PREFACE

For the development of any modern society Science play a key role. Progress in various fields of Science and Technology has become the tools to understand life processes. Since knowledge in all branches and fields is growing globally at a fast pace with new disciplines emerging. This approach has necessitated the revision of the present curriculum. At the undergraduate level effectual science education can be communicated only by restructuring the curriculum . To achieve this goal, it is, therefore, imperative to update the existing syllabus accordingly, taking into account the broader perspective of Curriculum. Effort is taken to make the syllabi compatible with other universities and at the same time it is ensured that the syllabus is not very intense. The present curriculum will expose students to various fields in Zoology. Curricula with basic as well as advanced concepts in the Zoology at the third year shall inspire the students for pursuing higher studies in Zoology. It is foresee that students will have more avenue to pursue their own interests and chosen field of courses, it will also enable students to get employed in the Biological research Institutes, Industries, Educational Institutes and in the range of concerning departments based on subject Zoology. The syllabus contains different components and learning outcomes specified. The other major components of the new syllabus is project .The aim of introducing project is to provide experiential learning through active participation that enables the student to develop and demonstrate analytical, judgmental, presentation and communication skills. Format provided along with the syllabus gives guidelines to engrave the project systematically. Committee comprising senior teachers were nominated from degree colleges after several interactive session and discussion the syllabus was prepared. On behalf of the Board Members, I place on record the endeavor by the committee and help rendered by one and all, It is hoped that this curriculum document, prepared would provide the level of competency.

From

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T. Y. B. Sc. Zoology
Semester based Credit and Grading System
(To be implemented from Academic Year 2017-18)
Semester V

Theory				
Course	**Unit**	**Topic**	**Credits**	**Lectures/week**
USZO501	I	Levels of organization	2.5	1
	II	Taxonomy of Phylum Protozoa to Phylum Nemathelminthes		1
	III	Taxonomy of Phylum Annelida to Phylum Echinodermata		1
	IV	Type study : Sepia		1
USZO502	I	Basic Hematology	2.5	1
	II	Applied Hematology		1
	III	Basic Immunology		1
	IV	Applied Immunology		1
USZO503	I	Molecular Biology	2.5	1
	II	Genetic engineering		1
	III	Human Genetics		1
	IV	Tissue Culture		1
USZO504	I	Integumentary system and derivatives	2.5	1
	II	Endocrine glands and regulation		1
	III	Human Osteology		1
	IV	Experimental and Chick Embryology		1
			10	**16**
Practical				
USZOP05		Practicals of Course USZO501 and Practicals of Course USZO502	3	8
USZOP06		Practicals of Course USZO503, USZO504 and Project Component	3	8
			6	**16**
Total			**16**	**32**

T. Y. B. Sc. Zoology
Semester V (Theory)

Course 11
Course Code: USZO501

Unit 1: Levels of organization

(15 lectures)

Learning objectives:
To comprehend, compare and distinguish the levels of organisation in the animal kingdom.
Learning outcome:
Learners will develop conceptual clarity with regard to the anatomy of animals at different levels. Learners shall comprehend the evolutionary perspective of each level of organisation. Learners will know the importance of the significance and advantages of each level of organisation.

1.1: Levels of Organization (3 lectures)

1.1.1: Unicellularity, multicellularity, colonization
1.1.2: Cellular grade of organization, tissue grade of organization, formation of germ layers

1.2: Symmetry (4 lectures)

1.2.1: Evolutionary perspective and definition
1.2.2: Types -
a. Asymmetry – e.g. *Amoeba*
b. Radial – e.g. Bi-radial - *Aurelia* (Jellyfish); Penta-radial - *Asterais* (Starfish)
c. Bi-lateral – e.g. Simple – *Planaria;* Complex - *Mus* (Rat)
1.2.3: Significance and Advantages

1.3: Coelom (4 lectures)

1.3.1: Evolutionary perspective and definition
1.3.2: Development of Coelom -
a. Organization of tissues
b. Diploblastic and Triploblastic organization
1.3.3: Types -
a. Acoelomate – e.g. Platyhelminthes - *Planaria*
b. Pseudocoelomate – e.g. Nematoda - *Ascaris* (Round worm)
c. Coelomate – e.g. Annelida - *Pheretima* (Earthworm)
1.3.4: Significance and Advantages

1.4: Segmentation/ Metamerism (4 lectures)

1.4.1: Evolutionary perspective and definition
1.4.2: Theories of segmentation
1.4.3: Types -
a. Homonymous – e.g. Annelida - *Pheretima* (Earthworm)
b. Heteronomous – e.g. Crustacean - *Panulirus* (Lobster)
c. Cephalization – e.g. Insecta - *Periplanata* (Cockroach)
d. Tagmatization – e. g. *Panulirus* (Lobster)

e. Cephalothorax – e.g. *Penaeus* (Prawn)

1.4.4: Significance and Advantages

Unit 2: Taxonomy of Phylum Protozoa to Phylum Nematoda (15 lectures)

Learning objectives:

To introduce the learners to the modern system of animal classification. To describe the distinguishing characters of major invertebrate phyla and their adaptive features with reference to their habitat.

