Janardan Bhagat Shikshan Prasarak Sanstha's

CHANGU KANA THAKUR

ARTS, COMMERCE & SCIENCE COLLEGE,

NEW PANVEL (AUTONOMOUS)

Re-accredited 'A+' Grade by NAAC
'College with Potential for Excellence' Status Awarded by UGC
'Best College Award' by University of Mumbai

Program: B.Sc

Revised Syllabus of T.Y.B.Sc. Zoology
Choice Based Credit & Grading System (75:25)
w.e.f. Academic Year 2019-20

Sr. No.	Heading	Particulars
1	Title of Course	Zoology
2	Eligibility for Admission	S.Y.B.Sc. with subject Zoology
3	Passing marks	40%
4	Ordinances/Regulations (if any)	
5	No. of Semesters	Two
6	Level	U.G.
7	Pattern	Semester (75:25)
8	Status	Revised
9	To be implemented from Academic year	2019-2020

PREAMBLE OF THE SYLLABUS:

The ongoing B.Sc. (H) Zoology course was introduced by the Faculty of Sciences from the academic year 2019-2020. The new T.Y.B.Sc. Zoology that will be effective from the academic year 2019- 2020, will follow the Semester mode. It has been prepared keeping in view the unique requirements of B.Sc. (H) Zoology students. The syllabus has been drawn up to introduction of the classical zoology with accommodation of widening horizons of the discipline of Biological Sciences.

The Board of Studies examined the existing syllabus and after analysing with respective subjects in term of content relevance, quality and pattern of teaching along with examination in present scenario.

With the holistic approach the syllabus including basic as well as advanced concepts in Zoology from first year and third year shall inspire the students for pursuing higher studies in Zoology and for becoming an entrepreneur and also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject Zoology.

OBJECTIVES OF THE COURSE:

- To nurture interest in the students for the subject of Zoology
- To create awareness of the basic and modern concepts of Zoology
- To orient students about the importance of abiotic and biotic factors of environment and their conservation.
- To provide an insight to the basic nutritional and health aspects of human life.
- To inculcate good laboratory practices in students and to train them about scientific handling of important instruments.

EXPECTED OUTCOME OF SYLLABUS

The present course of B.Sc. Zoology introduced by the Board of studies and Faculty of Sciences from the academic year 2019-2020 has some expected outcomes of entire syllabi as follows:

1. The present syllabus of Zoology which deals with animals and animal life, including the study of the structure, physiology, development, and classification of animals will make the students interest ignited keeping in mind to sustain the beauty of Animal World.

2. This syllabus include the classification of animals, invertebrates, including sponges, flatworms, molluscs, insects, arthropods, and echinoderms, and vertebrates, including fishes, amphibians, reptiles, birds, and mammals which will expect from the students to do daily assignments, various projects, quizzes based on animal life along with laboratory write-ups

which will help the students to inculcate Academic Writing in Science Research.

3. Holistic approach of the Zoology syllabus will lead the students to have and find the employment in the sector of Biological research Institutes, Industries, Educational Institutes and in the various concerning departments of State and Central Government based on subject Zoology

4. Holistic approach of the Zoology syllabus will lead the students to pursue higher studies in Zoology and become an entrepreneur.

T. Y. B. Sc. Zoology

For the subject of Zoology there shall be four papers for 45 lectures each comprising of four units of 08 L each along with Applied component Fishery Biology.

Semester-V

1. Paper-I -Unit-I will be for Enzymology
2. Paper-I- Unit II will be for Homeostasis
3. Paper-I- Unit-III will be for Endocrinology
4. Paper-I-Unit-IV will be for Tissue Culture
5. Paper-II-Unit-I will be for Molecular Biology
6. Paper-II- Unit-II will be for Genetic Engineering
7. Paper II- Unit- III will be for Human Genetics
8. Paper II- Unit- IV will be for Bioinformatics

Semester-VI

1. Paper-I- Unit-I will be for Chordata
2. Paper-I- Unit-II will be for Eurochordata I
3. Paper-I- Unit-III will be for Eurochordata II
4. Paper-I -Unit-IV will be for Type study - Shark.
5. Paper-II-Unit-I will be for Environment Management
6. Paper-II-Unit-II will be for Wildlife Management
7. Paper-II- Unit-III will be for Bioprospecting and Zoopharmacognosy
8. Paper II – Unit- IV will be for Zoogeography

SCHEME OF EXAMINATION FOR EACH SEMESTER:

Internal Evaluation: 25 (20 marks internal test and 05 marks for attendance)

Semester End Examination: 75 Marks will be as follows -:

I	**Theory:**	
	Each theory paper shall be of two and half hour duration.	
	All questions are compulsory and will have internal options.	
	Q-1	From Unit – I (having internal options.) 15 M
	Q-2	From Unit – II (having internal options.) 15 M
	Q-3	From Unit – III (having internal options.) 15 M
	Q-4	From Unit – IV (having internal options.) 15 M
	Q-5	Questions from all the FOUR Units with equal weightage of marks. Allotted to each Unit. 15 M
II	Practical	The External examination per practical course will be conducted as per the **Following** scheme.

Sr. No.	**Particulars of External Practical Examination**	**Marks**
1.	Laboratory Work	35
2.	Field visit and report	05
3.	Journal	05
4.	Viva	05
	TOTAL	**50**

Syllabus for T.Y.B.Sc.
Course - ZOOLOGY
(Credit Based Semester and Grading System)
(To be implemented from the Academic Year 2018- 2019)

SEMESTER- V					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES/ WEEK**
11	USC5ZO1	I	Basic Haematology	2.5	1
		II	Applied Haematology		1
		III	Basic Immunology		1
		IV	Applied Immunology		1
12	USC5ZO2	I	Mammalian Histology	2.5	1
		II	Toxicology		1
		III	General Pathology		1
		IV	Biostatistics		1
13	USC5ZO3	I	Principles of Taxonomy	2.5	1
		II	Kingdom: Animalia - I		1
		III	Kingdom Animalia - II		1
		IV	Type Study –Sepia		1
14	USC5ZO4	I	Integumentary system and derivatives	2.5	1
		II	Human Osteology		1
		III	Muscles of long bones of Human limbs		1
		IV	Developmental biology of Chick		1
				10	**16**
PRACTICAL					
USC5ZOP	Practicals based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**

Syllabus for T.Y.B.Sc.

