class Mastigophora e.g. *Trypanosoma*

Phylum Ciliophora

Class Ciliata e.g. *Opalina*

Class Phyllopharyngea e.g. *Dysteria*

Phylum Sporozoa

Class Aconoidasida e.g. *Plasmodium*

Class Conoidasida e.g. *Toxoplasma*

Unit II: Kingdom Animalia I (15L)

2.1: Phylum Porifera

a. General characters

b. Classification up to class with distinguishing features and suitable examples:

Class Calcarea e.g. *Leucosolenia* (Branched sponge)

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Class Hexactinellida e.g. *Hyalonema* (Glass-rope sponge)

Class Demospongia e.g. *Euspongia* (Bath sponge)

2.2: Phylum Cnidaria

a. General characters

b. Classification up to class with distinguishing features and examples

Class Hydrozoa e.g. *Hydra*

Class Scyphozoa e.g. *Aurelia* (Jelly fish)

Class Anthozoa e.g. *Meandrina* (Maze Coral)

2.3: Phylum Platyhelminthes

a. General characters

b. Classification up to class with distinguishing features and examples

Class Turbellaria e.g. *Dugesia* (Planaria)

Class Trematoda e.g. *Schistosoma* (Blood-fluke)

Class Cestoda e.g. *Taenia* (Tapeworm)

c. Morphology, life cycle and pathogenicity of *Fasciola hepatica*

2.4: Phylum Nematoda

a. General characters

b. Classification up to class with distinguishing features and examples

Class: Aphasmida (Adenophorea) e.g. *Trichinella* (Trichina worm)

Class: Phasmida (Secernentea) e.g. *Ascaris* (Roundworm)

Unit III: Kingdom Animalia II (15L)

3.1: Phylum Annelida

3.1.1: General characters

3.1.2: Classification up to class with distinguishing features and examples

Class Polychaeta e.g. *Neries* (Clamworm)

Class Oligochaeta e.g. *Pheretima* (Earthworm)

Class Hirudinea e.g. *Hirudinaria* (Leech)

3.2: Phylum Arthropoda

3.2.1: General characters

3.2.2: Classification up to class with distinguishing features and examples

Subphylum Chelicerata

Class Arachnida e.g. *Hottentotta* (Scorpion)

Class Merostomata e.g. *Limulus* (Horse-shoe crab)

Class Pycnogonida e.g. *Nymphon* (Sea spider)

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Subphylum Crustacea

Class Malacostraca e.g. *Scylla* (Crab)

Class Maxillipoda e.g. *Balanus* (Barnacle)

Subphylum Uniramia

Class Chilopoda e.g. *Scolopendra* (Centipede)

Class Diplopoda e.g. *Xenobolus* (Millipede)

Class Insecta e.g. *Attacus* (Moth)

3.3: Phylum Mollusca

3.3.1: General characters of the Phylum

3.3.2: Classification up to class with distinguishing features and examples

Class Aplousobranchia e.g. *Chaetoderma* (Glistening worm solenogaster)

Class Polyplacophora e.g. *Chiton* (Coat-of-mail shell)

Class Monoplacophora e.g. *Neopilina*

Class Gastropoda e.g. *Nerita* (Nerite)

Class Pelecypoda e.g. *Solen* (Razor clam)

Class Scaphopoda e.g. *Dentalium* (Tusk shell)

Class Cephalopoda e.g. *Nautilus* (Pearly nautilus)

3.4: Phylum Echinodermata

3.4.1 General characters

3.4.2 Classification up to class with distinguishing features and examples

Class Asterozoa e.g. *Protoreaster* (Starfish)

Class Ophiurozoa e.g. *Ophiothrix* (Brittle star)

Class Echinozoa e.g. *Clypeaster* (Sand dollar)

Class Holothurozoa e.g. *Cucumaria* (Sea cucumber)

Class Crinozoa e.g. *Antedon* (Sea lily)

3.5 Minor phyla

3.5.1: General characters along with examples of

Phylum Acanthocephala e.g. *Moniliformis*

Phylum Onychophora e.g. *Peripatus* (Velvet worm)

Phylum Chaetognatha e.g. *Sagitta* (Arrow worm)

3.5.2: *Peripatus*, a connecting link - Affinities with Phylum Annelida, Arthropoda and Mollusca.

3.6 Phylum Hemichordata

3.6.1: General characters, classification with distinguishing features and examples

Class Enteropneusta e.g. *Balanoglossus* (Acorn worm)

Class Pterobranchia e.g. *Rhabdopleura*

Class Planctosphaerozoa e.g. *Planctosphaera*

3.7 Basic concepts of phylogeny: Phylogenetic tree of invertebrates

Unit IV: Type study: *Sepia* (15L).

4.1: General characters and classification, Habit and habitat, External characters, mantle cavity, locomotion, economic importance

4.2: Digestive system, Respiratory system, Circulatory system, Excretory system, Nervous system and Sense organs, Reproductive system

Textbooks:

A manual of Zoology - Part I, Invertebrata; Ayyar, M. Ekambaranath

Invertebrate Zoology - Volumes of different Phyla; Hyman L.H.

Instant Notes in Animal Biology by Richard D. Jurd.

Introduction to Zoology - Vol I: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book Agency.

Modern text book of Zoology - Invertebrates; Eleventh; Edition Professor R.L. Kotpal; Rastogi publication
Invertebrate Zoology by E. L. Jordan & P. S. Verma Rev. edition, 2009, Chand publications
Invertebrate Zoology by P. S. Verma, edition, 2009, Chand publications
Zoology for degree students, Non chordates by V.K. Agarwal 2011, S. Chand Publication
Zoology for Degree Students, B.Sc. First Year, by V. K. Agarwal, Pub. S. Chand Coy.
B. Sc. Zoology, Invertebrate Zoology by V.K. Aggarwal 2017, S. Chand publications
Invertebrate Zoology by Fatik Baran 2012, PHI Learning
A Textbook of Invertebrates by N.C. Nair et al. 2010 Saras publications
Practical Zoology: Invertebrate, by S. S. Lal, 2016
Invertebrate Zoology by Ruppert, Fox, Barnes, 7th edition, 2003 publications Cengage Learning
Invertebrate Zoology by D.T. Anderson 2nd edition 2002, publications Oxford
Invertebrates by Richard C. Brusca et. al, 3rd edition 2016, publications Oxford
Biology of the invertebrates by Jan A. Pechenik, 7th edition, 2014 publications McGraw Hill
An introduction to the invertebrates by Janet Moore, 2nd edition 2006, publications Cambridge
Protozoology, by S. V. Nikam & S. T. Tanveer ed. 2011, Pub. Oxford Book Company (N.B.:

This book includes Phylum Sarcomastigophora)

ADDITIONAL READING

<https://www.earthlife.net/inverts/an-phyla.html>
<http://www.biologydiscussion.com/invertebrate-zoology/invertebrates-phyla/study-notes-on-invertebrates-phyla/28077>
<http://www.asfa.k12.al.us/ourpages/auto/2014/4/23/64232119/invertebrate-animal-phyla-notes.pdf>
<http://www.biology-pages.info/I/Invertebrates.html>
<https://portals.iucn.org/library/sites/library/files/documents/2012-064.pdf>
<http://instruction2.mtsac.edu/mcooper/Biology%202/Labs/Protistalab1.pdf>
<http://www.faculty.ucr.edu/~legneref/invertebrate/inverteb.htm>
<http://www.cbv.ns.ca/mchs/diversity/ProtozoansPage1.html>
http://bioweb.uwlax.edu/bio203/s2009/maiers_andr/Classification.htm
<https://www.earthlife.net/inverts/annelida.html>
<https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/worms-phyloplatyhelminthes-nematoda-and-annelida>
http://www.fossilmuseum.net/Tree_of_Life/PhylumAnnelida.htm
<http://www.austincc.edu/sziser/Biol%201413/LectureNotes/InexamIII/Phylum%20Annelida.pdf>
<http://animaldiversity.org/accounts/Annelida/classification/>

[org/~bernie/sciproject/project/Kingdoms/Animal%20Kingdom%20-%205/Local%20copy/classification/arthropoda.html](http://~bernie/sciproject/project/Kingdoms/Animal%20Kingdom%20-%205/Local%20copy/classification/arthropoda.html)
http://bio.rutgers.edu/~gb102/lab_2/309am-arthro.html
<http://www.auburn.edu/academic/classes/biol/1030/boyd/lect10-14outline.htm>
http://www.fossilmuseum.net/Tree_of_Life/PhylumArthropoda.htm
<http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2003/3Mollusca.htm>
http://www.fossilmuseum.net/Tree_of_Life/PhylumMollusca.htm
<http://www.geo.arizona.edu/geo3xx/geo308/FoldersOnServer/2003/Lab7EchinoArthro.htm>
<https://www.earthlife.net/inverts/echinodermata.html>
<http://www.uky.edu/OtherOrgs/KPS/paleoclass/pages/wimbergechinodermata.htm>
http://www.fossilmuseum.net/Tree_of_Life/Phylum-Echinodermata.htm

Course Code	SEM – V - Haematology and Immunology	Credits	Lectures/Week
KUSZO23502	Paper II Haematology and Immunology	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *The learner shall comprehend basic haematology. The learner will be able to identify various components of haemostatic systems.*
- *The learner shall understand immunopathology and the principles and applications of vaccines. The learner will develop basic understanding of immunology of organ transplantation*
- *The learner will be better equipped for further pathological course or working in a diagnostic laboratory.*
- *The learner will realize the significant role of immune system in giving resistance against diseases.*

Unit	Topics	No of Lectures
I	Basic Haematology	15
II	Applied Haematology	15
III	Basic Immunology	15
IV	Applied Immunology	15

Unit I: Basic Haematology (15L)

1.1: Composition of plasma: Water, respiratory gases, dissolved salts, plasma proteins,

nutrients, enzymes, hormones, nitrogenous waste products

1.2: Haematopoiesis: Erythropoiesis, leucopoiesis and thrombopoiesis

1.3: Erythrocytes: Structure and functions, abnormalities in structure, total count, variation

in number; ESR; types of anaemia

1.4: Haemoglobin: Structure, formation and degradation; variants of haemoglobin (foetal,

adult), abnormalities in haemoglobin (sickle cell and thalassemia)

1.5: Leucocytes: Types and functions, total count and variation in number; leukaemia and its types

1.6: Thrombocytes: Structure, factors and mechanism of clotting, failure of clotting mechanism

1.7: Blood volume: Total quantity and regulation; haemorrhage

Unit II: Applied Haematology (15L)

2.1: Introduction and scope of Applied Haematology: Clinical, microbiological, oncological and forensic haematology

2.2: Clinical significance of Diagnostic Techniques

2.2.1: Microscopic examination of blood:

Blood cancer (lymphoma, myeloma),

Infectious diseases (malaria, leishmaniasis),

Haemoglobinopathies (sickle cell anaemia, thalassemia)

2.2.2: Coagulopathies: Haemophilia and purpura

2.2.3: Biochemical examination of blood:

Liver function tests: AST, ALT, LDH, Alkaline phosphatase , Total and direct bilirubin

Kidney function test: Serum creatinine, Blood Urea Nitrogen (BUN)

Carbohydrate metabolism tests: Blood sugar, Glucose tolerance test, Glycosylated haemoglobin test

Other biochemical tests: Blood hormones - TSH, FSH, LH.