Learning outcome:

Learners will understand that scientific classification of animals is based on certain characteristics they have in common. Learners will be able to recall characteristics features and examples of each phylum. Learners will be familiar with protozoan and helminth parasites.

2.1: Principles of Taxonomy (1 lecture)

Linnaean Hierarchy, Binomial Nomenclature,
Five Kingdom classification

2.2: Phylum Protozoa (5 lectures)

2.2.1: General characters and classification
2.2.2: Locomotion in Protozoa - amoeboid, flagellar, ciliary, gliding
2.2.3: Reproduction in Protozoa - asexual and sexual
2.2.4: Morphology, life cycle, pathogenicity and control measures:
Plasmodium, Entamoeba

2.3: Phylum Porifera (3 lectures)

2.3.1: General organization and classification
2.3.2: Skeleton in sponges
2.3.3: Canal system in sponges

2.4: Phylum Cnidaria (2 lectures)

2.4.1: General characters and classification
2.4.2: *Obelia* - Polymorphism, life cycle and alternation of generations

2.5: Phylum Platyhelminthes (2 lectures)

2.5.1: General characters and classification
2.5.2: Life history of *Fasciola hepatica*

2.6: Phylum Nematoda (2 lectures)

2.6.1: General characters and classification
2.6.2: Life history of *Ascaris lumbricoides* and its parasitic adaptations

Unit 3: Taxonomy of Phylum Annelida to Phylum Hemichordata (15 lectures)

Learning objectives:
To introduce basic concepts of invertebrate classification in animal kingdom from phylum Annelida to Echinodermata. To study general characteristics and salient features of animals belonging to phylum Annelida to Hemichordata.
Learning outcome:
Learners will get an idea of higher groups of invertebrate animal life and their classification.

3.1: Phylum Annelida (3 lectures)
- 3.1.1: General characters and classification
- 3.1.2: Diversity in habit and habitat
- 3.1.3: Adaptive radiation in Class Polychaeta

3.2: Phylum Arthropoda (4 lectures)
- 3.2.1: General characters and classification
- 3.2.2: Larval forms of Crustacea; social life, moulting and metamorphosis in Insecta; Vision in Arthropoda
- 3.2.3: Affinities of Onychophora

3.3: Phylum Mollusca (3 lectures)
- 3.3.1: General characters and classification
- 3.3.2: Torsion and detorsion

3.4: Phylum Echinodermata (2 lectures)
- 3.4.1: General characters and classification
- 3.4.2: Water vascular system

3.5: Hemichordates (2 lectures)
General characters and classification, e.g. Balanoglossus

3.6: Basic concepts of phylogeny (1 lecture)

Unit 4: Type study - Sepia (15 lectures)

Learning objectives:
To study one invertebrate type animal, e.g. Sepia
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)**

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 12
Course Code: USZO502

Unit 1: Basic Hematology **(15 lectures)**

Learning objectives:
To introduce the learners to composition of blood. To acquaint the learners with the physiology of blood clotting, transport of gases and clinical aspects of haematology.
Learning outcome:
Learners would be able to realize the fundamental concepts in haematology.

1.1: Composition of blood **(1 lecture)**
Plasma & formed elements
1.2: Blood volume **(2 lectures)**
Total quantity and regulation; haemorrhage
1.3: Plasma proteins **(2 lectures)**
Inorganic constituents, respiratory gases, organic constituents other than proteins (include internal secretions, antibodies and enzymes)
1.4: RBCs **(2 lectures)**
Structure and functions, abnormalities in structure, total count, variation in number; types of anaemia and genetic disorders; ESR
1.5: Hemoglobin **(3 lectures)**
Structure, formation and degradation, role in transport of oxygen and carbon dioxide (Chloride shift and Bohr's effect); types of hemoglobin (foetal, adult and sickle)
1.6: WBCs **(2 lectures)**
Types of leukocytes and function; total count and variation in number; leucopoiesis and leukemia and its types
1.7: Blood clotting **(3 lectures)**
Thrombocytes; factors and mechanism of coagulation; anticoagulants; formation of blood platelets (thrombopoiesis); clotting mechanism; bleeding and clotting time; failure of clotting mechanism; haemophilia and purpura

Unit 2: Applied Hematology **(15 lectures)**

Learning objectives:
To introduce the learners to basics of applied hematology. To impart knowledge of basic diagnostic techniques used in pathology.
Learning outcome:
Learners will be familiar with different terminologies and diagnostic tests performed in a pathological laboratory. Learners will be better equipped for taking any further pathological course or working in a diagnostic laboratory.