Course-ZOOLOGY

(Credit Based Semester and Grading System)

(To be implemented from the Academic Year 2018-2019)

SEMESTER-VI					
THEORY					
COURSE NO.	**COURSE CODE**	**UNIT**	**TOPICS**	**CREDITS**	**LECTURES/ WEEK**
15	USC6ZO1	I	Enzymology	2.5	1
		II	Homeostasis		1
		III	Endocrinology		1
		IV	Tissue Culture		1
16	USC6ZO2	I	Molecular Biology	2.5	1
		II	Genetic Engineering		1
		III	Human Genetics		1
		IV	Bioinformatics		1
17	USC6ZO3	I	Chordata	2.5	1
		II	Euchordata- I		1
		III	Euchordata- II		1
		IV	Type study - Shark		1
18	USC6ZO4	I	Environment management	2.5	1
		II	Wildlife management		1
		III	Bioprospecting and Zoopharmacognosy		1
		IV	Zoogeography		1
				10	**16**
PRACTICAL					
USC6ZOP	Practicals based on all four courses			**06**	**16**
Total Number of Credits and Workload				**16**	**32**

SYLLABUS T.Y.B.Sc. ZOOLOGY
UNIT WISE DISTRIBUTION

Semester V			
Course 11	**Course 12**	**Course 13**	**Course 14**
Unit 1 Basic Haematology	Unit 1 Mammalian Histology	Unit 1 Principles of Taxanomy	Unit 1 Integumentary system and derivatives
Unit 2 Applied Haematology	Unit 2 Toxicology	Unit 2 Kingdom Animalia I	Unit 2 Human Osteology
Unit 3 Basic Immunology	Unit 3 General Pathology	Unit 3- Kingdo Animalia II	Unit 3- Muscles of long bones of Human limbs
Unit 4 Applied Immunology	Unit 4 Biostatistics	Unit 4 Type Study- Sepia	Unit 4 Developmental biology of Chick
Practical (USC5ZOP1)	Practical (USC5ZOP2)	Practical (USC5ZOP3)	Practical (USC5ZOP4)

SYLLABUS T.Y.B.Sc. ZOOLOGY
UNIT WISE DISTRIBUTION

Semester VI			
Course 15	**Course 16**	**Course 17**	**Course 18**
Unit 1 Enzymology	Unit 1 Molecular Biology	Unit 1 Chordata	Unit 1 Environmental Management
Unit 2 Homeostasis	Unit 2 Genetic Engineering	Unit 2 Euchordata I	Unit 2 Wildlife Management
Unit 3 Endocrinology	Unit 3 Human Genetics	Unit 3- Euchordata II	Unit 3- Bioprospecting and Zoopharmacognosy
Unit 4 Tissue Culture	Unit 4 Bioinformatics	Unit 4 Type Study- Shark	Unit 4 Zoogeography
Practical (USC6ZOP1)	Practical (USC6ZOP2)	Practical (USC6ZOP3)	Practical (USC6ZOP4)

Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester V
Paper I and Practical I

T.Y.B.Sc. Zoology Semester V (Theory)
Course Code: USC5ZO1
Course 11

Basic Haematology, Applied Haematology, Basic Immunology amd Applied Immunology

Unit I: Basic Haematology **(15 Lectures)**

Objective:

- *To introduce to the learner the composition of blood, haemorrhage and haematopoiesis and to acquaint the learner with the physiology of blood clotting and clinical aspects of haematology,*

Desired outcome:

- *Learner shall be familiar with the fundamental concepts in haematology.*
- *Learner shall comprehend basic haematology.*
- *Learner will be able to identify various components of haemostatic systems*

1.1: Composition of blood plasma

Water, plasma proteins, inorganic constituents, respiratory gases, organic constituents other than protein (include internal secretions, antibodies and enzymes)

1.2: Erythrocytes

Structure and functions, abnormalities in structure, total count, variation in number; ESR; types of anaemia

1.3: Hemoglobin

Structure, formation and degradation; variants of hemoglobin (foetal, adult), abnormalities in Hemoglobin (Sickle cell and Thalassemia)

1.4: Leucocytes

Types of leucocytes and function, total count and variation in number; leukemia and its types

1.5: Thrombocytes

Structure of thrombocytes, factors and mechanism of clotting, failure of clotting mechanism

1.6: Haematopoiesis

Erythropoiesis, leucopoiesis and thrombopoiesis

1.7: Blood volume

Total quantity and regulation; haemorrhage

Unit II: Applied Haematology **(15 Lectures)**

Objective

- *To introduce to the learner the basics of applied hematology and to impart knowledge of basic diagnostic techniques used in pathology.*

Desired outcome:

- *Learners shall get familiar with different terminologies and diagnostic tests performed in a pathological laboratory.*
- *Learners will be acquainted with diagnostic approaches in hematological disorders*
- *Learners will be better equipped for taking any further pathological course or working in a diagnostic laboratory.*

2.1 Introduction to Applied Haematology

Scope and brief introduction of basic branches: clinical, microbiological, oncological and forensic hematology

2.2 Diagnostic techniques used in haematology

2..1 Microscopic examination of blood: For detection of blood cancers (lymphoma, myeloma), infectious diseases (malaria, leishmaniasis), hemoglobinopathies (sickle cell, thalassemia)

2..2 Coagulopathies: Diagnostic methods (hemophilia and purpura)

2..3 Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB)

2..4 Biochemical examination of blood:

- Liver function tests: AST, ALT, Total bilirubin, Direct bilirubin, LDH and Alkaline phosphatase
- Kidney function tests**:** 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.

2..5 Blood Bank: Collection, storage & preservation of blood components, anticoagulants

Unit III: Basic Immunology **(15 Lectures)**

Objective:

- *To introduce the topic of immunology by emphasizing the basic concepts to build a strong foundation and to give an overview of the immune system that plays an important role in disease resistance.*

Desired outcome:

- *Learners would comprehend the types of immunity and the components of immune system.*
- *Learners would realize the significant role of immune system in giving resistance against diseases.*

3.1 : Overview of Immunology

3.1.1 : Concept of immunity**-**Antibody mediated and cell mediated immunity

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

- First line of defense - physical barriers and chemical barriers;

- Second line of defense- phagocytosis, inflammatory responses and fever

3.1.3 : Adaptive or Acquired 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 node and spleen

3.3: Antigens

Definition, properties of antigens; haptens

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 (15 L)

Objective:

- *To introduce to the learner immune related pathologies*
- *To introduce the concept of vaccines and vaccination.*
- *To familiarise the learner to immunological perspectives of organ transplant and tumour treatment.*

Desired outcome:

- *Learners shall understand immune related pathologies and the principles and applications of vaccines.*

- *Learners will develop basic understanding of immunology of organ transplantation.*

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 - Countercurrent, Laurel's Rocket and crossed immunoelectrophoresis

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 : Brief history of vaccination, 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, 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 mediated graft rejection, Antibody mediated graft rejection; Precautions against graft rejection

T.Y.B.Sc. Practical (Semester V)
Course codes: USC6ZOP1
COURSE 11

1. Enumeration of Erythrocytes – Total Count.
2. Enumeration of Leucocytes – Total Count.
3. Differential count of Leucocytes
4. Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method.
5. Estimation of haemoglobin by Sahli's acid haematin method.
6. Determination of serum LDH.
7. Estimation of total serum/ plasma proteins by Folin's method.
8. Estimation of serum/ plasma total triglycerides by Phosphovanillin method.
9. Latex agglutination test – Rheumatoid Arthritis.