Unit III: Basic Immunology (15L)

3.1: Overview of Immunology

3.1.1: Concept of immunity

3.1.2: Innate immunity - Definition, factors affecting innate immunity, Mechanisms of innate

immunity - First line of defence - physical and chemical barriers; Second line of defence - phagocytosis, inflammatory responses and fever

3.1.3: Adaptive or Acquired immunity, Antibody mediated and cell mediated immunity; Active

Acquired immunity - Natural and Artificial; Passive Acquired immunity - Natural and Artificial

3.2: Cells and Organs of immune system

3.2.1: Cells of immune system - B cells, T cells and null cells, macrophages, dendritic cells

and mast cells

3.2.2: Organs of immune system

Primary: Thymus and bone marrow

Secondary: Lymph nodes and spleen

3.3: Antigens: Definition and properties; haptens

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3.4: Antibodies: Definition, basic structure, classes of antibodies - IgG, IgA, IgM, IgD and IgE

3.5: Antigen processing and presentation

3.5.1: Endogenous antigens - cytosolic pathways

3.5.2: Exogenous antigens - endocytic pathways

Unit IV: Applied Immunology (15L)

4.1: Antigen-Antibody interaction

4.1.1: General features of antigen-antibody interaction

4.1.2: Precipitation reaction - Definition, characteristics and mechanism.

Precipitation in gels (slide test)

Radial immunodiffusion (Mancini method)

Double immunodiffusion (Ouchterlony method)

4.1.3: Immunoelectrophoresis - Counter-current and Laurel's Rocket electrophoresis

4.1.4: Agglutination reaction definition, characteristics and mechanism.

Haemagglutination (slide and micro-tray agglutination)

Passive agglutination

Coomb's test

4.1.5: Immunoassay - ELISA

4.2: Vaccines and Vaccination

4.2.1: Principles of vaccines - active and passive immunization, Routes of vaccine administration

4.2.2: Classification of vaccines:

Live attenuated

Whole-Killed or inactivated

Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines

4.2.3: Adjuvants used for human vaccines:

Virosomes and Liposomes

Saponins

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Water-in-oil emulsions

4.2.4: Vaccines against human pathogens:

Polio

Hepatitis A and B

Tuberculosis (BCG)

4.3: Transplantation Immunology: Introduction to transplantation; Types of grafts;

Immunologic basis of graft rejection: MHC compatibility in organ transplantation,

Lymphocyte and Antibody mediated graft rejection; Precautionary measures against graft rejection

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Textbooks:

Human Physiology - Volume 1; C.C. Chatterjee.

Essentials of Haematology; Shirish M. Kawthalkar; Jaypee Brothers.

Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas J.

Kipps, Josef Prchal, Uri Seligsohn.

Essential Haematology; Victor Hoffbrand, Paul Moss, John Pettit.

Rapid Review of Hematology; Ramadas Nayak; Jaypee Brothers.

Precise Haematology; Usha Rusia, Meera Sikka, Renu Saxena; Wiley India.

Short Textbook of Haematology; Shah B.S.; C.B.S. Publisher and Distributor.

Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd., Kolkata; 1999.

Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of

India

Pvt. Ltd., New Delhi; 1978.

A Text book of Practical Physiology; First Edition; V.G. Ranade; A.V.G. Prakashan, Pune; 1968.

Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.

Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.

Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.

Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.

Harrison's Hematology and Oncology; 3rd Edition (Harrison's Specialty); Dan Longo; McGraw-Hill.

Essentials of Haematology; Second Edition; Kawthalkar Shirish M.; Jaypee; 2013.

Medical Biochemistry by C. Jaypee; 2012.

Essentials in Hematology and Clinical Pathology; Nayak, Ramadas.

Clinical Pathology and Hematology; Maheshwari, Nanda; Jaypee.

Practical Hematology; Dacie J V; Churchill Livingstone; 2006.

Lecture Notes: Haematology; Hatton, Chris S. R. Hughes-Jones, Nevin C. Hay, Deborah; Wiley-Blackwell.

ABC series: ABC of Clinical Haematology; Provan; Drew Publisher: BMJBooks.

Principles of Anatomy & Physiology; Thirteenth Edition; Gerard J. Tortora & Bryan Derrickson; Biological Science Textbooks, Inc.; 2012.

Biochemistry; Fourth Edition; U. Satyanarayana & U. Chakrapani; Elsevier; 2013.

Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.

Immunology - Essential and Fundamental; Pathak S., & Palan U.; Science Publishers; 2005.

Immunology: A textbook; Rao C. V.; Alpha Science Int'l Ltd.; 2005.

Ananthanarayan and Paniker's textbook of Microbiology; C. J. Paniker (Ed.);

Ananthanarayan R.; Orient Blackswan; 2005.

Textbook of Immunology; Haleem Khan, Rajendra Sagar, Sadguna.

Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher

J. Woolverton; McGraw-Hill Education; 2014.

Immunology; Third Edition; Janis Kuby; W.H. Freeman; 1997.

Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara Osborne

& Janis Kuby; W.H. Freeman; 2007.

Concepts in Biochemistry; Third Edition; Rodney Boyer; John Wiley & Sons, Inc.; 2006.

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Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.

Cellular and Molecular immunology; Abbas A. K., Lichtman A. H. & Pillai S.; Elsevier Health

Sciences; 2014.

Roitt's Essential Immunology - Vol. 20; Delves P. J., Martin S. J., Burton D. R., & Roitt I.

M.; John Wiley & Sons; 2011.

The Elements of Immunology; Khan F.H.; Pearson Education, India; 2009.

Kuby Immunology; Sixth Edition; Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne & Janis Kuby; W.H. Freeman; 2007.

Janeway's Immunobiology; Murphy K. & Weaver C.; Garland Science; 2016.

Fundamental Immunology; Paul W. E.; Philadelphia: Lippincott-Raven; 1999.

Immunology - Introductory Textbook; Shetty N.; New Age International; 2005.

Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher

J. Woolverton; McGraw-Hill Education; 2014.

Medical Biochemistry; Fourth Edition; John Baynes & Marek Dominiczak; Saunders (Elsevier); 2014.

Lehninger's Principles of Biochemistry; David Lee Nelson, A. L. Lehninger, Michael M Cox;

W.H. Freeman, New York; 2008.

Biochemistry; 5th ed.; J M Berg, J L Tymoczko and Lubert Stryer; W.H. Freeman, New York; 2002.

Biochemistry; 2nd edition; Donald Voet and Judith G Voet; J. Wiley and Sons, New York;

1995.

ADDITIONAL READING:

Biology - A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015.

Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005.

Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007.

Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw-Hill

Education; 2012.

Biology - Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005.

The Emperor of All Maladies: A biography of Cancer; Siddhartha Mukherjee; Scribner, New York; 2010.

Molecular Cell Biology; Fifth edition; Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris

A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky & James Darnell; W.H.

Freeman & Company, New York; 2004.

'India facing shortage of life-saving albumin serum'; written by Abantika Ghosh, New Delhi; The Indian Express, October 16, 2014, 2:25 am.

Articles on "Blood groups"; (1) The Indian Express, August 15, 2012/ Times of India, August 16, 2012; (2)Times of India, September 11, 2014.

'Nanoparticle vaccine shows potential as immunotherapy to fight multiple cancer types';

UT Southwestern Medical Center; Science Daily, April 24 2017;
<https://www.sciencedaily.com/>.

Textbook of Biochemistry with clinical correlations; Fourth Edition: Edited by Thomas M.Devlin; Wiley-Liss Publication.

Biochemistry; Third Edition: Pamela C. Champe, Richard A. Harvey, Denise R. Ferrier; Indian Edition by JP Publication.

Course Code	SEM – 5 – Histo-toxico-pathology and biostatistics	Credits	Lectures/Week
KUSZO23503	Paper III Histology, Toxicology, Pathology and Biostatistics	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *Learner would appreciate the well planned organization of tissues and cells in the organ systems.*
- *To make the learner understand the need and importance of different types of tissues in the vital organs and their functions.*
- *Learner will be familiar with various medical terminology pertaining to pathological condition of the body caused due to diseases*
- *The course will prepare learner to develop broad understanding of the different areas of toxicology. It will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas*
- *The learner will be able to collect, organize and analyse data using parametric and nonparametric tests. They will also be able to set up a hypothesis and verify the same using limits of significance.*

Unit	Topics	No of Lectures
I	Mammalian Histology	15
II	Toxicology	15
III	General Pathology	15
IV	Biostatistics	15

Unit I: Mammalian Histology (15L)

1.1: Vertical section (V.S.) of skin: Layers and cells of epidermis; papillary and reticular

layers of dermis; sweat glands, sebaceous glands and skin receptors

1.2: Digestive System

1.2.1: Vertical section (V.S.) of tooth; hard tissue - dentine and enamel; soft tissue - dentinal

pulp and periodontal ligaments

1.2.2: Transverse section (T.S.) of tongue - mucosal papillae and taste buds

1.2.3: Alimentary canal - Transverse section (T.S.) of stomach, small intestine, large

intestine

of mammal.

1.2.4: Glands associated with digestive system - Transverse section (T.S.) of salivary glands, liver.