2.1: Introduction to Applied Hematology **(3 lectures)**

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

2.2: Diagnostic techniques used in hematology

2.2.1: Microscopic examination of blood: For detection of blood cancers (Lymphoma, Myeloma); infectious diseases (Malaria, Filariasis, Leishmaniasis); hemoglobinopathies (Sickle cell, Thalassemia) **(2 lectures)**

2.2.2: Coagulopathies: Diagnostic methods (hemophilia and purpura) **(1 lecture)**

2.2.3: Microbiological examination: Blood culture: Method and application in diagnosis of infectious diseases (Typhoid and TB) **(1 lecture)**

2.2.4: Biochemical examinations of blood for: **(5 lectures)**

Liver function tests: Albumin, AST, ALT, AST:ALT ratio, Total bilirubin, Direct bilirubin, Prothrombin time / International normalized ratio (PT/INR), Serum glucose, LDH and Alkaline phosphatase

Kidney function tests: Serum creatinine, blood urea nitrogen

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

Other biochemical tests: Blood hormones (Thyroid, FSH, LH), Cancer Antigen test (CA124 or CA125)

2.2.5: Blood Bank: Collection, storage, preservation of its components **(1 lecture)**

2.2.6: Blood transfusion: Crossing matching, Transfusion of blood and bone marrow transplant **(2 lectures)**

Unit 3: Basic Immunology **(15 lectures)**

Learning objectives:

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

Learning 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 **(1 lecture)**

Definition and scope

3.2: Components of immune system:

3.2.1: Innate immunity – Definition, Factors affecting innate immunity, Mechanisms of innate immunity – physical barriers, chemical barriers and cellular barriers **(2 lectures)**

3.2.2: Adaptive or Acquired immunity – Active Acquired immunity – Natural and Artificial; Passive Acquired immunity – Natural and Artificial **(1 lecture)**

3.3: Cells and Organs of immune system

3.3.1: Cells of immune system – B cells, T cells and null cells, macrophages, dendritic cells and mast cells **(1 lecture)**

3.3.2: Organs of immune system – Primary – Thymus and bone marrow; Secondary - Lymph node and spleen **(2 lectures)**

3.4: Antigens

Definition, properties of antigens; haptens **(1 lecture)**

3.5: Antibodies **(2 lectures)**

Definition, basic structure, classes of antibodies – IgG, IgA, IgM, IgD and IgE **(2 lectures)**

3.6: Hypersensitivity, Autoimmunity and Immunodeficiency **(3 lectures)**

3.6.1: Definition of Hypersensitivity; Classification of hypersensitivity reactions: Type-I, Type-II, Type-III and Type-IV (one example of each type)

3.6.2: Introduction and a brief account of autoimmunity and example, Rheumatoid arthritis

3.6.3: Introduction to immunodeficiency – Congenital, e.g. SCID; Acquired, e.g. AIDS

Unit 4: Applied Immunology **(15 lectures)**

Learning objectives:

To introduce the learners to immune related pathologies. To make the learners understand the concept of vaccines and vaccination. To familiarise the learners to immunological perspectives of organ transplant and tumour treatment.

Learning outcome:

Learners would understand immune related pathologies. Learners would understand the principle and applications of vaccines. Learners would develop basic understanding of immunology of organ transplantation and cancer treatment.

4.1: Antigen-Antibody interaction **(5 lectures)**

General features of antigen-antibody interaction; Precipitation reaction: Definition, characteristics and mechanism, precipitation in gels (slide test) - Radial immunodiffusion (Mancini method), Double immunodiffusion (Ouchterlony method); Agglutination reaction: definition, characteristics and mechanism, Haemagglutination (slide and micro-tray agglutination), passive agglutination, Coomb's test and ELISA

4.2: Vaccines and Vaccination **(5 lectures)**

Brief history of vaccination, principles of vaccines, Active and Passive immunization; Routes of vaccine administration

Classification of Vaccines: Live attenuated, Whole-Killed or inactivated, Sub-unit vaccines: Toxoids, Protein vaccines, Viral-like particles, DNA vaccines

Adjuvants: Introduction and application; Adjuvants used for human vaccines (Alum, Virosomes and Liposomes, Saponins, Water-in-oil emulsions)

Vaccines against human pathogens: Polio; Hepatitis A and B; Rotavirus; Tuberculosis (BCG); Diphtheria, Tetanus and Pertussis (DPT); Typhoid (TAB) vaccines

4.3: Transplantation and Tumour immunity (5 lectures)

Transplantation: Introduction to transplantation; Types of grafts; Immunologic basis of graft rejection: MHC compatibility in organ transplantation, Lymphocyte mediated graft rejection, Antibody mediated graft rejection; Prevention of graft rejection; Immunosuppressive therapy

Tumour immunology (Cancer immunology): Introduction to cellular transformation and cancer; Tumour antigens and immune surveillance; Immunotherapy: Antigen-independent cytokine therapy, Stimulation of cell-mediated immune responses, Passive immunotherapy

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 13
Course Code: USZO503

Unit 1: Molecular Biology (15 lectures)

Learning objectives:
Introduce the learners to chemical and molecular processes that affect genetic material. It also intends to make them understand the concept of DNA damage and repair, and how gene control is necessary for cell survival.
Learning outcome:
The course will prepare learners to recognize the significance of molecular biology as a basis for the study of other areas of biology and biochemistry. Moreover, it will also assist them in understanding related areas in relatively new fields of genetic engineering and biotechnology.