T.Y.B.Sc. Semester V

Course codes: USC6ZOP1

Reference and Additional Reading:

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- Williams Hematology; Kenneth Kaushansky, Marshall A. Lichtman, E. Beutler, Thomas
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- 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
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Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester V
Paper II and Practical II

T.Y.B.Sc. Zoology Semester V (Theory)
Course Code: USC5ZO2
Course 12

Mammalian Histology, Toxicology, General Pathology and Biostatistics

Unit I: Mammalian Histology (15 Lectures)

Objective:

- *To familiarize the learners with the cellular architecture of the various organs in the body.*
- *To make the learners understand the need and importance of different types of tissues in the vital organs and their functions.*

Desired outcome:

- *Learners would appreciate the well planned organization of tissues and cells in the organ systems.*

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 Lectures)

Objective:

- *To introduce the learners to the principles of toxicology with particular emphasis on toxic responses to chemical exposures, nature and effect of toxicity and toxicity testing.*
- *It also intends to develop amongst students an introductory understanding of regulatory affairs in toxicology.*

Desired outcome:

- *The course will prepare learners 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.*

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), 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, subacute toxicity, subchronic toxicity and chronic toxicity.

2.1.5 : Concept of LD_{50}, LC_{50}, ED_{50}

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).

2.2 : 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 (15 Lectures)

Objective:

- *To introduce the learners to basics of general pathology.*
- *To impart knowledge of retrogressive, necrotic, pathological conditions in the body.*
- *To explain repair mechanism of the body.*

Desired outcome:

- *Learners will be familiar with various medical terminology pertaining to pathological condition of the body caused due to diseases.*

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).

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 (15 Lectures)

Objective:

- *To make learners familiar with biostatistics as an important tool of analysis and its applications.*

Desired outcome:

- *The learners will be able to collect, organize and analyze data using parametric and non- parametric tests.*
- *They will also be able to set up a hypothesis and verify the same using limits of significance.*

4.1: Probability Distributions

Normal, Binomial, Poisson distribution, Z-transformation, p-value. Probability - Addition and multiplication rules and their applications.

4.2: Measures of Central Tendency and Dispersion

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 tests

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

T.Y.B.Sc. Zoology Semester V
(Practical) Course Code: USC5ZO2
Course 12

1. **Study of mammalian tissues:**
   i. V.S. of Tooth
   ii. T.S. of Stomach
   iii. T.S. of small intestine
   iv. 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) :
   i. Vitiligo
   ii. Psoriasis
   iii. Bed sores
   iv. Necrosis
   v. Oedema
4. Study and interpretation of pathological reports: Blood, Urine and Stool (feces)
5. To study the effect of CCl_4 on the level of enzyme activity in liver on aspartate and alanine amino transferase, alkaline phosphatase (*in vitro* approach)
6. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) & manually:

1. Problems based on Z test
2. Problems based on t test
3. Problems based on Chi square test
4. Correlation, regression analysis using given data demonstration only.
5. Problems based on ANOVA – demonstration only.

T.Y.B.Sc. Semester V

Course codes: USC6ZOP2

Reference and Additional Reading:

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Toxicology

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

- A Textbook of Veterinary and General Pathology; Second edition; J. L. Vagad; IBDC Publishers
- Clinical Pathology; Guru G.; NCERT; 1988
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- Textbook of Pathology; Harsh Mohan; Jaypee Publishers

Biostatistics

- Biostatistics – The Bare Essentials; Third Edition; Geoffrey R. Norman, David L. Streiner; B.C. Decker, Inc., Hamilton; 2008

- Fundamentals of Biostatistics; Second Edition; Veer BalaRastogi; Ane Books Pvt. Ltd., New Delhi; 2009 (Reprint 2010)
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- 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
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- Biostatistics – A Guide to Design, Analysis, and Discovery; Second Edition; Ronald N. Forthofer, EunSul 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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- 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
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Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester V
Paper III and Practical III

T.Y.B.Sc. Zoology Semester V (Theory)
Course Code: USC5ZO3
Course 13

Principles of Taxonomy, Kingdom: Animalia – I, Kingdom: Animalia – II and Type study- *Sepia*

Learning objectives:

- *To introduce the principles of taxonomy in animal kingdom and modern classification of lower groups of organisms with evolution point of view, from unicellular to multicellular organization*.

Learning outcome:

- *Learners will apprehend the basis of classification and modern classification up to class of the lower invertebrate animal life.*

Unit 1: Principles of Taxonomy

1.1 : Levels of Organization: (1 lectures)

1.1.1 : Unicellularity, colonization of cells, multicellularity.

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

1.2 : Symmetry (2 lectures)

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. one invertebrate and one vertebrate

1.2.3 Evolutionary significance of symmetry.

1.3 : Coelom (2 lectures)

1.3.1 : Basic concept and definition.

1.3.2 : Formation of coelom.

1.3.3 : Types -

a. Acoelomate –Platyhelminthes

b. Pseudocoelomate –Nemathelminthes

1.3.4 : Evolutionary significance of coelom.

1.4 Metamerism **(2 lectures)**

1.4.1 : Basic concept and definition

1.4.2 : Types –

a. Pseudometamerism

b. True metamerism –

i) Homonomous – e.g. Annelida

ii) Heteronomous – Cephalization – e.g. Insecta - Cephalothorax – e.g. Crustacean

1.4.3 : Evolutionary significance of metamerism.

1.5 : Taxonomy (4 Lectures)

1.5.1 : Basic concept, definition and objectives.

1.5.2 : Linnaean Hierarchy, Binomial Nomenclature.

1.5.3 : Five Kingdom classification: General characters of Kingdoms with examples – Monera, Protista, Fungi, Plantae, Animalia .

1.6 : Kingdom Protista

Animal like Protists -Protozoa (4 Lectures)

1.6.1 : General characters of Protozoa

1.6.2 : Classification with examples- Phylum: Mastigophora, Sarcodina, Ciliophora and Sporozoa .

1.6.3 : Morphology, life cycle, pathogenicity and control measures of *Entamoeba histolytica*

Unit II- : Kingdom: Animalia - I

Learning objectives:

To comprehend the general characters and classification of Kingdom Animalia, from porifera to Aschelminthes and specific characters of organisms.

Learning outcome*:*

The learners will be familiarized with classification up to phylum Aschelminthes along with their examples.

2.3.1 : Phylum: Porifera (3 lectures)

a. General characters
b. Classification up to class with suitable examples: Class - Calcarea, Hexactinellida and Demospongia.
c. Skeleton in sponges.

2.3.2 : Phylum: Cnidaria (3 lectures)

a. General characters
b. Classification up to class with examples- Class- Hydrozoa, Scyphozoa and Anthozoa.
c. Polymorphism in Cnidaria.