Unit II: Toxicology (15 L)

2.1: Basic toxicology

2.1.1: Introduction to toxicology - brief history, different areas of toxicology, principles and

scope of toxicology

2.1.2: Toxins and Toxicants - Phytotoxins (caffeine, nicotine), Mycotoxins (aflatoxins), 19

Zootoxins (cnidarian toxin, bee venom, scorpion venom, snake venom)

2.1.3: Characteristics of Exposure - Duration of exposure, Frequency of exposure, Site of

exposure and Routes of exposure

2.1.4: Types of Toxicity - Acute toxicity, Sub-acute toxicity, Sub-chronic toxicity and Chronic

toxicity

2.1.5: Concept of LD50

, LC50

, ED50

2.1.6: Dose Response relationship - Individual / Graded dose response, Quantal dose response, shape of dose response curves, Therapeutic index, Margin of safety

2.1.7: Dose translation from animals to human - Concept of extrapolation of dose, NOAEL (No Observed Adverse Effect Level), Safety factor, ADI (Acceptable Daily Intake)

2.1.8: Target organ toxicity:

Hepatotoxicity: susceptibility of the liver, types of liver injury, examples of hepatotoxicants;

Neurotoxicity: vulnerability of nervous system, examples of neurotoxicants;

Nephrotoxicity: susceptibility of kidney, examples of nephrotoxicants

2.2: Regulatory toxicology

2.2.1: OECD guidelines for testing of chemicals (an overview)

2.2.2: CPCSEA guidelines for animal testing centre, ethical issues in animal studies

2.2.3: Animal models used in regulatory toxicology studies

2.2.4: Alternative methods in toxicology (*in vitro* tests)

Unit III: General Pathology (15L).

3.1: General Pathology: Introduction and scope

3.2: Cell injury: Mechanisms of cell injury: ischemic, hypoxic, free radical mediated and chemical

3.3: Retrogressive changes: Definition, cloudy swelling, degeneration: fatty, mucoid and

amyloid (causes and effects)

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3.4: Disorders of pigmentation: Endogenous: Brief ideas about normal process of pigmentation, melanosis, jaundice (causes and effects)

3.5: Necrosis: Definition and causes; nuclear and cytoplasmic changes; types: coagulative, liquefactive, caseous, fat and fibroid

3.6: Gangrene: Definition and types - dry, moist and gas gangrene

Unit IV: Biostatistics (15L)

4.1: Probability Distributions: Normal, Binomial, Poisson distribution, Z-transformation, pvalue,

Probability - Addition and multiplication rules and their applications

4.2: Measures of Variation: Variance, standard deviation, standard error

4.3: Testing of Hypothesis: Basic concepts, types of hypothesis: Null hypothesis and Alternate hypothesis, Levels of significance and testing of hypothesis

4.4: Parametric and non-parametric test: Parametric tests: two-tailed Z-test and t-test

Non-parametric test: Chi-square test and its applications

4.5: Correlation: Correlation coefficient and its significance

Textbooks:

A Textbook of Histology; Deshmukh Shivaji; Dominant Pub.

Colour Textbook of Histology; Gartner, Leslie P.; Saunders.

A Textbook of Histology; Mathur Ramesh; Anmol Pub.

A Textbook of Histology and A Practical Guide; Gunasegaran J.P.; Elsevier

A Textbook of Histology; Khanna D.R.; Sonali Pub.

Practical Zoology; Second Edition; Dr. K.C. Ghose&Dr. B. Manna; New Central Book Agency Pvt. Ltd. , Kolkata; 1999.

Casarett and Doulls Toxicology - The basic science of poisons; Edited by Curtis Klaassen; McGraw-Hill; 2001.

Toxicological testing handbook - Principles, applications and data interpretation; David Jacobson-Kram and Kit Keller; CRC Press; 2006.

Principles and methods of toxicology; A. Wallace Hayes; CRC Press; 2007.

Toxicology - principles and methods; M.A. Subramanian; MJP Publishers, Chennai; 2004.

Fundamentals of Toxicology; Kamleshwar Pandey and JP Shukla; New Central book agency Ltd., Kolkata; 2011.

Elements of Toxicology; Kamleshwar Pandey and JP Shukla; Wisdom Press, New Delhi; 2010.

Principles and Applications of Toxicology; Lahir Y.K.; Seekay Publications; 2013.

Essentials of Clinical Toxicology; Lall S.; Narosa Publishing House; 1998.

A Textbook of Veterinary and General Pathology; Second edition; J. L. Vagad; IBDC Publishers.

Clinical Pathology; Guru G.; NCERT; 1988.

Clinical Pathology; Batra Neelam; Vikas Publishing House Pvt. Ltd.; Nov. 1982.

Essentials of General Pathology; Dr. Sudha Shivraj, Dr. Satish Kumar Amarnath, Dr. Sheela Devi; Exclusively distributed by CBS Publishers & Distributors.

Textbook of Pathology; Harsh Mohan; Jaypee Publishers.
Biostatistics - The Bare Essentials; Third Edition; Geoffrey R. Norman, David L. Streiner;
B.C. Decker, Inc., Hamilton; 2008.
Fundamentals of Biostatistics; Second Edition; Veer Bala Rastogi; Ane Books Pvt. Ltd.,
New Delhi; 2009 (Reprint 2010).
Fundamentals of Biostatistics; Second Revised Edition; Irfan Ali Khan and Atiya Khanum;
Ukaaz Publications, Hyderabad; 2004.
Instant Medical Biostatistics; Dr. Ranjan Das and Dr. Papri N. Das; Ane Books Pvt. Ltd.,
New Delhi; 2009.
Primer of Biostatistics; Fifth Edition; Stanton A. Glantz; McGraw-Hill Companies, Inc.; 2002.
Basic Biostatistics - Statistics for Public Health Practice; Second Edition; B. Burt Gerstman; Jones and Bartlett Learning Burlington; 2015.
Biostatistics - A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Forthofer, Eun Sul Lee and Mike Hernandez; Elsevier, Inc., (Academic Press), USA; 2007.
Statistics in Biology and Psychology; Sixth Edition; Debajyoti Das and Arati Das; Academic Publishers, Kolkata.

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ADDITIONAL READING:

Biology - A Global Approach; Tenth Edition (Global Edition); Campbell, Reece, Urry, Cain, Wasserman, Minorsky & Jackson; Pearson Education Ltd., England; 2015.
Biology; Seventh Edition; Neil A. Campbell & Jane B. Reece; Pearson Education, Inc.; 2005.
Biology; Student Edition; Kenneth R. Miller & Joseph S. Levine; Prentice Hall; 2007
Biology: Eleventh Revised Edition; Sylvia S. Mader & Michael Windelspecht; McGraw-Hill Education; 2012.
Biology - Concepts & Applications; Sixth Edition; Cecie Starr; Brooks/ Cole; 2005.
Prescott's Microbiology; Ninth Edition; Joanne M. Willey, Linda M. Sherwood & Christopher J. Woolverton; McGraw-Hill Education; 2014.
Disease & Medicine in India - A Historical Overview; Deepak Kumar; Tulika Books, India;
2012.

Course Code	SEM – V – Comparative anatomy and developmental biology	Credits	Lectures /Week
KUSZO23504	Paper 4 Anatomy and Developmental Biology	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *To introduce the learner to different bones of human skeleton and their functional importance.*
- *Learner will be able to understand the importance of various types of epidermal and dermal derivatives along with their functions.*
- *Learner will be able to understand the structure, types and functions of human skeleton., To introduce the learner to the basics of developmental biology with reference to chick as a model and also familiarize with experiments related to it.*
- *Learner will be able to understand the processes involved in embryonic development and practical applications of studying the chick embryology.*

Unit	Topics	No of Lectures
I	Integumentary system and derivatives	15
II	Human Osteology	15
III	Muscles of long bones of Human limbs	15
IV	Developmental biology of Chick	

Unit I: Integumentary system and derivatives (15L)

1.1: Basic structure of integument: Epidermis and dermis

1.2: Epidermal derivatives of Vertebrates

1.2.1: Hair, hoof, horn, claw, teeth, beak and epidermal scales (small scales, large scales,

modified scales - spine)

1.2.2: Glands - types (mucous, serous, ceruminous, poison, uropygial and salt gland) and functions

1.2.3: Type of feathers

1.3: Dermal derivatives of Vertebrates: Scales in fish; scutes in reptiles and birds; dermal

scales in mammals - Armadillo, Antler - Caribou

1.4: Special derivatives of integument: Wart in toad, rattle in snake, whale bone in baleen

whale, kneepads in camel.

Unit II: Human Osteology (15L)

2.1: Introduction: Bone structure (Histology), physical properties, chemical composition and

general functions of bones.

Cartilage: General structure, functions

2.2: Axial skeleton

2.2.1: Skull: General characteristics of skull bones - Cranial and facial bones

2.2.2: Vertebral column: General characteristics of a vertebra, structure of different types of

vertebrae (cervical, thoracic, lumbar, sacrum and coccyx)

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2.2.3: Ribs and sternum: General skeleton of ribs and sternum

2.2.4: Hyoid bone: Structure and function.

2.3: Appendicular skeleton

2.3.1: Pectoral girdle and bones of forelimbs

2.3.2: Pelvic girdle and bones of hind limbs

Unit III: Muscles of long bones of Human limbs (15L)

3.1: Introduction and types of long limb muscles

3.1.1: Flexors, Extensor, Rotator, Abductors, Adductors

3.2: Muscles of forelimbs

3.2.1: Muscles that move the arm (Humerus) - *Triceps brachii*, *Biceps brachii*, *brachialis* and *brachioradialis*

3.2.2: Muscles that move the forearm (Radius-ulna) - *Flexor carpi radialis*, *Flexor carpi ulnaris* and *Extensor carpi ulnaris*

3.2.3: Muscles that move the wrist, hand and fingers - *Flexor digitorum superficialis*, *Extensor carpi radialis* and *Extensor digitorum*

3.3: Muscles of hindlimbs

3.3.1: Muscles that move the thigh (Femur) - Sartorius, Adductor group, Quadriceps group

(*Rectus femoris*, *Vastus lateralis*, *Vastus medialis*), Hamstring group (*Biceps femoris*, *Semimembranosus*, *Semitendinosus*)

3.3.2: Muscles that move the lower leg (tibia-fibula) - *Fibularis longus*, *Gastrocnemius*, *Tibialis anterior*, *Soleus*, *Extensor digitorum longus* and *Fibularis tertius*

3.3.3: Muscles that move the ankle, foot and toes - *Tibialis anterior*, *Extensor digitorum*,

Longus and *Fibularis* muscles

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Unit IV: Developmental biology of Chick (15L)

4.1: Introduction to Developmental Biology: Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.

4.2: Development of Chick embryo

4.2.1: Structure of Hen's egg, physico-chemical nature and forms of yolk - granular, platelets

and spheres; fertilization, cleavage, blastulation, gastrulation

4.2.2: Structure of chick embryo - 18hours, 24 hours, 33 hours, 48 hours and 72 hours

4.2.3: Extra embryonic membranes

4.2.4: Organizer: Introduction, Spemann Mangold experiment, Hensen's node as an Organizer

Textbooks:-

Comparative Anatomy of the Vertebrates; Ninth Edition; Kent, G.C. and Carr R.K.; The McGraw-Hill Companies; 2000.