1.1: Types of mutation (4 lectures)

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 (4 lectures)

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, 2-aminopurine), intercalating agents (acridine dyes, ethidium bromide and ICR compounds), deaminating agents (bisulfite compounds and nitrous acid), hydroxylating agents (hydroxylamine), alkylating agents (ethylmethanesulphonate, ethylethane sulphonate, mustard gas, nitrogen mustard, polycyclic aromatic hydrocarbons), aflatoxin (aflatoxin B_1)

1.3: Preventative and repair mechanisms for DNA damage (5 lectures)

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

1.4: Eukaryotic gene expression (2 lectures)

1.4.1: Regulatory proteins – zinc fingers, helix-turn-helix domain and leucine zipper
1.4.2: DNA methylation

Unit 2: Genetic Engineering **(15 lectures)**

Learning objectives:
To introduce learners to a set of techniques to modify an organism's genome to produce improved or novel genes and organisms.
Learning outcome:
The learners will get acquainted with the vast array of techniques used to tamper 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: **(2 lectures)**
Introduction, nomenclature and types with examples, working mechanism, Ligases – E.coli DNA ligase, T4 DNA ligase, polynucleotide kinase, phosphatases, DNA and RNA polymerases, reverse transcriptase, terminal transferase

2.1.2: Vectors for gene cloning: **(2 lectures)**
General properties, advantages and disadvantages of cloning vectors - plasmid vectors, phage vectors, cosmid vectors, phasmid vectors, BAC vectors

2.1.3: Cloning techniques: **(2 lectures)**
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

2.1.4: Transfection techniques: **(2 lectures)**
Liposome mediated gene transfer, calcium phosphate precipitation method, electroporation, virus mediated gene transfer - Retrovirus

2.2: Techniques in Genetic Engineering

2.2.1: PCR techniques: **(1 lectures)**
Principle of polymerase chain reaction (PCR), Variants in PCR, Applications of PCR

2.2.2: Sequencing techniques: **(2 lectures)**
DNA sequencing: Maxam-Gilbert method, Sanger's method – Manual and automated methods
Protein sequencing: Sanger's method, Edman's method, Applications of sequencing techniques

2.2.3: Separation and detection techniques: **(4 lectures)**
Blotting techniques: Southern blotting, Northern blotting and Western blotting Applications of blotting techniques
Microarray techniques: ESTs, DNA Microarray and Applications

Unit 3: Human Genetics **(15 lectures)**

Learning objectives:
To introduce learners with genetic alterations in human genome and their diagnosis.

Learning outcome:
The learners will 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 (5 lectures)

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 (Autoploidy and Alloploidy)

3.2: Genetic Disorders (5 lectures)

3.2.1: Inborn Errors of Metabolism: Phenylketonuria, G-6-PD deficiency, Alkaptonuria, Albinism, Niemann Pick syndrome
3.2.2: Single gene mutation: Cystic fibrosis, Muscular dystrophy
3.2.3: Multifactorial: Breast Cancer, Diabetes mellitus, Ischemic heart
3.2.4: Uniparental Disomy: Angelman Syndrome and Prader Willi Syndrome

3.3: Diagnosis (5 lectures)

3.3.1: Prenatal Diagnosis (Amniocentesis) and chorio-villus sampling - Ultrasound scanning and Fetoscopy, Banding techniques (G, C, Q), FISH and M-FISH, Protein truncation test (PTT), Single Nucleotide Polymorphism and its applications
3.3.2: Applications: Principles and strategies in identifying the abnormal genes (position independent and dependent), use of abnormalities, confirming a candidate gene
3.3.3: Genetic counselling: Psycho-social aspects for the individual and the family in connection with genetic investigations

Unit 4: Tissue Culture (15 lectures)

Learning objectives:
Introduce the learners to fundamental concepts of cell culture and guide them progressively to certain areas which now-a-days are basic to the performance of animal cell culture.
Learning outcome:
The course will prepare learners to understand significance of cell culture as a tool in specialized areas of research and 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 (2 lectures)

4.1.1: Advantages of tissue culture – control of the environment, characterization and homogeneity of sample, economy, scale and mechanization, *in vitro* modeling of *in vivo* conditions
4.1.2: Limitations of tissue culture – expertise, quantity, dedifferentiation and selection, origin of cells, instability

4.2: Aseptic techniques (3 lectures)

4.2.1: Objectives of aseptic techniques – maintaining sterility

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

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

4.3: Culture media (5 lectures)

4.3.1: Physicochemical properties – pH, CO_2 and bicarbonate, buffering, O_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: Primary culture and establishment of cell lines (5 lectures)

4.4.1: Establishment of primary cultures from various sources – normal 'versus' tumour, adult 'versus' embryo, human 'versus' animal, source of material

4.4.2: Isolation of cells – enzyme digestion, perfusion, mechanical disaggregation, explants cultures

4.4.3: Substrate for attachment

4.4.4: Culture conditions – selection against some cell types, conditioned medium, feeder cells

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T. Y. B. Sc. Zoology
Semester V (Theory)

Course 14
Course Code: USZO504

Unit 1: Integumentary system and derivatives (15 lectures)

Learning objectives:
To introduce the learners to understand different integumentary structures and derivatives in the vertebrates and to acquaint learners with special derivatives of epidermis.
Learning outcome:
Learners will be able to understand the importance of epidermal and dermal derivatives and their functions.