2.3.3 : Phylum Platyhelminthes (5 lectures)

a. General characters.
b. Classification up to class with examples- Class- Turbellaria, Trematoda, Cestoda .
c. Morphology, life cycle and Pathogenecity of *Fasciola hepatica.*

2.2.4 : Phylum Aschelminthes (4 lectures)

a. General characters.
b. Classification up to class with examples-
   Class-: Nematoda, Nematomorpha, Rotifera and Gastrotricha.
c. Diseases caused by nematodes in humans- Ascariasis, Enterobiasis, Filariasis and Loiasis.

Unit 3: Kingdom: Animalia - II **(15 lectures)**

Learning objectives:

To introduce basic concepts of classification up to class in animal kingdom from phylum Annelida to Hemichordat and to familiarize with their characters.

Learning outcome:

Learners will get an idea of higher groups of invertebrate animal life, their classification and their peculiar aspects.

3.1 : Phylum: Annelida **(4 lectures)**

3.1.1. : General characters.

3.1.2. : Classification up to class with examples- Class-- Polychaeta, Oligochaeta and Hirudinea.

3.1.3. : Regeneration, asexual reproduction, epitoky and swarming in class Polychaeta.

3.2 : Phylum: Arthropoda **(4 lectures)**

3.2.1. General characters.

3.2.2. Classification up to class with examples-
Class- Merostomata, Arachnida, Crustacea, Myriapoda, and Insecta

3.2.3. Social organization in termites.

3.3 Phylum: Onychorphora **(2 Lectures)**

3.3.1. Peripatus, a connecting link.

3.3.2. Affinities of Phylum Onychophora with following phyla --

a. Annelida,
b. Arthropoda,
c. Mollusca,

3.3.3. Peculiar Onychophoran characteristics.

3.4 : Phylum Mollusca **(3 lectures)**

3.4.1. General characters.

3.4.2. Classification up to class with examples-
Class- Aplacophora, Polyplycophora, Monoplacophora, Gastropoda, Pelycypoda, Scaphopoda and Cephalopoda .

3.4.3. Shells in Mollusca.

3.5 : Phylum: Echinodermata **(3 lectures)**

3.5.1. General characters.

3.5.2. Classification up to class with examples-
Class -Asteroidea, Ophiuroidea, Echinoidea, Holothuroidea and Crinoidea.

3.5.3. Water vascular system in Starfish.

3.6 Minor phyla **(1 lecture)**

3.6.1. General characters along with examples of -

a. Phylum Acanthocephala- Acoelomate
b. b.Phylum Chaetognatha-- Coelomate
(Description of examples not expected)

3.7 Phylum –Hemichordata **(1 lecture)**

3.7.1. General characters and classification with examples

Class- Enteropneusta, Pterobranchia and Planctosphaeroidea.

3.8 Basic concepts of phylogeny **(1 lecture)**

Unit 4 Type study- ***Sepia***

Learning objective-

To acquaint learners with the details of Sepia *as a representative of invertebrate animals.*

Learning outcome-

Learners will get an idea of general characteristics and details of invertebrate animal systems.

4.1: General characters and classification, Habit and habitat, External characters, mantle cavity, locomotion, economic importance. **(5 lectures)**

4.2: Digestive system, Respiratory system, Circulatory system, excretory system, nervous system, Sense organs and Reproductive system. **(10 lectures)**

T.Y.B.Sc. Semester V (Practical)
Course Code: USC5ZO3 Course 13

1. **Levels of Organization.**
   - **a. Symmetry: -**
     - i) Asymmetry- eg. Sponge
     - ii) Radial: Bi-radial eg. Combjelly Pentaradial eg. Adult Brittle star
     - iii)Bi- lateral -eg. Any tetrapod.
   - **b. Coelom: -**
     - i) Acoelomate –e.g. Tapeworm
     - ii) Pseudo-coelomate- e.g. Ascaris
     - iii)Coelomate –e.g. Frog
   - **c. Segmentation:**
     - i) Homonomous- eg. Nereis
     - ii) Heteronomous- Cephalization: e.g. Honey-bee, Cephalothorax: -e.g. Crab
2. **Taxonomy**
   - **a. Kingdom- Protista:**
     - **1) Animal like Protists-Protozoa**
       - i. Phylum: Sarcodina e.g Amoeba
       - ii. Phylum: Mastigophora e.g, Noctiluca
       - iii. Phylum: Ciliophora e.g, Vorticella
       - iv. Phylum: Sporozoa, e.g,Monocystis
   - **b. Kingdom Animalia**
     - **1) Phylum- Porifera:-**
       - i. Class- Calcarea – e.g. Scypha
       - ii. Class Hexactinellida – e.g. Hyalonemma
       - iii. ClassDemospongia- e.g. Spongilla
     - **2) Phylum Cnidaria:-**
       - i. Class Hydrozoa – e.g. Vellela
       - ii. Class Scyphozoa- e.g. Rhizostoma
       - iii. Class Anthozoa- e.g. Corallium
     - **3) Phylum Platyhelminthes:-**
       - i. Class Turbellaria- e.g. Planaria
       - ii. Class Trematoda - e.g. Liverfluke
       - iii. Class Cestoda - e.g. Taenia solium
     - **4) Phylum Aschelminthes-**
       - i. Class Nematoda- e.g. Trichinella
       - ii. Class Nematomorpha- e.g. Gordius
       - iii. Class Rotifera- e.g. Mytilina
       - iv. Class Gastrotricha-e.g. Chaetonotus
       - v. Class Kinorhyncha-e.g. Echinoderes
     - **5) Phylum Annelida: -**
       - i. Class -Polychaeta- e.g. Arenicola
       - ii. Class- Oligochaeta- e.g. Tubifex

iii. Class- Hirudinea - e.g. Pontobdella

6) Phylum Arthropoda: -

i. Class- Merostomata-e.g.Limulus
ii. Class- Arachnida- e.g. Scorpion
iii. Class- Crustacea - e.g. Balanus
iv. Class- Myriapoda- e.g. Scolopendra
v. Class- Insecta- e.g. Coccinella

7) Phylum Onychophora e.g.Peripatus

8) Phylum Mollusca: -

i. Class- Aplacophora e.g. Chaetoderma
ii. Class Polyplacophora e.g. Chiton
iii. Class Monoplacophor e.g. Neopilina
iv. Class Gastropoda e.g. Achatina
v. Class Pelycypoda e.g. Donax
vi. Class Scaphopoda e.g. Dentalium
vii. Class Cephalopoda e.g. Octopus

9) Phylum Echinodermata:

i. Class Asteroidea e.g. Starfish
ii. Class Ophiuroidea e.g. Brittle star
iii. Class Echinoidea e.g. Echinus
iv. Class Holothuroidea e.g.Holothuria
v. Class Crinoidea e.g.Crinoid

10) Phylum Hemichordata:

i. Class Enteropneusta e.g. Saccoglossus
ii. Class Pterobranchia e.g.Rhabdopleura
iii. Class Planctosphaeroidea e.g.Planctosphaera

3. Minor Phyla

a. Acoelomate:

i) Phylum Acanthocephala e.g. Echinorhynchus

b. Coelomate:

i) Phylum Chaetognatha e.g. Sagitta.