Text book of Chordates; Saras publication.

Modern text book of Zoology; Prof. R.L. Kotpal.

Integumentary system and its derivatives; Samuel D. Hodge.

Atlas of Human Anatomy - Vol I; R.D. Sinelnikov; Mr. Publishers Moscow.

A Guide of Osteology (for medical students); Prakash Kendra, Lucknow.

Text Book of Comparative Anatomy and Physiology; Tortora.

Human Osteology - Tim D White.

Text Book of Human Osteology - Singh Inderbir.

Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India

Pvt. Ltd., New Delhi; 1978.

Human Anatomy - John W. Hole, Jr., Karen A. Koos, Publisher: W. C. Brown Publisher, USA.

Principles of Anatomy and Physiology - Gerard T. Tortora and Sandra Reynolds Grabowski. Publisher: Harpers Collins College Publishers (7th Edition).

Developmental biology - Gilbert.

Development of Chick - Patten.

Developmental Biology - Wolpert.

Text book of Embryology - N. Arumugam.

Chicken Development - Embryology; W.H. Freeman & B. Bracegirdle.

Practical Zoology; Second Edition; Dr. K.C. Ghose & Dr. B. Manna; New Central Book Agency Pvt. Ltd. , Kolkata; 1999.

ADDITIONAL READING

Comparative Anatomy of Vertebrates by Sumitra Saxena and R. K. Saxena.

Comparative Anatomy of Vertebrates by S. K. Kulshrestha.

Vertebrates: Comparative Anatomy, Function, Evolution by Kenneth Kardong.

Comparative Anatomy of the Vertebrates by George C Kent and Robert K. Carr.

Comparative Anatomy of Vertebrates by Robert Wiedersheim.

Illustrations of Comparative Anatomy, Vertebrate and Invertebrate - For The Use of Students In The Museum Of Zoology And Comparative Anatomy.

Human Osteology, 3rd Edition by Tim D. White, Michael T. Black and Pieter A.

Folkens.

Hand Book of Osteology, 13th Edition by S. Poddar and Ajay Bhagat.

The Anatomy and Biology of the Human Skeleton by D. Gentry Steele.

Atlas of Chick Development - By Ruth Bellairs and Mark Osmond.

Laboratory embryology of the chick by Lloyd Eugene Downs.

Vertebrate Embryology: A Laboratory Manual - Richard M. Eakin.

Molecular Embryology: Methods and Protocols by Paul T. Sharpe, Ivor.

Dictionary of Developmental Biology and Embryology by Frank J. Dye.

Course Code	SEM – 6 – Chordates and type study	Credits	Lectures /Week
KUSZO23601	Paper I Taxonomy - Chordates and Type Study	2	3

Course Outcomes:

After successful completion of this course, students would be able to

- *Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features.*
- *To introduce the learners to the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat.*
- *Learners will get an idea of vertebrate animal life after studying one representative animal- shark.*

Unit	Topics	No of Lectures
I	Phylum Chordata: Group Protochordata and Group Euchordata I	15
II	Group Euchordata II	15
III	Group Euchordata III	15
IV	Type study: Shark	15

Unit I: Phylum Chordata: Group Protochordata and Group Euchordata I (15L)

1.1: General characters, Difference between non-chordates and chordates

Origin of chordates: Annelids as ancestors, Arachnids as ancestors and affinities with

Echinodermata

1.2: Protochordata

1.2.1: General characters of Group Protochordata

1.2.2: Distinguishing characters of Subphylum Urochordata and Cephalochordata

1.2.3: Subphylum Urochordata

Class Ascidiacea e.g. *Herdmania*

Class Thaliacea e.g. *Salpa*

Class Larvacea e.g. *Oikopleura*

1.2.4: Subphylum Cephalochordata

Class Leptocardii e.g. *Branchiostoma (Amphioxus)*

1.3: Group Euchordata I

Group Euchordata: General characters

Subphylum Vertebrata: General characters

Division Agnatha and Gnathostomata: Distinguishing characters.

General characters with examples of:

Class Ostracodermii e.g. *Cephalaspis*

Class Cyclostomata e.g. *Petromyzon* (Lamprey)

Unit II: Group Euchordata II (15L)

2.2.1: Division: Gnathostomata

- Superclass: Pisces and Tetrapoda
- Superclass - Pisces: Distinguishing characters

Class Placodermi e.g. *Climatius*

Class Chondrichthyes e.g. *Rhinobatos* (Guitar fish)

Class Osteichthyes e.g. *Exocetus* (Flying fish)

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2.2.2: Dipnoi (Lung fish): Distribution, habit and habitat, external and internal characters,

affinities with super class Pisces, affinities and differences with class Amphibia

2.3: Superclass Tetrapoda

Class Amphibia: General characters

Examples:

- a. Limbless amphibian e.g. *Ichthyophis* (Caecilian)
- b. Tailed amphibian e.g. *Amphiuma*
- c. Tailless amphibian e.g. *Hyla* (Tree frog)

Unit III: Group Euchordata III (15L)

3.1: Class Reptilia: General characters

Examples

- a. Extinct reptile e.g. *Ichthyosaurus*
- b. Living fossil e.g. *Sphenodon* (Tuatara)
- c. Aquatic reptile e.g. *Chelonia* (Sea turtle)
- d. Arboreal reptile e.g. *Chamaeleo* (Chamaeleon)

3.2: Class Aves: General Characters

Examples

- a. Arboreal bird e.g. *Melanerpes* (Wood pecker)
- b. Terrestrial bird e.g. *Gallus* (Fowl)
- c. Swimming bird e.g. *Phalacrocorax* (Cormorant)
- d. Wading bird e.g. *Ardeola* (Heron)
- e. Birds of prey e.g. *Tyto* (Owl)
- f. Flightless birds e.g. *Dromaius* (Emu)

3.3: Class Mammalia: General characters

Examples

- a. Egg-laying mammals e.g. *Ornithorhyncus* (Duck-billed platypus)
- b. Pouched mammals e.g. *Macropus* (Kangaroo)
- c. Insect eating mammals e.g. *Sorex* (Common shrew)
- d. Toothless mammals e.g. *Bradypus* (Sloth)
- e. Gnawing mammals e.g. *Funambulus* (Squirrel)
- f. Primates e.g. *Macaca* (Monkey)

Unit IV: Type study: Shark (15L)

4.1: Habit & habitat, distribution, external characters, classification and economic importance.

4.2: Skin, exoskeleton, endoskeleton and systems

- a) Digestive system
- b) Respiratory system
- c) Blood vascular system
- d) Nervous system and receptor organs
- e) Urinogenital system, copulation, fertilization and development

Textbooks:

Modern text book of Zoology - Vertebrates; Professor R.L. Kotpal; Rastogi publication; Third Edition 2012.

Vertebrate Zoology for Degree students; V. K. Agarwal; S. Chand Publication; 2012.

Fundamentals of Zoology, Dr. K. C. Ghosh and Dr. B. Manna, New Central book Agency (P) Ltd.

Chordate Zoology Volume II, Prof. N. Arumogam. Saras Publication.

Chordate Anatomy Mohan P. Arora, Himalaya Publishing House, First edition.

The life of Vertebrates; J.Z. Young; ELBS - Oxford University Press; Third edition, 2006

Textbook of chordate Zoology, Vol. II, G.S. Sandhu, H. Bhaskar; Campus Book International, First edition, 2005.

Introduction to Zoology - Vol II: K. K. Chaki, G. Kundu and S. Sarkar, New Crystal Book

Agency.

URL for search on net: <https://www.amazon.com/Protozoology-Susheel-Vilas-Nikam/dp/9350300044>.

Chordate Zoology by E. L. Jordan and P. S. Verma, edition, 2009, Chand publications.

Chordate Zoology by P. S. Verma, edition, 2009, Chand publications.

Modern Textbook of Zoology Vertebrates by R.L. Kotpal, edition Jan 2015, Rastogi publications.

Practical Zoology: Vertebrate, by S. S. Lal, 2015.

A Textbook of Invertebrate Zoology & Cell Biology, by V. S. Kanwate, A. N. Kulkarni et al.

ed. Alka Prakashan.

The Animal Kingdom: An Elementary Textbook in Zoology; Specially Classified and Arranged for the Use of Science Classes, Schools and Colleges (Classic Reprint), by Ellis

A. Davidson, Sept. 2015, Publisher: Forgotten Book.

ADDITIONAL READING

<http://faculty.collegeprep.org/~bernie/sciproject/project/Kingdoms/Animal%20Kingdom%20-%205/Local%20copy/classification/chordata.html>

<http://www.ucmp.berkeley.edu/chordata/chordata.html>

<http://animaldiversity.org/accounts/Chordata/>

<https://www.earthlife.net/inverts/chordata.html>

<http://www.nhc.ed.ac.uk/index.php?page=493.450>

<https://manoa.hawaii.edu/exploringourfluidearth/biological/invertebrates/phylumchordata>

<http://www.nhptv.org/wild/chordata.asp>

<https://www.shapeoflife.org/phylum-chordata-advanced>

Course Code	SEM – 6-Physiology and animal tissue culture	Credits	Lectures /Week
KUSZO23602	Paper II Physiology and Tissue Culture	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *To introduce to the learner the fundamental concepts of enzyme biochemistry and to enable the learner realize applications of enzymes in basic and applied sciences*
- *The learner shall comprehend the adaptive responses of animals to environmental changes for their survival.*
- *The learner shall understand fundamentals of enzyme structure, action and kinetics. The learner shall appreciate the enzyme assay procedures and the therapeutic applications of enzymes.*
- *The learner shall understand the significance of tissue culture as a tool in specialized areas of research. The learner will appreciate its applications in various industries.*

Unit	Topics	No of Lectures
I	Enzymology	15
II	Homeostasis	15
III	Endocrinology	15
IV	Animal Tissue Culture	15

Unit I: Enzymology (15L)

1.1: Introduction and Nomenclature: Definition; concept of activation energy; nomenclature and classification (based on IUB - Enzyme Commission) of enzymes; chemical nature of enzyme, co-factors and co-enzymes

1.2: Enzyme Action and Kinetics: Mechanism; Factors affecting enzyme activity - substrate, pH and temperature. Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of K_m , V_{max} and K_{cat}

1.3: Enzyme Inhibition: Competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors

1.4: Regulation of Enzyme Activity: Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)

1.5: Industrial applications of enzymes: Food and detergents

Unit II: Homeostasis (15L)

2.1: Homeostasis

2.1.1: External and internal environment; Acclimation and acclimatization

2.1.2: Body clock - Circadian & Diurnal rhythm

2.2: Thermoregulation

2.2.1: Endothermy and ectothermy

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2.2.2: Temperature balance: Heat production - shivering and non-shivering thermogenesis;

brown fat, mechanisms of heat loss

2.2.3: Adaptive response to temperature - daily torpor, hibernation, aestivation

2.3: Osmotic and Ionic Regulation

2.3.1: Living in hypo-osmotic, hyper-osmotic and terrestrial environment - Water absorption,

salt water ingestion and salt excretion, salt glands, metabolic water

2.3.2: Role of kidney in ionic regulation

Unit III: Endocrinology (15L).