1.1: Basic structure of integument (2 lectures)
Epidermis and dermis; classification of keratinized and non-keratinized derivatives

1.2: Epidermal derivatives of Vertebrates (5 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), feathers

1.3: Dermal derivatives of vertebrates (3 lectures)
Scales in fish; scutes in reptiles and birds; dermal scales in mammals - Armadillo, Antler - Caribou

1.4: Special derivatives of integument (Epidermal) (5 lectures)
Wart in toad; rattle in snake; horny beak in turtle, birds, monotremes; spur in male birds - jacana, fowl; whale bone - baleen whale; liliac callosities – African mandrill; kneepads - camel

Unit 2: Endocrine glands and regulation (15 lectures)

Learning objectives:
To introduce the learners about the details of endocrine glands and their regulation.
Learning outcome:
Learners will be able to understand the types & secretions of endocrine glands and their functions.

2.1: (2 lectures)
General organization of mammalian endocrine system

2.2: **(6 lectures)**

Hormones: Classification, properties, mechanism of hormone action, hormone secretion and transport

2.3: **(7 lectures)**

Histology, functions and disorders of the following endocrine glands: Pituitary, Thyroid, Parathyroid, Pancreas, Adrenal, Testis and Ovaries

Unit 3: Human Osteology **(15 lectures)**

Learning objectives:

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

Learning outcome:

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

3.1: Introduction **(2 lectures)**

Cartilage & Bone Structure

Physical properties, chemical composition & functions of bones

3.2: Axial skeleton **(7 lectures)**

3.2.1: Skull: general characteristics of skull bones

1) cranial bones 2) facial bones

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

3.2.3: Ribs & sternum (Thorax): General skeleton of ribs & sternum

3.2.4: Hyoid bone: General structure

3.3: Appendicular skeleton **(4 lectures)**

3.3.1: Pectoral girdle and Pelvic girdle

3.3.2: Forelimbs and Hindlimbs

3.4: Sexual dimorphism of human skeleton **(2 lectures)**

3.4.1: Sternum

3.4.2: Sacrum

3.4.3: Pelvis

Unit 4: Experimental and Chick embryology **(15 lectures)**

Learning objectives:

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

Learning outcome:

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

4.1: Introduction to experimental embryology (5 lectures)

Germplasm theory, Mosaic theory, Regulative theory, Gradient theory, Spemann's theory of organizers Basic concept and principles of experimental embryology - brief idea of morphogenesis and organogenesis , fate maps, cell adhesion, cell affinity and differentiation

4.2: Development of Chick (5 lectures)

Structure of chick embryo - 24 hours, 36 hours, 48 hours, 72 hours

4.3: Signaling pathways and intercellular communication during development (2 lectures)

Induction and competence, epithelial-mesenchymal interaction

4.4: Recent trends in developmental biology (3 lectures)

Methods to determine the role of genes during development (transgenic and chimeric mouse, "knockout" experiments), Genes contributing to developmental defects (oncogenes), multipotent and pluripotent stem cells and their niche (bk gilbert pg 92-95)

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T. Y. B. Sc. Zoology
Semester V (Practical)

Course 11
Course Code: USZO501

1. Levels of organization

a. Symmetry:
- i. Asymmetry, e.g. Sponge
- ii. Radial: Bi-radial, e.g. Comb jelly
  Penta-radial, e.g. Adult Brittle star
- iii. Bi- lateral, e.g. Larva of Brittle star and human

b. Coelom:
- i. Acoelomate, e.g. Tapeworm
- ii. Pseudocoelomate, e.g. Ascaris
- iii. Coelomate, e.g. Frog

c. Segmentation:
- i. Homonymous, e.g. Nereis
- ii. Heteronomous, e.g. Cockroach

d. Cephalization:
- i. Cephalization, e.g. Honey bee
- ii. Cephalothorax, e.g. Crab

2. Taxonomy of Protozoa to Hemichordata

a. Phylum Protozoa:
- i. Class Rhizopoda, e.g. Amoeba - amoeboid locomotion, asexual reproduction – binary fission
- ii. Class Ciliophora, e.g. Vorticella - ciliary locomotion, sexual reproduction - conjugation
- iii. Class Flagellata, e.g. Noctiluca - flagellar locomotion
- iv. Class Sporozoa, e.g. Monocystis - gliding locomotion

b. Phylum Porifera:
- i. Class Calcarea - Canal system, e.g. Scypha - Sycon type
  Leucosolenia - Ascon type
- ii. Class Demospongia - Canal system, e.g. Spongilla larva - Rhagon type
  Adult - Leuconoid type

iii. Class Hexactinellida - Observation of sponge spicules (permanent slide/photograph), e.g. Hyalonemma