4. General Topics in Invertebrates:

a. Protozoans

Locomotion -Amoeboid locomotion-Amoeba, Ciliary locomotion- Vorticella Flagellar locomotion- Noctiluca, Gliding locomotion-Monocystis **Reproduction**- Asexual reproduction – Binary fission- Amoeba Sexual reproduction- Conjugation- Paramoecium

b. Sponges

Canal system: Sycon type - Scypha, Ascon type- Leucosolenia, Leucon type - Spongilla Sponge spicules: Monaxon,Triaxon, Tetraxon,Polyaxon

c. Insects:

Types of metamorphosis: Ametabolous- e.g.Lepisma, Hemimetabolous- e.g. Locust Holometabolous e.g. Butterfly.

Study tour-Visit to local fish market/Aquarium/Any other place to observe invertebrates.

T.Y.B.Sc. Semester V

Course Code: USC6ZOP3

Reference and Additional Reading:

REFERENCES

- Zoology for Degree Students-I;Dr.V.K.Agarwal.S.Chand
- Modern text book of Zoology – Invertebrates; Eleventh; Edition Professor R.L. Kotpal;
- Rastogi publication
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Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester V
Paper IV and Practical IV

T.Y.B.Sc. Semester V (Theory)
Course Code: USC5ZO4 Course 14

Integumentary system, Human Osteology and Limb Muscles and Developmental Biology of Chick

Unit 1: Integumentary system and derivatives (15 Lectures)

Objective:

To introduce the learners to understand different integumentary structures and derivatives in the vertebrates and to acquaint learners with special derivatives of integument.

Desired outcome:

Learners will be able to understand the importance of epidermal and dermal derivatives and their functions.

1.1: Basic structure of integument (1 Lecture)

Epidermis and dermis.

1.2: Epidermal derivatives of Vertebrates (6 Lectures)

Hair, hoof, horn, claw, teeth, beak, epidermal scales (large scales, small scales,modified scales - spine), glands - types and functions (mucous, serous, ceruminous,
poison, uropygial, salt), type of feathers.

1.3: Dermal derivatives of Vertebrates (4 Lectures)

Scales in fish; scutes in reptiles and birds; dermal scales in mammals
- Armadillo, Antler -Caribou

1.4: Special derivatives of integument (4 Lectures)

Wart in toad, rattle in snake, whale bone in baleen whale,kneepads in camel.

Unit 2: Human Osteology (15 Lectures)

***O*bjective:**

To introduce the learners to different bones of human skeleton and their importance.

Desired outcome:

Learners will be able to understand the structure, types and functions of humanskeleton.

2.1: Introduction (2 lectures)

Bone structure, physical properties, chemical composition andfunctions of bones.

2.2: Axial skeleton (8 lectures)

2.2.1 : Skull: General characteristics of skull bones
a) Cranial bones b) Facial bones

2.2.2 : Vertebral column: General characteristics of a vertebra, structure of different types of vertebrae (cervical, thoracic, lumbar, sacrum & coccyx).

2.2.3 : Ribs and sternum (Thorax): General skeleton of ribs and sternum.
2.2.4 : Hyoid bone: Structure and function.

2.3: Appendicular skeleton (5 lectures)

2.3.1 : Pectoral girdle and Pelvic girdle.
2.3.2 : Bones of forelimbs and hind limbs.

Unit 3: Muscles of long bones of Human limbs (15 lectures)

Objectives:

- *To study long limb muscles involved in body movements.*
- *To identify various arrangements of the long limb muscles and to relate thearrangement with contraction and motion.*
- *To study muscle injuries and syndromes.*

Desired outcome:

Learners will be able to understand the types of long limb muscles, its arrangementand their role in body movements.

3.1: Introduction and types of long limb muscles (1 lecture)

3.1.1: Flexors, Extensor, Rotator, Abductors, Adductors

3.2: Muscles of forelimbs (6 lectures)

3.2.1. : Muscles that move the arm (Humerus)-Triceps Brachii,Biceps Brachii, Brachialis, Brachioradialis
3.2.2. Muscles that move the forearm (Radius-ulna) - Flexor carpi radialis, Flexor carpiulnaris, Extensor carpi ulnaris
3.2.3. Muscles that move the wrist, hand and fingers - Flexor digitorium superficialis, Extensor carpi radialis, Extensor digitorum

3.3: Muscles of hindlimbs (6 lectures)

3.3.1. Muscles that move the thigh (Femur) - Sartorius, Adductor group, Quadriceps group- Rectus femoris, Vastus lateralis, Vastusmedialis, 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, Fibularistertius
3.3.3. Muscles that move the ankle, foot and toes - Tibialis anterior, Extensor digitorum longus, Fibularis muscles

3.4: Muscle injuries (1 lecture)

Injury in buttock - Gluteus maximus and Gluteus medius, knee- Quadriceps group, leg and foot while running.

3.5: Muscle syndromes (1 lecture)

Shin splint syndrome, Plantar fasciitis and Stress fractures.

Unit 4: Developmental biology of Chick (15 lectures)

Objective:

To introduce to the learners the basics of developmental biology with reference tochick as a model and also understand experiments related to it.

Desired outcome:

Learners will be able to understand the processes involved in embryonic developmentand its application.

4.1: Introduction to Developmental Biology (5 lectures)

4.1.1. :Basic concept and principles of developmental biology - morphogenesis, organogenesis, fate maps, cell adhesion, cell affinity and cell differentiation.

4.2: Development of Chick embryo (10 lectures)

4.2.1. Structure of Hen's egg, fertilization, cleavage, blastulation and gastrulation

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

4.2.3. Extra embryonic membranes

T.Y.B.Sc. Semester V (Practical)
Course code: USC5ZOP4
Course 14

1. Study of integumentary systems and its derivatives - V.S. of Skin of Shark, Frog, *Calotes*, Pigeon and Human.
2. Study of Human Axial Skeleton - Skull and Vertebral column.
3. Study of Human Appendicular Skeleton - Girdles and Limb bones.
4. Study of muscles of forelimbs - Biceps Brachii, Brachialis, Brachio radialis. Triceps Brachii, Flexor carpi radialis, Flexorcarpi ulnaris, Extensor carpi ulnaris.
5. Study of muscles of hindlimbs.- Sartorius, Adductor group, Quadriceps group- Rectus femoris, Vastus lateralis, Vastus medialis, Hamstring group (Biceps femoris, Semimembranosus, Semitendinosus),Fibularis longus, Gastrocnemius,
6. Tibialis anterior, Soleus, Extensor digitorum longus, Fibularistertius.
7. Study of ontogeny of chick embryo using permanent slides -18 hrs, 24 hrs, 33 hrs, 48hrs and 72 hrs.
8. Prepare temporary mounting of chick embryo upto 48 hrs of incubation (demonstration).