3.1: General organization of mammalian endocrine system

3.2: Hormones: Classification, properties, mechanism of hormone action

3.3: Histology, functions and disorders of the following endocrine glands:

Pituitary

Thyroid

Parathyroid

Pancreas

Adrenal

Unit IV: Animal Tissue Culture (15L)

4.1: Aseptic techniques

4.1.1: Sterilization - basic principles of sterilization, importance of sterility in cell culture

4.1.2: Sterile handling - swabbing, capping, flaming, handling bottles and flasks, pipetting,

pouring

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4.2: Culture media

4.2.1: Types of media - Natural and Artificial media

4.2.2: Balanced Salt Solutions

4.2.3: Complete Media - amino acids, vitamins, salts, glucose, oxygen supplements, hormones and growth factors, antibiotics

4.2.4: Factors influencing cell culture - surface tension and foaming, viscosity, temperature,

osmolality, pH, CO₂, bicarbonate and O₂

4.3: Advantages of tissue culture - control of the environment, *in vitro* modelling of *in vivo*

conditions

4.4: Limitations of tissue culture

4.5: Culture techniques

4.5.1: Preparation of cells / organs for culture

4.5.2: Cover slip, Flask and Tube culture

4.5.3: Primary and established cell lines

4.5.4: Hybridoma technology

Textbooks:

Comparative Animal Physiology; Knut Schmidt Nielson; Cambridge Press.

Comparative Animal Physiology; Prosser and Brown.

Comparative Animal Physiology; William S Hoar.

Text book of Comparative Physiology; R Nagabhushanam, Ms Kodarkar, Sarojini R. India Book House Pvt. Ltd.

Animal Physiology; N. Arumugam, A. Mariakuttikan; Saras Publication.

Text book of Endocrinology; Williams .

Textbook of Endocrinology Hardcover; Dharmalingam; 2010.

Endocrinology; 6th Edition; Mac Hadley , Jon E. Levine.

Bailey's textbook of histology Hardcover; Frederick R Bailey.

Mechanisms of Body Functions; Second Edition; Dexter M. Easton; Prentice-Hall of India

Pvt. Ltd., New Delhi; 1978.

Culture of animal cells - A manual of basic technique; R. Ian Freshney; John Wiley and Sons Publications; 2005.

Basic cell culture - A practical approach; J. M. Davis; Oxford University Press; Indian edition; 2005.

Animal cell culture - Biotechnology Series: Vol.1; Bina Mishra, B. P. Mishra, Pran P. Bhat, P.N. Bhat; Studium Press (India) Pvt. Ltd; 2011.

Animal cell culture - Concept and Applications; Shweta Sharma; Oxford book Company;

2012.

Biotechnology of Animal Tissues; Dr. P. R. Yadav and Dr. Rajiv Tyagi; Discovery Publishing House, New Delhi; 2006.

ADDITIONAL READING:

A textbook of Enzymes: Shailendra Singh; Campus Book International, New Delhi 2007.

Biochemical Adaptation: Mechanism and Process in Physiological Evolution: Peter W. Hochachka& George N. Somero, Oxford University Press.

Comparative Animal Physiology: P. C. Withers, Thomson Publishing Co.

Mammalian Endocrinology: Ashoke Kumar Boral. New Central Book Agency Ltd.

Endocrinology-Hormones and Human Health: Prakash S. Lohar, MJP Publishers, Chennai. 2005.

Biotechnology-an introduction: Second Edition: S. Ignacimuthu, S. J, Narosa Publications.

Animal Biotechnology: R. Sasidhara, MJP Publishers, Chennai. 2006.

Course Code	SEM – 6-Molecular Biology ,genetics and bioinformatics	Credits	Lectures /Week
KUSZO23603	Paper III Genetics and Bioinformatics	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *The learner shall become aware of the impact of changes occurring at gene level on human health and its diagnosis.*
- *Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material.*
- *The learner shall get acquainted with the vast array of techniques used to manipulate genes which can be applied in numerous fields like medicine, research, etc. for human benefit.*
- *Learner shall become aware of the computational point of view of studying the genomes.*

Unit	Topics	No of Lectures
I	Molecular Biology	15
II	Genetic Engineering	15
III	Human Genetics	15
IV	Bioinformatics	15

Unit I: Molecular Biology (15 L)

1.1: Types of mutation

1.1.1: Point mutations - substitution, deletion and insertion mutations

Substitution mutations - silent, missense and nonsense mutations, transition and transversion

Deletion and Insertion mutations - frameshift mutations

1.1.2: Trinucleotide repeat expansions - fragile X syndrome, Huntington disease

1.1.3: Spontaneous mutation - tautomeric shifts, spontaneous lesions

1.2: Induced mutations

1.2.1: Physical agents:

Ionizing radiation (X-rays, α , β and γ rays)

Non-ionizing radiation (UV light)

1.2.2: Chemical agents:

Base analogs (5-bromouracil)
Intercalating agents (ethidium bromide)
Deaminating agents (nitrous acid)
Hydroxylating agents (hydroxylamine)
Alkylating agents (mustard gas)
Aflatoxin (aflatoxin B1)

1.3: Preventative and repair mechanisms for DNA damage

1.3.1: Mechanisms that prevent DNA damage - superoxide dismutase and catalase
1.3.2: Mechanisms that repair damaged DNA - direct DNA repair (alkyl transferases, photoreactivation, excision repair)
1.3.3: Postreplication repair - recombination repair, mismatch repair, SOS repair

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1.4: Eukaryotic gene expression

1.4.1: Regulatory protein domains - zinc fingers, helix-turn-helix domain and leucine zipper

1.4.2: DNA methylation

Unit II: Genetic Engineering (15 L)

2.1: Tools in Genetic Engineering

2.1.1: Enzymes involved in Genetic Engineering: Introduction, nomenclature and types of

restriction enzymes with examples, Ligases - *E. coli* DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA polymerases, reverse transcriptase, terminal transferase

2.1.2: Vectors for gene cloning: General properties, advantages and disadvantages of cloning

vectors - plasmid vectors (pBR322), phage vectors (λ Phage), cosmid vectors (c2XB)

2.1.3: Cloning techniques: Cloning after restriction digestion - blunt and cohesive end ligation, creation of restriction sites using linkers and adapters, cloning after homopolymer tailing, cDNA synthesis (Reverse transcription), genomic and cDNA libraries

2.2: Techniques in Genetic Engineering

2.2.1: PCR techniques: Principle of polymerase chain reaction (PCR), Applications of PCR

2.2.2: Sequencing techniques: DNA sequencing: Maxam-Gilbert method, Sanger's method

Protein sequencing: Sanger's method, Edman's method Applications of sequencing techniques

2.2.3: Detection techniques: Blotting techniques - Southern blotting, Northern blotting and

Western blotting Applications of blotting techniques

Unit III: Human Genetics (15L)

3.1: Non-disjunction during mitosis and meiosis

3.1.1: Chromosomal Aberrations: Structural: Deletion: types, effects and disorders;

Translocation: types: Robertsonian and non-Robertsonian disorders;

Inversion: types, effects and significance;

Duplication and their evolutionary significance (multigene families)

Numerical: Aneuploidy and Polyploidy (Autopolyploidy and Allopolyploidy)

3.2: Genetic Disorders

3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism

3.2.2: Single gene mutation: Cystic fibrosis

3.2.3: Multifactorial: Breast Cancer

3.2.4: Uniparental Disomy: Angelman Syndrome and Prader-Willi Syndrome

3.3: Diagnosis

3.3.1: Prenatal Diagnosis: Amniocentesis and Chorionic villus sampling, Banding techniques

(G, C, Q), FISH, Protein truncation test (PTT)

3.3.2: Genetic counselling

Unit IV: Bioinformatics (15L)

4.1: Introduction

4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, OMIM, PubMed)

4.1.2: Applications of Bioinformatics

4.2: Databases - Tools and their uses

4.2.1: Biological databases;

Primary sequence databases: Nucleic acid sequence databases (GenBank, EMBLEBI, DDBJ) Protein sequence databases (UniProtKB, PIR)

Secondary sequence databases

Derived databases - PROSITE, BLOCKS

Structure databases and bibliographic databases

4.3: Sequence alignment methods

4.3.1: BLAST, FASTA

4.3.2: Types of sequence alignment (Pairwise & Multiple sequence alignment)

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4.3.3: Significance of sequence alignment

4.4: Predictive applications using DNA and protein sequences

4.4.1: Evolutionary studies: Concept of phylogenetic tree, convergent and parallel evolution

4.4.2: Pharmacogenomics: Discovering a drug: Target identification

4.4.3: Protein Chips and Functional Proteomics: Different types of protein chip (detecting and

quantifying), applications of Proteomics

4.4.4: Metabolomics: Concept and applications

Textbooks:

Genetics - The continuity of life; Daniel Fairbanks and Ralph Andersen; Brooks/ Cole Publishing Company; 1999.

Introduction to Molecular Biology; Peter Paoletta; Tata McGraw Hill; 2010.

Molecular Biology; David Freifelder; Narosa Publishing House; 2008.

Genetics; Robert Weaver and Philip Hedrick; McGraw Hill; 2001.

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Current Protocols in Molecular Biology; Frederick M. Ausubel, Roger Brent, Robert E. Kingston, David D. Moore, Seidman J. G., John A. Smith and Kevin Struhl; John Wiley & Sons, Inc.; 2003.

Introduction to Proteomics; Daniel C. Liebler; Humana Press; 2002.

Molecular cloning; Joseph Sambrook, David William Russell; Third Edition; CSHL Press; 2001.

Gene Cloning - An Introduction; Brown .T.A; Fourth Edition; Wiley-Blackwell; 2011.