c. Phylum Cnidaria:
i. Class Hydrozoa, e.g. Vellela
ii. Class Scyphozoa, e.g. Rhizostoma
iii. Class Anthozoa, e.g. Corallium (Red coral)

d. Phylum Platyhelminthes:
i. Class Turbellaria, e.g. Planaria
ii. Class Trematoda, e.g. Liverfluke
iii. Class Cestoda, e.g. Taenia solium

e. Phylum Nemathelminthes, e.g. Trichinella

f. Phylum Annelida:
i. Class Polychaeta, e.g. Arenicola/ Nereis
ii. Class Oligochaeta, e.g. Tubifex/ Earthworm
iii. Class Hirudinea, e.g. Pontobdella/ Leech

g. Phylum Arthropoda:
i. Class Merostomata, e.g. Limulus (King crab)
ii. Class Arachnida, e.g. Scorpion
iii. Class Crustacea, e.g. Balanus
iv. Class Myriapoda, e.g. Scolopendra (Centipede)
v. Class Insecta, e.g. Coccinella (Ladybird beetle)
vi. Class Onychophora, e.g. Peripatus
vii. Observation and identification of planktonic crustaceans
viii. Types of Metamorphosis in insects

h. Phylum Mollusca:
i. Class Aplacophora, e.g. Chaetoderma
ii. Class Polyplacophora, e.g. Tonicella/ Chiton
iii. Class Monoplacophora, e.g. Neopilina
iv. Class Gastropoda, e.g. Achatina
v. Class Pelycypoda, e.g. Donax/ Unio
vi. Class Scaphopoda, e.g. Dentalium
vii. Class Cephalopoda, e.g. Octopus

i. 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 (Sea cucumber)
v. Class Crinoidea, e.g. Crinoid (Sea lily)

j. Phylum Hemichordata (Acorn worms):

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

Note: Visit to local fish market to study available invertebrates

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 12
Course Code: USZO502

1. Enumeration of erythrocytes - Total count
2. Erythrocyte Sedimentation Rate by suitable method – Westergren or Wintrobe method
3. Estimation of haemoglobin by Sahli's acid haematin method
4. Enumeration of leucocytes –Total Count
5. Differential count of WBC
6. Determination of Serum LDH
7. Estimation of total 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. Zoology
Semester V (Practical)

Course 13
Course Code: USZO503

1. Isolation & Estimation of RNA by Orcinol method (formula method and standard graph)
2. Isolation & Estimation of DNA by Diphenylamine method (formula method and standard graph)
3. Separation of proteins by SDS-PAGE from the given sample (plasma proteins)
4. Colorimetric estimation of proteins from given sample by Bradford's method
5. 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
6. Problems in genetics based on abnormalities in chromosomes:
   a. Interpret the following formula:
      46, XY, t (2;5) (q21; q31)
      Answer:
      Total number of chromosomes present = 46, male.
      Reciprocal translocation between chromosomes 2 and 5. Breakage and reunion has occurred between long arm of 2^{nd} chromosome, band 21 and long arm of 5^{th} chromosome, band 31
   b. Duplication:
      46, XX, dup (1) (q22qq25)
      Total number of chromosomes = 46, female. Duplication on chromosome number 1, long arm between band 1q22 and 1q25
   c. Turner's Syndrome:
      45, X
   d. Klinefelter's Syndrome:
      47, XXY
7. Stained preparation of Onion root tip and calculation of Mitotic index (permanent slide to be provided)
8. Survey of human traits following Mendelian inheritance:
   (Hair on back of hand, Bent little finger, widows peak, tongue rolling, ear lobe, Cephalic index)
   Preparation of report
9. Identification of contrasting traits in drosophila using photographs
10. Culture of drosophila, crossing based on traits, study of inheritance pattern (demonstration only)
11. Sterilization technique (Workplace, Glassware, Chemicals, Biological fluids or samples)
12. Use of autoclave for sterilization of equipments for tissue culture
13. Packaging of glassware
14. Trypsinization and vital staining using Trypan blue stain

15. Tissue culture media preparation, aseptic transfer & inoculation of culture
16. Streaking of butt, slant and plate (continuous and discontinuous methods) with E.coli (Demonstration only)

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 14
Course Code: USZO504

1. To study T.S. of integument: amphibian, reptilian, avian, mammalian
2. To study horns, antlers
3. To study different types of scales: dermal, epidermal
4. To study epidermal glands: mucous, sebaceous, sweat, poison, uropygial
5. To study special integumentary derivatives
6. To study the histology of glands: T.S. of pituitary, thyroid, pancreas, adrenal, ovary, testis
7. To study human skeleton: study of axial skeleton
   1. Skull bone
   2. Ossicles of middle ear
   3. Hyoid bone
   4. Rib cage
   5. Sternum
   6. Vertebral column -
      I. Cervical vertebrae
         a. Typical cervical vertebrae (3-6)
         b. Atlas or 1^{st} cervical vertebra
         c. Axis or 2^{nd} cervical vertebra
         d. 7^{th} cervical vertebra
      II. Thoracic vertebrae (8-19)
      III. Typical lumbar vertebra (20-24)
      IV. Sacral vertebrae and coccyx (synsacrum)
         Sacrum (25-29)
         Coccyx (30-33)
8. Observation of developing chick embryo -18 hours, 24 hours, 36 hours, 48 hours, 72 hours
9. To prepare temporary mounting of chick embryo up to 72 hours
10. To study the effect of temperature in the development of chick embryo upto 48 hours/ 72 hours