T.Y.B.Sc. Semester V
Course code: USC5ZOP4

References and Additional Reading Material:

REFERENCES:

Integumentary system and derivatives

- 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 of zoology; Prof. R.L. Kotpal
- Integumentary system and its derivatives; Samuel D. Hodge

Human Osteology

- 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 DWhite
- 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

Muscles of Long Bones of Human Limbs

- Human anatomy by John. W. Hole, Jr., Karen A. Koos, Publisher: Wm.C. Brown Publisher, USA.
- Principles of anatomy and physiology by Gerard T. Tortora and Sandra Reynolds Grabowski. Publisher: Harpers Collins College Publishers (7th Edition).

Developmental Biology of Chick

- Developmental biology; Gilbert
- Developmental biology; 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

Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester VI
Paper I and Practical I

T.Y.B.Sc. Semester VI
(Theory) Course
Code: USC6ZO1
Course 15
Enzymology, Homeostasis, Endocrinology and Animal Tissue Culture

Unit I: Enzymology **(15 Lectures)**

Objective:

- *To introduce to the learner the basic concepts of enzyme biochemistry and to make the learner realize the power and application of enzymes in basic and applied science.*

Desired outcome:

- *Learners shall be able to understand basics of enzyme structure and function.*
- *Learners will be able to comprehend variations in enzyme activity and kinetics.*
- *Learners shall appreciate the enzyme assay procedures and the therapeutic application of enzymes.*

1.1: Introduction and Nomenclature

Definition; Concept of activation energy; Nomenclature and classification (based on enzyme Commission) of enzymes; Co-factors and Co-enzymes.

1.2: Enzyme Action

Mechanism of enzyme action; Factors affecting enzyme activity - pH and temperature; Enzyme structure (lysozyme and serine protease) .

1.3: Enzyme kinetics

Derivation of Michaelis-Menten equation and Lineweaver-Burk plot; Concept and significance of K_m, V_{max} and K_{cat}; Modulation of enzyme activity with reference to GDH.

1.4: Enzyme inhibition

Enzyme inhibitors, competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors.

1.5: Regulation of enzyme activity

Allosteric regulation and regulation by covalent modification of enzymes; Isozymes (LDH)

1.6: Applications

Clinical significance and industrial applications of enzymes.

Unit II: Homeostasis **(15 Lectures)**

Objective:

- *To introduce to the learner the concept of homeostasis*
- *To familiarize the learner with concepts of thermoregulation and osmoregulation*

Desired outcome:

- *Learners shall comprehend the adaptive responses of animals to environmental changes for their survival.*

2.1: Homeostasis

External and internal environment; Acclimation and acclimatization; Body clock- Circadian & Diurnal rhythm

2.2: Thermoregulation

Endothermy, ectothermy (relation between temperature and biological activities); Temperature balance; Heat production - shivering and non-shivering thermogenesis; Brown fat - special thermogenic tissue in mammals, Mechanisms of heat loss; Adaptive response to temperature - daily torpor, hibernation, aestivation

2.3: Osmotic and Ionic regulation

Maintaining water and electrolyte balance; Ionic regulation in iso-osmotic environment; Living in hypo-osmotic and hyper-osmotic environment; Problems of living in terrestrial environment: water absorption, salt water ingestion and salt excretion, Salt glands, Role of kidney in ionic regulation, Metabolic water

Unit III: Endocrinology (15 Lectures)

Objective:

- *To introduce to the learner the details of endocrine glands and its disorders.*

Desired outcome:

- *Learners shall be able to understand the types & secretions of endocrine glands and their functions.*

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 (15 Lectures)

Objective:

- To *introduce to the learner the fundamental concepts of tissue culture and guide them progressively to certain areas that are basic to animal tissue culture.*

Desired outcome:

- *The learners shall understand the significance of tissue culture as a tool in specialized areas of research*
- *The learners will appreciate its applications in industries like biotechnology, in*

fields such as in vitro fertilization and replacement of animals in medical and toxicology experiments.

4.1: Introduction to animal cell culture

4.1.1: Advantages of tissue culture – control of the environment, characterization and homogeneity of sample, economy, scale and mechanization, *in vitro* modelling of *in vivo* conditions

4.1.2: Limitations of tissue culture – expertise, quantity, dedifferentiation and selection, origin of cells, instability

4.2: Aseptic techniques

4.2.1: Sterilization – basic principles of sterilization, importance of sterility in cell culture

4.2.2: Sterile handling – swabbing, capping, flaming, handling bottles and flasks, pipetting, pouring

4.3: Culture media

4.3.1 : Physicochemical properties – and bicarbonate, buffering, O_2, pH, CO_2 osmolality, temperature, viscosity, surface tension and foaming

4.3.2 : Types of media – Natural and Artificial media

4.3.3 : Serum – protein, growth factors, hormones, nutrients and metabolites, lipids, minerals and inhibitors

4.3.4 : Balanced Salt Solutions

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

4.4: Cell lines

4.4.1 : Primary and established cell lines and their characters.

4.4.2 : Preparation of cells/organs for culture

4.4.3 : Coverslip, Flask and Tube culture

4.4.4 : Hybridoma technology- an example of application of animal cell culture

T.Y.B.Sc. Semester VI (Practical)
Course Code: USC6ZO1
Course 15

1. Effect of varying pH on activity of enzyme Acid Phosphatase
2. Effect of varying enzyme concentration on activity of enzyme Acid Phosphatase
3. Effect of varying substrate concentration on activity of enzyme Acid Phosphatase
4. Effect of inhibitor on the activity of enzyme Acid Phosphatase
5. Separation of LDH isozymes by agarose gel electrophoresis
6. Histology of glands: T.S. of pituitary, thyroid, parathyroid, pancreas, adrenal, ovary, testis.
7. Instruments for tissue culture- Autoclave, Millipore filter, CO_2 incubator, Laminar air-flow. (Principle & use)
8. Packaging of glassware for tissue culture.
9. Aseptic transfer techniques.
10. Trypsinization and vital staining using Trypan blue stain.

Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester VI
Paper II and Practical II

T. Y. B. Sc. Semester VI (Theory)
Course Code: USC6ZO2
Course 16

Molecular Biology, Genetic Engineering, Human Genetics and Bioinformatics

Unit I: Molecular Biology (15 Lectures)

Objective:

- *To introduce learner to chemical and molecular processes that affect genetic material.*
- *To make learner understand the concept of DNA damage and repair, and how gene control is necessary for cell survival.*

Desired outcome:

- *Learner shall get an insight into the intricacies of chemical and molecular processes that affect genetic material.*
- *The course shall prepare learner to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry.*
- *Learner shall also understand related areas in relatively new fields of genetic engineering and biotechnology.*

1.1: Types of mutation

1.1.1 : Point mutations – substitution, deletion and insertion mutations
- Substitution mutations – silent (same-sense), 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/mutagens/mutagenic agents/DNA damage

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 B_1)

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

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 Lectures)

Objective:

- *To introduce learner to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms.*

Desired outcome:

- *The learners 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.*

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 : 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 : Separation and detection techniques: Blotting techniques: Southern blotting, Northern blotting and Western blotting Applications of blotting techniques

Unit III: Human Genetics (15 Lectures)

Objective:

- *To introduce learner with genetic alterations in human genome and their diagnosis.*

Desired outcome:

- *The learners shall become aware of the impact of changes occurring at gene level on human health and its diagnosis.*

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 chorio-villus sampling, Banding techniques (G, C, Q), FISH, Protein truncation test (PTT),

3.3.2 : Genetic counselling: Psycho-social aspects for the individual and the family in connection with genetic investigations

Unit IV: Bioinformatics (15 Lectures)

Objectives:

- *To introduce learner to bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.*

Desired outcome:

- *Learner shall become aware of the computational point of view of studying the genomes.*

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, EMBL-EBI, DDBJ)
Protein sequence data bases (UniProtKB, PIR, PDB)
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)

4.3.3 : Significance of sequence alignment

4.4: Predictive applications using DNA and protein sequences(5 L)

- **4.4.1 :** Evolutionary studies: Concept of phylogenetic trees 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

T. Y. B. Sc. Semester VI (Practical)
Course Code: USC6ZO62
Course 16

1. Isolation & Estimation of RNA by Orcinol method.
2. Isolation & Estimation of DNA by Diphenylamine method.
3. Separation of Genomic DNA by Agarose gel electrophoresis.
4. Colorimetric estimation of proteins from given sample by Bradford's method.
5. Problems related to Restriction endonucleases.
6. Karyotype (Idiogram) analysis for the following syndromes with comments on numerical & 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

    Interpretation of genetic formula: Deletion, duplication, inversion and translocation.
7. Calculation of mitotic index from the photograph or stained preparation of onion root tip or cancer cells.
8. Exploring BLAST tool (nucleotide sequence comparison).
9. Exploring the integrated database system at NCBI server and querying (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT).
10. Exploring bibliographic database PubMed (Data mining-Downloading a research paper on subject of interest, use of operators (AND, OR & NOT).

T. Y. B. Sc. Semester VI
Course Code: USC6ZO2

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Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester VI
Paper III and Practical III

T. Y. B. Sc. Semester VI (Theory)
Course Code: USC6ZO3
Course 17
Phylum Chordata, Group Euchordata- I, Group Euchordata II and Type study - Shark

Unit 1: Phylum Chordata (**15 lectures**)

Learning objectives:

To introduce basic concepts of modern Chordate classification with evolution point of view and to understand the concept of taxonomy in higher animal kingdom.

Learning outcome:

Learners will get an idea of origin of Chordates, its taxonomy up to class with reference to phylogeny and their special features.

1.1 : **General characters** **(7 lectures)**

1.1.1 : Difference between nonchordates and chordates.

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

1.1.3 : Classification – outline giving reasons**,** with schematic diagram –

Phylum chordata**:** Group -protochordata (Acrania)

Subphylum-Urochordata – Class Ascidiacea, Thaliacea, Larvacea

Subphylum-Cephalochordata- Class Leptocardi Group**:** Euchordata (Craniata)

Subphylum- Vertebrata: Division-Agnatha-

Class- Ostracodermii, Class- Cyclostomata Division-Gnathostomata-

Superclass- Pisces: Class-Placodermi, Chondrichthyes, Osteichthyes

Superclass Tetrapoda:Class- Amphibia, Reptilia, Aves, Mammalia

1.2 : Protochordates (**4 lectures)**

1.2.1 : General characters of Group Protochordata,Classification up to class with examples General characters of Subphylum Urochordata and Cephalochordata with examples

1.2.2 : Retrogressive metamorphosis in Ascidian

1.3 : Euchordates (**4 lectures**)

General characters - Group Euchordata. , Subphylum Vertebrata

Distinguishing characters -Division Agnatha and Gnathostomata.

General characters with examples- Class Ostracodermii and Cyclostomata.

Unit 2: Group Euchordata- I **(15 lectures)**

2.1 : Division – Gnathostomata (**5 lectures)**

Superclass – Pisces and Tetrapoda

Superclass – Pisces- Distinguishing characters.

Class- Placodermi,Chondrichthyes and Osteichthyes-Distinguishing characters .

Examples:

a. Sharks, e.g. Hammer headed shark

b. Skates and rays, e.gs. Saw fish

c. Chimeras e.g Spotted rat fish

d. Flying fish, e.g. Exocoetus

2.2 : Dipnoi (Lung fish) - (**3 Lectures)**
Distribution, habit and habitat,External and internal characters, affinities with superclass Pisces, affinities and differences with class Amphibia

2.3 : Migration in fish: Reasons for migration, types of migration **(3 Lectures)**
Examples- Eel and Salmon

2.4 : Superclass Tetrapoda- (**4 Lectures**)
Class Amphibia -General characters, Examples:
a. Limb-less amphibian, e.g. Ichthyophis
b. Tailed amphibian, e.g. Amphiuma
c. Tail-less amphibian, e.g. Hyla 2.3.: Neoteny and Paedogenesis in Amphibia

Unit 3: Group Euchordata II - Reptilia, Aves and Mammals **(15 Lectures)**

Learning objectives:

To introduce the learners to the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat.

Learning outcome:

Learners will understand the characteristic features and examples of class of Reptilia, Aves and Mammalia.

3.1 : Class Reptilia: General characters. (**2 lectures)**
3.1.1 : Examples
a. Extinct reptile, e.g. Ichthyosaurus
b. Living fossil, e.g. Sphenodon
c. Aquatic reptile, e.g. Chelone
d. Arboreal reptile, e.g. Chamaeleon

3.2 : Class Aves- General Characters (**6 lectures)**
3.2.1 : Examples-
a. Arboreal bird e.g Wood pecker

b. Terrestrial bird e.g. Jungle fowl

c. Swimming bird e.g. Cormorant

d. Wading bird, e.gs. Pond heron

e. Birds of prey, e.g. Owl

f. Flightless birds e.g. Emu

3.2.2 : Flight adaptations in birds

3.3 : Class Mammalia **(5lectures)**

3.3.1 : General characters and examples -

a. Egg-laying mammals, e.g. Duck-billed platypus

b. Pouched mammals, e.g.Kangaroo

c. Insect eating mammals, e.g. Common shrew

d. Toothless mammals, e.g.Sloth

e. Gnawing mammals, e.g. Squirrel

f. Primates, e.g. Lemur

3.3.2 : Adaptations in aquatic mammals with examples. **(2 lectures)**

Unit 4: Type study - Shark **(15 lectures)**

Learning objectives:

To study in depth one vertebrate animal type i. e. general characteristics and salient features of animal type - shark.

Learning outcome:

Learners will get an idea of vertebrate animal life after studying one representative animal Shark.