Recombinant DNA - Genes and Genomes- A short course; 3rd Edition; Watson, J.D., Myers, R.M., Caudy A., Witkowski, J.K.; Freeman and Co. NY; 2007.

Principles Of Gene Manipulation & Genomics; Primrose SB and R. Twyman; Blackwell Science Publications; 2006.

Methods In Enzymology, Vol 152; Berger SI, Kimmer AR; Academic Press; 1987.

Genomes 3; Third Edition; T.A.Brown; Garland Science Publishing; 2007.

Molecular Biotechnology - Principles and applications of recombinant DNA; Glick, B.R. and Pasternak, J. J.; ASM press, Washington; 2010.

Microbiology; Fifth Edition; Pelczar, M.J. et al; Tata McGraw-Hill Co., New Delhi; 2001.

Introduction to Protein Structure; Second Edition; Branden C. and Tooze J.; Garland Publishing; 1999.

Proteins; Second Edition; Creighton T.E.; W.H. Freeman; 1993.

Proteomics - Protein Sequence to Function; Pennington, S.R and M.J. Dunn; Viva Books; 2002.

Genetic engineering - Principles and Practice; Sandhya Mitra; Macmillan India Ltd., New Delhi.

Biotechnology - Fundamentals and Applications; Third Enlarged Edition; S.S. Purohit; Student Edition, Jodhpur; 2005.

Biotechnology - Expanding Horizons; B.D.Singh; Kalyani Publishers, Ludhiana.

A textbook of Biotechnology; R.C.Dubey; S.Chand and Company Ltd., New Delhi.

Cell and Molecular Biology; Eighth Edition; E.D.P. De Robertis, E.M.F. De Robertis Jr.; Info-Med Ltd.; 1988.

Genetics (Bios Instant Notes); Third Edition; G.I. Hickey, H.L. Fletcher and P. Winter; Taylor and Francis Group, New York; 2007.

Genetics - A Conceptual Approach; Third Edition; Benjamin A. Pierce; W.H. Freeman and Company, New York; 2008.

New Clinical Genetics; Second Edition; Andrew Read and Dian Donnai; Scion Publishing Ltd., UK; 2011.

Genetics; Third Edition; Robert F. Weaver and Philip W. Hedrick; Wm. C. Brown Publishers (The McGraw-Hill Companies, Inc.); 1997.

Human Molecular Genetics; Fourth Edition; Tom Strachan and Andrew Read; Garland Science, USA; 2011.

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The Science of Genetics - An Introduction to Heredity; Fourth Edition; George W. Burns;

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Bioinformatics - Concepts, Skills, and Applications; S.C. Rastogi & others; CBS Publishing; 2003.

Bioinformatics - A practical guide to analysis of Genes & Proteins; Andreas D Baxevanis

& B F Francis; John Wiley; 2000.

Introduction to Bioinformatics; 1st Edition; T K Attwood, D J parry-Smith; Pearson Education, 11th Reprint; 2005.

Bioinformatics; 1st Edition; C S V Murthy; Himalaya Publishing House; 2003.

Bioinformatics sequence and genome analysis; David W. Mount; Cold spring Harbor Laboratory Press; 2004.

Basic Bioinformatics; S. Ignacimuthu, S.J.; Narosa Publishing House; 1995.

An Introduction to Bioinformatics Algorithms; Neil C. Jones and Pavel A. Pevzner; MIT Press, First Indian Reprint; 2005.

Bioinformatics - Managing Scientific Data; Zoe Lacroix, Terence Critchlow; Morgan Kaufmann Publishers (Elsevier Science); 2003 (for the V unit).

Phylogenetics: Theory and Practice of Phylogenetic Systematics; Second edition; Bruce

S. Lieberman; Wiley-Blackwell; 2011.

Molecular Evolution: A Phylogenetic Approach; Roderick D.M. Page, Dr Edward C. Holmes; Well Publishing; 1998.

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edition; Springer publications; 2001.

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Metabolomics - A Powerful Tool in Systems Biology; Jens Hřiriis Nielsen, Michael C. Jewett; Springer; 2007.

Systems Metabolic Engineering; Dr. Christoph Wittmann, Sang Yup. Lee; Springer; 2012

Bioinformatics (Bios Instant Notes); Second Edition (Special Indian Edition); T. Charlie Hodgman, Andrew French and David R. Westhead; Garland Science (Taylor and Francis Group); 2010.

Understanding Bioinformatics; Marketa Zvelebil and Jeremy O. Baum; Garland Science (Taylor and Francis Group); 2008.

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Bioinformatics Computing - The complete practical guide to bioinformatics for life scientists; Bryan Bergeron; Eastern Economy Edition; Prentice-Hall of India Pvt. Ltd., New Delhi; 2003.

Bioinformatics; Prakash S. Lohar; MJP Publishers, Chennai; 2009.

Introduction to Bioinformatics; First Edition; S. Sundara Rajan and R. Balaji ; Himalaya Publishing House, Mumbai; 2002.

Molecular Biology - Bios Instant Notes; Fourth Edition; Alexander McLennan, Andy Bates, Phil Turner & Mike White; Garland Science; 2013.

ADDITIONAL READING

The Gene: An Intimate History; Siddhartha Mukherjee; Scribner, New York; 2016.

The Handling of Chromosomes; Sixth Edition; C.D. Darlington & L.F. La Cour; George Allen & Unwin Ltd., London; 1976.

Molecular Cell Biology; Fifth edition; Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Matthew P. Scott, S. Lawrence Zipursky & James Darnell; W.H. Freeman & Company, New York; 2004.

Course Code	SEM – 6-Environment management and zoopharmacognosy	Credits	Lectures /Week
KUSZO23604	Paper IV Environmental Biology and Zoopharmacognosy	2.5	3

Course Outcomes:

After successful completion of this course, students would be able to

- *To acquaint the learner with key concepts of embryology,pollution*
- *Learner will be able to understand various methods for wildlife conservation*
- *Apply knowledge to overcome the issues related to wildlife conservation and management, understand the paradigms of discovery and commercialization of biological resources and knowledge gained from self-medication observed in*

animals.

- Learner will understand the different factors affecting environment, its impact and environment management laws., will become acquainted with how and why different animal species are distributed around the globe

Unit	Topics	No of Lectures
I	Environment management	15
II	Wildlife Management	15
III	Bioprospecting and Zoopharmacognosy	15
IV	Zoogeography	15

Unit I: Environment management (15L)

1.1: Natural resources and their Classification

1.1.1: Forest resources, water resources (surface and ground) and mineral resources

1.1.2: Energy resources: renewable (solar, tidal, wind, biofuel) and non-renewable resources

(coal, petroleum oil, natural gas)

1.2: Exploitation and Modification of Natural Resources: Impact on climate, flora and fauna

1.3: Waste Management

1.3.1: Technologies in solid waste management:

a) Traditional methods for solid waste management: Composting, Incineration, Landfill Recycling, Windrow composting

b) Modern methods for solid waste management: Anaerobic digestion, ethanol production, biodrying, pyrolysis, Upflow anaerobic sludge blanket (UASB) technology, waste autoclave

1.3.2: e-waste and hazardous waste (biological, chemical, medical and nuclear) management

1.4: Water management

1.4.1: Rainwater harvesting: Definition ways of harvesting, components, model of rain water

harvesting: Rural and Urban, Advantages and disadvantages

1.4.2: Watershed management: Definition, need and objectives, classification (mini, micro,

mili, sub-watershed, macro-watershed), Watershed management practices: Contour, gully control, stone bunds. Growing greenery and integrated watershed approach (IWA).

1.4.3: Case study: Ice-stupa artificial glaciers by Sonam Wangchuk

1.4.4: Effluent treatment, recycling plants, control and treatment of sewage water.

1.5: Acts and Rules of Environment Management

1.5.1: Environment Protection Act - 1986, Air (Prevention and Control of Pollution) Act

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1981, Water (Prevention and Control of Pollution) Act - 1974

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1.5.2: Hazardous Wastes (Management and Handling) Rules - 1989

1.5.3: EIA (Environmental Impact Assessment)

1.5.4: Role of Central and State Government (Pollution Control Board) and NGOs

Unit II: Wildlife Management (15L)

2.1: Habit, Habitat, Territory and Niche of Wild Animals: Herbivores, carnivores, solitary, social (flock, pod, community), pack and herd, types of habitats and territories, niche concept

2.2: Threats to Wildlife

2.2.1: Poaching and hunting, deforestation, encroachment, competition (intra-specific and inter-specific), overgrazing and climate change, diseases (zoonosis and reverse zoonosis)

2.2.2: Tourism and human animal conflict

2.3: Wildlife Conservation

2.3.1: Techniques and methods used for wildlife census: Aerial counts, camera trap, line

transect census and track surveys, capture mark recapture method, wildlife radio telemetry

2.3.2: Forest management, policies and Acts:

Harvesting Trees, Thinning harvest, Clearcut Harvest, Shelterwood harvest, Seed tree harvest, Group selection harvest, Single-tree selection harvest, Prescribed burning, Reforestation

Forest policy 1894, 1952, 1988;

The Indian Forest Act, 1927; Forest (Conservation) Act, 1980

Unit III: Bioprospecting and Zoopharmacognosy (15L)

3.1: Bioprospecting

3.1.1: Traditional and modern bioprospecting, economic value of bioprospecting

3.1.2: Bioprospecting and conservation, advantages and disadvantages

3.2: Zoopharmacognosy

3.2.1: Definition and types

3.2.2: Self-medication and its mechanism

3.2.3: Methods of self-medication through:

a) Ingestion - ants and mammals

b) Geophagy - invertebrates and birds

c) Absorption and adsorption

3.2.4: Applications - Social and trans-generational aspects of insects, birds and mammals

3.2.5: Contribution to human medicines

Unit IV: Zoogeography (15L).

4.1: Introduction: Plate tectonics and continental drift theory

4.2: Animal Distribution and Barriers

4.2.1: Isolating Mechanisms

4.2.2: Patterns of animal distribution - continuous, discontinuous and bipolar

4.2.3: Barriers of distribution - Topographic, climatic, vegetative, large water masses, land

mass, lack of salinity and special characteristic habit (homing instinct).

4.2.4: Means of dispersal - land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

4.3: Zoogeographical Realms: Palearctic, Ethiopian, Oriental, Australian, Neotropical,

Nearctic and Antarctic

Textbooks:

Essentials of Environmental Science; N. Vasudevan; Narosa Publishing House Pvt. Ltd.