Note : short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations

T. Y. B.Sc. Zoology
Semester based Credit and Grading System
(To be implemented from Academic Year 2017-18)

Semester VI

T. Y. B. Sc. Zoology

Theory				
Course	**Unit**	**Topic**	**Credits**	**Lectures/week**
USZO601	I	Minor Phyla and Protochordata	2.5	1
	II	Taxonomy – Pisces and Amphibia		1
	III	Taxonomy – Reptilia, Aves and Mammals		1
	IV	Type study : Shark		1
USZO602	I	Enzymology	2.5	1
	II	Homeostasis (Temperature and Ionic regulation)		1
	III	Histology		1
	IV	General Pathology		1
USZO603	I	Zoogeography	2.5	1
	II	Toxicology		1
	III	Biostatistics		1
	IV	Bioinformatics		1
USZO604	I	Environment management	2.5	1
	II	Wildlife management		1
	III	Bioethics, Bioprospecting and Zoopharmacognosy		1
	IV	General Entomology		1
			10	**16**
Practical				
USZOP07		Practicals of Course USZO601 and Practicals of Course USZO602	3	8
USZOP08		Practicals of Course USZO603, USZO604 and Project Component	3	8
			6	**16**
Total			**16**	**32**

Semester VI (Theory)

Course 15
Course Code: USZO601

Unit 1: Minor Phyla and Protochordata (15 lectures)

Learning objectives:
To introduce classification, general characters and phylogeny of minor phyla and protochordates.
Learning outcome:
Learners will get an idea of basic morphological and physiological details of minor phyla and protochordates. Study of phylogeny will help learners to understand the evolutionary relationships between organisms.

1.1: Minor phyla (6 lectures)
- 1.1.1: General features
  - a. Acoelomate – Phylum Acanthocephala, e.gs. *Macracanthorynchus, Moniloformis* (3 lectures)
  - b. Coelomate – Phylum Chaetognatha, e.g. *Sagitta* (3 lectures)

1.2: The Protochordates (9 lectures)
- 1.2.1: General overview, characteristics and salient features of Urochordates and Cephalochordates (2 lectures)
  - a. Urochordata, e.g. *Ascidia* (2 lectures)
  - b. Cephalochordata, e.g. *Branchiostoma* (2 lectures)
- 1.2.2: Retrogressive metamorphosis in Ascidian (1 lecture)
- 1.2.3: Phylogeny of Urochordates and Cephalochordates (2 lectures)

Unit 2: Taxonomy - Pisces and Amphibia (15 lectures)

Learning objectives:
To describe general features and classify fish and amphibians.
Learning outcome:
Learners will be able to identify classes of fish and amphibians by their anatomical features. Learners will be able to compare and contrast characters of fishes and amphibians. Learners will be able to describe evolutionary trends implied by their classification.

2.1: Division - Agnatha (3 lectures)
- 2.1.1: Classification of living Agnatha up to classes
- 2.1.2: General characters of the jawless fishes, e.gs.*Petromyzon* (lamprey) and *Myxine* (hagfish)

2.2: Division - Gnathostomata – Superclass - Pisces (6 lectures)

2.2.1: General characters and classification up to order Placoderms, Chondrichthyes and Osteichthyes

Examples: a. Sharks, e.g. *Sphyrna* (Hammer headed shark)
b. Skates and rays, e.gs. *Pristis* (Saw fish), *Dasyatis* (Sting ray)
c. Chimeras, e.g. *Hydrolagus* (Spotted rat fish)
d. Lung fish, e.g. *Lepidosiren* (Australian lungfish)
e. Flying fish, e.g. *Exocoetus*

2.3: Superclass Tetrapoda; Class Amphibia (6 lectures)

2.3.1: General overview, classification, characteristics and salient features up to orders

Examples of each order namely -
a. Limb-less amphibian, e.g. *Ichthyophis*
b. Tailed amphibian, e.g. *Amphiuma*
c. Tail-less amphibian, e.g. *Hyla*

2.3.2: Neoteny in Amphibia, e.g. Axolotl larva

Unit 3: Taxonomy - Reptilia, Aves and Mammals (15 lectures)

Learning objectives:
To introduce the learners to the modern system of animal classification. To describe the distinguishing characters of classes Reptilia, Aves and Mammalia and their adaptive features with reference to their habitat.

Learning outcome:
Learners will understand that scientific classification of animals is based on certain characteristics they have in common. Learners will be able to recall characteristic features and examples of each class of Reptilia, Aves and Mammalia.