4.1 : Habit & habitat, distribution, external characters and classification, and economic importance **(3 lectures)**

4.2 : Skin, exoskeleton, endoskeleton, Digestive system, respiratory system, blood vascular System, nervous system, receptor organs, urinogenital system, copulation, fertilization and development. **(12 lectures)**

T. Y. B. Sc. Semester VI (Practical)
Course Code: USC6ZO3
Course 17

1. Group - Protochordata

Subphylum Urochordata -

- **a.** Class Larvaceae, e.g. Oikopleura
- **b.** Class Ascidiacea, e.g. Ciona
- **c.** Class Thaliacea, e.g. Salpa

Subphylum Cephalochordata:

- **a.** Class Leptocardii, e.g. Branchiostoma (Amphioxus)

2. Subphylum Vertebrata:

- **i.** Division Agnatha
  - **a.** Class Ostracodermi, e.g. Pharyngolepis,
  - **b.** Class Cyclostomata, e.g. Petromyzon
- **ii.** Division- Gnathostomata
  - Superclass - Pisces:
    - **a.** Class Placodermi e.g.Bothriolepis
    - **b.** Class Chondrichthyes- e.g.. Rhinobates e.g. Chimaera
    - **c.** Class- Osteichthyes -e.g.Protopterus , e.g. Catfish
  - Superclass - Tetrapoda :
    - **a.** Class Amphibia, e.g. Ichthyophis, e.g. Alytes, e.g. Triton
    - **b.** Class Reptilia: e.g. Geochelone (Indian star tortoise), Sphenodon , Varanus, Alligator

3. Class Aves:

E.g. Archaeopteryx, Ostrich, Penguin, Flamingo, Vulture, Hornbill

4. Class Mammalia

E.g. Duck-billed platypus, Dasyurus (Tiger cat), Dugong, Flying , Squirrel, Gorilla.

5. Shark: Study of endoskeleton of shark:

- **a.** Axial- skull and vertebral column
- **b.** Appendicular- pelvic and pectoral fins, pelvic and pectoral girdle.

6. Visit to local fish market/Aquarium/ zoo/ National park/Any other relevant place to observe Chordate animals.

T. Y. B. Sc. Semester VI
Course Code: USC6ZO3

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Syllabus for T.Y.B.Sc.
Program B.Sc.

Course: ZOOLOGY

Semester VI
Paper IV and Practical IV

T.Y.B.Sc. Semester VI (Theory)
Course Code: USC6ZO4
Course 18
Environment and Wildlife management, Bioprospecting, Zoopharmacognosy and Zoogeography

Unit 1: Environment management (15 lectures)

Objective:

To introduce the learners to understand the importance of different factors ofenvironment and its management.

Desired outcome:

Learners will understand the different factors affecting environment, itsimpact and environment management laws.

1.1: Natural resources and their classification (2 lectures)

Forest resources, water resources (surface and ground), mineral resources,energy resources: renewable and non-renewable resources.

1.2: Exploitation and modification of natural resources (2 lectures)

Impact on climate, flora and fauna.

1.3: Waste Management (2 lectures)

3R's (Reduce, Reuse & Recycle) of solid waste, e-waste, hazardous waste.

1.4: Water Management (4 lectures)

Rain water harvesting, watershed management, effluent treatment,recycling plants, control and treatment of sewage water.

1.5: Rules and Acts of Environment Management (5 lectures)

Environment Protection Act, Air (Prevention and Control of Pollution) Rules- 1982, Water (Prevention and Control of Pollution) Rules-1978, Hazardous Wastes (Management and Handling) Rules-1989, EIA(Environmental Impact Assessment), Role of Central and State Government(Pollution Control Board) and NGOs.

Unit 2: Wildlife management (15 lectures)

Objective:

To introduce the learners to the importance of wildlife conservation.

Desired outcome:

Learners will be able to understand the wildlife habitat projects for animalprotection.

2.1: Habit, habitat, territory and niche of wild animals (2 lectures)

Herbivores, carnivores, solitary, pack and herd.

2.2: Threats to wildlife (6 lectures)

Diseases (zoonosis and reverse zoonosis), competition, hunting andpoaching, encroachment, deforestation, tourism, overgrazing, humananimal conflict and climate change.

2.3: Wildlife conservation: Techniques and methods (7 lectures)

Ex-situ conservation (Zoos, cryogenics, seedbank, germplasm and genebank), in- situ conservation (Bio-reserves, Sanctuaries and National Parks).

Unit 3: Bioprospecting and Zoopharmacognosy (15 lectures)

Objective:

To introduce the learners to understand prospecting in biology and importance of pharmacognosy.

Desired outcome:

Learners will understand the paradigms of discovery and commercialization ofbiological resources andknowledge gained by self-medication by animals.

3.1: Bioprospecting (7 lectures)

- **3.1.1.** Traditional and modern bioprospecting
- **3.1.2.** Economic value of bioprospecting
- **3.1.3.** Bioprospecting and conservation
- **3.1.4.** Advantages and disadvantages

3.2: Zoopharmacognosy (8 lectures)

- **3.2.1** Definition and types
- **3.2.2** Self-medication and its mechanism
- **3.2.3** Methods of self-medication through- Ingestion- ants and mammals, Geophagy- invertebrates and birds
- **3.2.4** Absorption and adsorption
- **3.2.5** Applications – birds, mammals, social and trans-generational aspects 3.2.6: Contribution to human medicines.

Unit 4: Zoogeography (15 lectures)

***O*bjective:**

To introduce learners to a branch of science dealing with the geographic distributionof animals.

Desired outcome:

The learners will become acquainted with how and why different animal species aredistributed around the globe.

4.1: Introduction **(2 lectures)**

Plate tectonics and continental drift theory.

4.2: Animal distribution and barriers **(7 lectures)**

4.2.1 : Patterns of animal distribution – continuous, discontinuous, isolation andbipolarity.

4.2.2 : Barriers of distribution –Topographic, climatic, vegetative, large watermasses, land mass, lack of salinity and special characteristic habit(homing instinct).

4.2.3 : 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 **(6 lectures)**

4.4.1 : Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic.

T.Y.B.Sc. Semester VI (Practical)
Course code: USC6ZOP
Course 18

1. Estimation of phosphates from sample water.
2. Estimation of BOD and COD from sample water.
3. Estimation of Nitrates from sample water.
4. Estimation of acidity and alkalinity of sample water by methyl orange and phenolphthalein indicator.
5. Comparative study of sound intensity in different places by Decibel meter.
6. Study of threatened animal species inhabiting Indian continent with reasons for decline- Great Indian bustard, One-horned rhinoceros, Royal Bengal tiger, Blackbuck, lion tailed macaque, Nilgiri Thar, Asiatic lion, Snow leopard, Gharial, and Gangetic dolphin.
7. Study of Zoopharmacognosy in ants, cats, elephants and dogs.
8. Indicate the distribution of fauna in the world map w.r.t. to its realm and comment on the pattern of distribution.
9. Study tour/Visit to Zoo/Sanctuary/National park/Research institute.

T. Y. B. Sc. Semester VI
Course Code: USC6ZO4

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