New Delhi 110002.

Environmental Biology; P.S Verma, V.K Agarwal; S. Chand & company Ltd. New Delhi 110055.

A textbook of Environmental Science; Arvind Kumar; A P H Publishing Corporation, New

Delhi 110002.

Environmental Biotechnology - Basic Concepts and Application; Indu Shekhar Thakur; I.

K. International Pvt. Ltd. New Delhi 110016.

Text book of environmental science; S. C. Santra.

Wild life management; Rajesh Gopal.

Wildlife Management and Conservation - Contemporary Principles and Practices; Paul R.

Krausman and James W. Cain III.

Wildlife Ecology, Conservation, and Management; John M. Fryxell, Anthony R. E. Sinclair,

Graeme Caughley.

Molecular Biotechnology - Principles and Practices; Channarayappa.

Biotechnology - P. K. Gupta.

Biotechnology - B. D. Singh.

Biotechnology Fundamentals & Applications - S. S. Purohit.

Pharmacognosy and Pharmaco biotechnology- Ashutosh Kar.

Trease and Evans Pharmacognosy - Evans, W.C.

Pharmacognosy - Kokate, C. K. A. and Purohit, A.P.

Practical Pharmacognosy- Gokhale, S. B. and Kokate, C. K.

Text book of Pharmacognosy; T. E. Wallis.

Zoogeography - The Geographical Distribution of Animals; Philip J. Darlington JR;

Academic Publishers, Kolkata

Animal Geography - Newbegin.

Vertebrate Paleontology - Romer.

Ecological animal geography- Allee, Park and Schmidt.

Zoogeography of India and South East Asia - Dr. S. K. Tiwari; CBS Publishers and Distributors, Delhi; 1985.

ADDITIONAL READING

Environmental Management: Principles and Practice by Christopher J. Barrow.

Introduction to Environmental Management by Mary K. Theodore and Louis Theodore.

Effective Environmental Management: Principles and Case Studies by Rory Sullivan and Hugh Wyndham.

Solid Waste Management: Principles and Practice by Ramesha Chandrappa, Diganta Bhusan Das.

Solid Waste Management: An Indian Perspective by M. S. Bhatt and Asheref Illiyan.

Solid Waste Management by Subhash Anand.

Watershed Management by Vijay P. Singh and Ram Narayan Yadava.

Watershed Management by J. V. S. Murty.

Water Resources, Conservation and Management by S.N. Chatterjee.

Watershed Management - By Madan Mohan Das, Mimi Das Saikia.

Concepts in Wildlife Management by B. B. Hosetti.

Wildlife Management Practices by James Durell.

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Wildlife: management and conservation by M. M. Ranga.

Ecological Census Techniques: A Handbook by William J. Sutherland - 2006.

CRC Handbook of Census Methods for Terrestrial Vertebrates by Davis.

Selecting Wildlife Census by R. F. H. Collinson.

Forest Measurements: Fifth Edition by Thomas Eugene Avery and Harold E. Burkhardt.

Techniques for wildlife investigations and management by Clait E. Braun, Wildlife Society.

Zoopharmacognosy by Jesse Russell, Ronald Cohn.

News Feature: Animals that self-medicate by Joel Shurkin.

Zoopharmacognosy and Herbal Pharmacology by Thomas H. Ingraham.

How Animals Heal Themselves: Self-Selection: Self-Selection: Giving Animals the Choice

to Select Their Own Natural Medicines: Ingraham Applied Zoopharmacognosy by Caroline Ingraham.

<https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4267359/>.

Zoopharmacognosy: The Use of Medicinal Plants by Animals by Eloy Rodriguez and

Richard Wrangham https://link.springer.com/chapter/10.1007/978-1-4899-1783-6_4

<http://www.calmercreatures.co.uk/zoopharmacognosy-dogs/>.

Zoopharmacognosy, The Self-Medication Behavior Of Animals by Eraldo Medeiros Costa-Neto.

<http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.940.6592&rep=rep1&type=pdf>

Course Code	SEM V - Course Title	Credits	Lectures/ Week
KUZO23P50 1/502	Practical 1 (Paper 1 + Paper 2)	3	3
<p>Course Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • Learner will gain knowledge of various invertebrates • Learner will understand the interaction of various hematological and immunological aspects . • Learner will be able to analyze with the knowledge the hematological and immunological aspects of a disease or disorder • Learner will be able to apply the knowledge in understanding the hematological and immunological aspects of a disease or disorder • 			
Paper 1			
1	<p>Classification of phyla up to class and study of the general characters up to class.</p> <p>Kingdom Protista - Animal-like Protists: Protozoa</p> <p>A. Phylum: Sarcomastigophora</p> <p>Class Sarcodina e.g. <i>Amoeba</i></p> <p>Class Mastigophora e.g. <i>Euglena</i></p> <p>B. Phylum: Ciliophora</p> <p>Class Ciliata e.g. <i>Paramecium</i></p> <p>Class Phyllopharyngea e.g. <i>Dysteria</i></p> <p>C. Phylum: Sporozoa,</p> <p>Class Aconoidasida e.g. <i>Eimeria</i></p> <p>Class Conoidasida e.g. <i>Sarcocystis</i></p> <p>Kingdom Animalia</p> <p>D. Phylum: Porifera</p> <p>Class Calcarea e.g. <i>Scypha</i> (Little vase sponge)</p> <p>Class Hexactinellida e.g. <i>Hyalonemma</i> (Glass-rope sponge)</p> <p>Class Demospongia e.g. <i>Spongilla</i> (Freshwater sponge)</p> <p>E. Phylum Cnidaria</p> <p>Class Hydrozoa e.g. <i>Vellela</i> (By-the-wind sailor)</p> <p>Class Scyphozoa e.g. <i>Rhizostoma</i> (Barrel jellyfish)</p> <p>Class Anthozoa e.g. <i>Corallium</i> (Coral)</p> <p>F. Phylum Platyhelminthes</p> <p>Class Turbellaria e.g. <i>Dugesia</i> (Planaria)</p> <p>Class Trematoda e.g. <i>Fasciola</i> (Liverfluke)</p> <p>Class Cestoda e.g. <i>Taenia</i> (Tapeworm)</p> <p>G. Phylum Nematoda</p>		

	<p>Class Aphasmda (Adenophorea) e.g. <i>Trichinella</i> (Trichina worm) Class Phasmida (Secernentea) e.g. <i>Ascaris</i> (Roundworm) H. Phylum Annelida Class Polychaeta e.g. <i>Arenicola</i> (Lugworm) Class Oligochaeta e.g. <i>Tubifex</i> (Sludge worm) Class Hirudinea e.g. <i>Pontobdella</i> (Marine leech) I. Phylum Arthropoda Subphylum Chelicerata Class Arachnida e.g. <i>Hotentotta</i> (Scorpion) Class Merostomata e.g. <i>Limulus</i> (Horseshoe crab) Class Pycnogonida e.g. <i>Nymphon</i> (Sea spider) 25 Subphylum Crustacea Class Malacostraca e.g. <i>Panulirus</i> (Lobster) Class Maxillipoda e.g. Cyclops (Copepods) Subphylum Uniramia Class Chilopoda e.g. <i>Scolopendra</i> (Centipedes) Class Diplopoda e.g. <i>Xenobolus</i> (Millipedes) Class Insecta e.g. <i>Attacus</i> (Moth) J. Phylum Mollusca Class Aplacophora e.g. <i>Chaetoderma</i> (Glisten worm solenogaster) Class Polyplacophora e.g. <i>Tonicella</i> (Lined Chiton) Class Monoplacophora e.g. <i>Neopilina</i> Class Gastropoda e.g. <i>Turbo</i> (Turban shell) Class Pelycypoda e.g. <i>Donax</i> (Wedge shell) Class Scaphopoda e.g. <i>Dentalium</i> (Tusk shell) Class Cephalopoda e.g. <i>Octopus</i> K. Phylum Echinodermata Class Asteroidea e.g. <i>Asterias</i> (Starfish) Class Ophiuroidea e.g. <i>Ophiothrix</i> (Brittle star) Class Echinoidea e.g. <i>Echinus</i> (Sea urchin) Class Holothuroidea e.g. <i>Cucumaria</i> (Sea cucumber) Class Crinoidea e.g. <i>Crinoid</i> (Sea lily) L. Phylum Hemichordata Class Enteropneusta e.g. <i>Saccoglossus</i> Class Pterobranchia e.g. <i>Rhabdopleura</i> Class Planctosphaeroidea e.g. <i>Planctosphaera</i></p>
2	<p>Minor Phyla Acoelomate M. Phylum Acanthocephala e.g. <i>Echinorhynchus</i> Coelomate N. Phylum Chaetognatha e.g. <i>Sagitta</i> O. Phylum Onychophora e.g. <i>Peripatus</i> (Velvet worm)</p>
3	<p>Study of <i>Sepia</i> with the help of diagram / Photograph / Simulation whichever possible. No</p>

	<p>animal shall be dissected.</p> <p>a) Digestive system, b) Reproductive system c) Nervous system d) Jaws e) Radula f) Chromatophores g) Spermatophores h) Statocyst</p>		
4	<p>Study tour - Visit to fish market / Aquarium / Local Gardens / Local available niche / National Parks / Sanctuaries / and such other places to observe invertebrates with special emphasis on Western Ghats and coast of Maharashtra and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.</p>		
Paper 2			
8	Enumeration of Erythrocytes - Total Count.		
9	Enumeration of Leucocytes - Total Count.		
10	Differential count of Leucocytes.		
11	Erythrocyte Sedimentation Rate by suitable method - Westergren or Wintrobe method.		
12	Estimation of haemoglobin by Sahli's acid haematin method		
13	Determination of serum LDH by using colorimeter / spectrophotometer		
14	Estimation of total serum/ plasma proteins by Folin's method.		
15	Estimation of serum/ plasma total triglycerides by Phosphovanillin method.		
16	Latex agglutination test - Rheumatoid Arthritis.		
17	Determination of bleeding and clotting time		
Course Code	SEM V - Course Title	Credits	Lectures/ Week
KUZO23P50 3/504	Practical 2 (Paper 3 + Paper 4)	3	3
Course Outcomes:			

After successful completion of this course, students would be able to

- Learner will gain the knowledge of Various diseases
- Interactions in between different toxins and their cellular interactions can be understood
- Biostatistics and other analytical methods will help to analyse the given data
- Analysis of the given data can be used to conclude with the help of biostatistics

Paper 3

1	Study of mammalian tissues: V.S. of Tooth, T.S. of Stomach, T.S. of small intestine, T.S. of Liver
2	Microtomy: Tissue preservation and fixation, dehydration, infiltration, paraffin embedding and block preparation, sectioning, staining.
3	Identification of diseases or conditions (from slides or pictures): Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema
4	To study the effect of CCl ₄ on the level of enzyme activity in liver on aspartate and alanine amino transferase, alkaline phosphatase (<i>in vitro</i> approach)..
5	Study and interpretation of abnormal pathological reports: Blood (CBC), Urine (Routine) and Stool (Routine).
6	Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) and manually: a. Problems based on Z-test b. Problems based on t-test c. Problems based on Chi-square test d. Correlation, regression analysis - demonstration only. e. Problems based on ANOVA - demonstration only. (Learner is expected to identify appropriate test for the given problem)

Paper 4

7	Study of integumentary systems - V. S. of Skin of Shark, Frog, <i>Calotes</i> , Pigeon and Human
8	Study of Human Axial Skeleton - Skull (whole) and Vertebral column (axis, atlas, typical cervical, typical thoracic, typical lumbar, sacrum, coccyx)
9	Study of Human Appendicular Skeleton - Pectoral and pelvic girdle with limb bones.
10	Study of muscles of forelimbs - <i>Biceps brachii</i> , <i>Brachialis</i> , <i>Brachio radialis</i> , <i>Triceps</i>

	<i>brachii, Flexor carpi radialis, Flexor carpi ulnaris and Extensor carpi ulnaris</i>
11	Study of muscles of hind limbs - Sartorius, Adductor group, Quadriceps group <i>Rectus femoris, Vastus lateralis, Vastus medialis, Hamstring group (Biceps femoris, Semimembranosus, Semitendinosus), Fibularis longus, Gastrocnemius Tibialis anterior, Soleus, Extensor digitorum longus, Fibularis tertius</i>
12	Study of ontogeny of chick embryo using permanent slides - 18 hours, 24 hours, 33 hours, 48 hours and 72 hours
13	Preparation of temporary mounting of chick embryo up to 48 hours of incubation.

Course Code	SEM VI - Course Title	Credits	Lectures/ Week
KUZO23P60 1/602	Practical 1 (Paper 1 + Paper 2)	3	3
<p>Course Outcomes:</p> <p>After successful completion of this course, students would be able to</p> <ul style="list-style-type: none"> • A thorough knowledge of chordates will be gained • Similarities and differences in between chordates can be understood • Usage of the characters to identify the organisms 			
Paper 1			
1	<p>Group Protochordata Subphylum Urochordata Class Larvacea e.g. <i>Oikopleura</i> (Sea squirt) Class Ascidiacea e.g. <i>Ciona</i> (Transparent Sea squirt) Class Thaliacea e.g. <i>Salpa</i> (Common salp) Subphylum Cephalochordata Class Leptocardii e.g. <i>Branchiostoma</i> (<i>Amphioxus</i>) Subphylum Vertebrata: Division Agnatha Class Ostracodermi e.g. <i>Pharyngolepis</i> Class Cyclostomata e.g. <i>Petromyzon</i> (Lamprey)</p>		
2	<p>Division Gnathostomata ○ Superclass Pisces: Class Placodermi e.g. <i>Bothriolepis</i> Class Chondrichthyes e.g. <i>Rhinobatos</i> (Guitar fish), <i>Chimaera</i> (Rabbitfish) Class Osteichthyes e.g. <i>Protopterus</i>, <i>Clarius</i> (Catfish) ○ Superclass Tetrapoda: Class Amphibia e.g. <i>Alytes</i> (Midwife toad) and <i>Triton</i> (Salamander) Class Reptilia e.g. <i>Varanus</i> (Monitor lizard) and <i>Crocodylus</i> (Crocodile)</p>		
3	<p>Class Aves: Examples: <i>Eudyptes</i> (Penguin), <i>Phoenicopterus</i> (Flamingo) and <i>Gyps</i> (Vulture)</p>		
4	<p>Class Mammalia: Examples: <i>Dasyurus</i> (Quoll), <i>Petaurista</i> (Flying squirrel) and <i>Macaca</i> (Monkey).</p>		
5	<p>5. Study of Shark with the help of diagram / Photograph / Simulation whichever possible. No animal shall be dissected. a) Digestive system b) Heart and Aortic arches</p>		

	c) Urinogenital System d) Endoskeleton of shark: i. Axial - Skull and vertebral column ii. Appendicular - Pelvic and pectoral fins, pelvic and pectoral girdle
6	Visit to fish market / Aquarium / Zoo/ National Park / Local Gardens / Local available niche / Sanctuaries / and such other places in Maharashtra and / or India and / or abroad to observe chordates and prepare a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student.
Paper 2	
7	Effect of varying pH on activity of enzyme Acid Phosphatase.
8	Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase
9	Effect of varying substrate concentration on activity of enzyme Acid Phosphatase
10	Effect of inhibitor on the activity of enzyme Acid Phosphatase
11	Separation of LDH isozymes by agarose / polyacrylamide gel electrophoresis
12	Histology of endocrine glands: T.S. of pituitary, thyroid, parathyroid, pancreas, adrenal.
13	Instruments for tissue culture - Autoclave Millipore filter, CO ₂ incubator, Laminar air-flow. (Principle and use).
14	Packaging of glassware for tissue culture.
15	Aseptic transfer techniques
16	Trypsinization and vital staining using Trypan blue stain.

Course Code	SEM VI - Course Title	Credits	Lectures/ Week
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KUZO23P60 3/604	Practical 2 (Paper 3 + Paper 4)	3	3
Course Outcomes:			
After successful completion of this course, students would be able to			
<ul style="list-style-type: none"> • Learner will gain the knowledge of Various mutations and biostatistical methods • Interactions in between DNA and RNA can be understood • Biostatistics and other analytical methods will help to analyse the given data • Analysis of the given data can be used to conclude with the help of biostatistics 			
Paper 3			
1	Quantitative Estimation of RNA by Orcinol method.		
2	Quantitative Estimation of DNA by Diphenylamine method.		
3	Separation of Genomic DNA by Agarose gel electrophoresis.		
4	Colorimetric estimation of proteins from given sample by Folin-Lowry's method		
5	Problems based on Restriction endonucleases.		
6	Karyotype (Idiogram) analysis for the following syndromes with comments on numerical and / or structural variations in chromosomes (no cutting of chromosomes): a. Turner's syndrome b. Klinefelter's syndrome c. Down's syndrome d. Cri-du-chat syndrome e. D-G translocation f. Edward's syndrome g. Patau's syndrome		
7	Interpretation of genetic formulae: Deletion, duplication, inversion and translocation		
8	Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.		
9	Explore BLAST for nucleotide sequence comparison		
10	Explore the databases (Nucleotide, Protein) at NCBI for querying a nucleotide or protein sequence.		
11	Exploring bibliographic database PubMed for downloading a research paper on subject of interest with the use of operators.		
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Paper 4	
12	Estimation of phosphates from sample water.
13	Estimation of BOD from sample water.
14	Estimation of COD from sample water
15	Estimation of Nitrates from sample water.
16	Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.
17	Comparative study of sound intensity in different places by Decibel meter.
18	Study of bioprospecting: a. Tumour suppression compounds e.g. Sponge. b. Skin erythema treatment from gel - <i>Aloe vera</i>, <i>Aloe ferox</i>.
19	Study of Zoopharmacognosy in ants, cats, elephants and dogs
20	Indicate the distribution of fauna in the world map with respect to its realm and comment on the pattern of distribution. a. Palearctic: Giant Panda and Japanese Macaque b. Ethiopian: Common ostrich and African bush elephant c. Oriental: Indian one-horned Rhinoceros and Gharial d. Australian: Platypus and Red Kangaroo e. Neotropical: Guanaco and South American Tapir f. Nearctic: Virginia opossum and Sea otter g. Antarctic: Emperor Penguin and Antarctic Minke Whale
21	Excursion (Study tour / Visit) to Zoo / Sanctuary / National park / Research institute, etc. and submit a report. College may conduct more than one field visit for wide exposure, if feasible. However, at least one field visit should be such that it is affordable to every student

***Note - The practicals may be conducted by using specimens authorized by the wild life and such other regulating authorities though it is strongly recommended that the same should be taught by using photographs/audio-visual aids/simulations/models etc. as recommended by the UGC and as envisaged in the regulation of the relevant monitoring bodies. No new specimens, however, shall be procured for the purpose of conducting practicals mentioned here-in above.**

N.B:

I) It is pertinent to note that we have to adhere strictly to the directions as given in the UGC

Circular F14-4/2006 (CPP-II).

II) Apart from the Institutional Animal Ethics Committee (IAEC) and any other Committee

appointed by a Competent Authority / Body from time to time, every college should constitute

the following Committees:

1) A Committee for the Purpose of Care and Supervision of Experimental Animals (CPCSEA) and

2) A Dissection Monitoring Committee (DMC) to ensure that no dissections are done.

Composition of DMC shall be as follows:

i) Head of the Concerned Department (Convener / Chairperson)

ii) Two Senior Faculty Members of the concerned Department

iii) One Faculty of related department from the same College

iv) One or two members of related department from neighbouring colleges.

Use of animals for any experiment / dissection /mounting is banned. Simulations, authorized permanent specimens / slides, charts, models and other innovative methods are encouraged.

Evaluation Scheme for Third Year (UG) under AUTONOMY

Scheme of Examination (Theory and Practical)

(a) External assessment of one hundred (100) marks per course per semester should be

conducted as per the following skeleton question paper pattern.

(c) One practical examination of fifty (50) marks per course each should be conducted at the

end of every semester.

SKELETON- EXAMINATION PATTERN (THEORY)

Time: 3 hours Total marks: 100

Q1 Based on Unit 1 20 marks

Q.2. Based on Unit 2 20 marks

Q.3. Based on Unit 3 20 marks

Q.4. Based on Unit 4 20 marks

Q.5. Based on all four Units 20 marks

***Internal option scheme shall be followed from time to time as per university guidelines for T. Y. B. Sc.**

- A candidate will be allowed to appear for the practical examinations only if he/she submits a certified journal of S.Y.B.Sc. or a certificate from the Head of the department / Institute to the effect that the candidate has completed the practical course of S.Y.B.Sc. as per the minimum requirements. In case of loss of journal, a candidate must produce a certificate from the Head of the department/Institute that the practicals for the academic year were completed by the student. However, such a candidate will be allowed to appear for the practical examination, but the marks allotted for the journal will not be granted.