3.1: Class Reptilia (3 lectures)

3.1.1: General overview, classification, characteristics and salient features of subclasses and orders

Examples of each order namely -
a. Aquatic reptile, e.g. *Chelone*
b. Extinct reptile, e.g. *Ichthyosaurus*
c. Living fossil, e.g. *Sphenodon*
d. Arboreal reptile, e.g. *Chamaeleon*

3.2: Class Aves (6 lectures)

3.2.1: General overview, classification, characteristics and salient features of orders

Examples of each order in accordance to groups -
a. Arboreal birds, e.g. *Treron* (Green pigeon)
b. Terrestrial birds, e.g. *Gallus* (Jungle fowl)
c. Swimming / diving birds, e.gs. *Pelicanus/ Phalacrocoracidae* (Pelican/Cormorant)

d. Shore birds and wading birds, e.gs. *Scolopacidae* (Sandpiper), *Ardeola grayii* (Pond heron)
e. Birds of prey, e.gs. *Strigiformes* (Owl), *Accipitriformes* (Eagle)

3.3: Class Mammalia (6 lectures)

3.3.1: General overview, classification, characteristics and salient features of orders
Examples of each order in accordance to groups -
a. Egg-laying mammals, e.g. *Ornithorhynchus anatinus* (Duck-billed platypus)
b. Pouched mammals, e.g. *Macropus* (Kangaroo)
c. Insect eating mammals, e.g. *Sorex araneus* (Common shrew)
d. Toothless mammals, e.g. *Folivora* (Sloth)
e. Gnawing mammals, e.g. *Sciuridae* (Squirrel)
f. Aquatic mammals, e.g. *Delphinus* (Dolphin)
g. Primates, e.g. *Lemuroidea* (Lemur)

Unit 4: Type study - Shark (15 lectures)

Learning objectives:
To study general characteristics and salient features of animal type - shark. To study in depth one vertebrate animal type.
Learning outcome:
Learners will get an idea of vertebrate animal life and its classification.

4.1: (3 lectures)

Habit & habitat, distribution, external characters and classification, and economic importance

4.2: (12 lectures)

Skin, exoskeleton, endoskeleton, digestive system, respiratory system, blood vascular system, nervous system, receptor organs, urinogenital system, copulation, fertilization and development

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T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 16
Course Code: USZO602

Unit 1: Enzymology **(15 lectures)**

Learning objectives:
To introduce the learners to the basic concepts of enzyme biochemistry. To make the learners realize the power and application of enzymes in basic and applied science.
Learning outcome:
Learners must be able to understand basics of enzyme structure and function. Learners must comprehend variations in enzyme activity and kinetics. Learners must appreciate the enzyme assay procedures and the therapeutic application of enzymes.

1.1: **(3 lectures)**
Definition, nomenclature and classification (based on Enzyme Commission) of enzymes, cofactors and coenzymes, the concept and properties of active site

1.2: **(3 lectures)**
Factors affecting enzyme activity - pH and temperature; concept of activation energy; Enzyme structure (lysozyme and serine protease)

1.3: **(3 lectures)**
Enzyme kinetics, Concept of steady state, Derivation of Michaelis-Menton equation and Lineweaver-Burk plot, Enzyme assay, concept and significance of k_m, V_{max} and k_{cat}, modulation of enzyme activity with reference to GDH

1.4: **(2 lectures)**
Enzyme inhibitors, competitive and non-competitive inhibitors and their kinetics; therapeutic applications of enzyme inhibitors

1.5: **(2 lectures)**
Regulation of enzyme activity; Hill equation; allosteric regulation and regulation by covalent modification of enzymes; Zymogen (pepsinogen and proelastase); Isozymes (LDH)

1.6: **(2 lectures)**
Clinical significance and industrial applications of enzymes

Unit 2: Homeostasis (Temperature and Ionic regulation) **(15 lectures)**

Learning objectives:
To introduce the learners to the concept of homeostasis. To familiarize the learners with thermoregulation, osmoregulation and feedback mechanism.

Learning outcome:
Learners would be able to understand the concept of positive and negative feedback mechanisms. Learners would comprehend the adaptive responses of animals to environmental changes.

2.1: Homeostasis (5 lectures)

External and internal environment; Acclimation and acclimatization; Control systems in biology: Feedback mechanism - negative feedback and positive feedback with suitable examples

2.2: Thermoregulation (5 lectures)

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 (5 lectures)

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 3: Histology (15 lectures)

Learning objectives:
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.
Learning outcome:
Learners would appreciate the well planned organization of tissues and cells in the organ systems.

3.1: Vertical section (V.S.) of skin (3 lectures)

Layers and cells of epidermis; papillary and reticular layers of dermis; sweat glands, sebaceous glands and skin receptors

3.2: Digestive System

3.2.1: Vertical Section (V.S.) of tooth – hard tissue – dentine and enamel; soft tissue – dentinal pulp and periodontal ligaments **(2 lectures)**
3.2.2: Transverse section (T.S.) of tongue – mucosal papillae and taste buds **(2 lectures)**
3.2.3: Alimentary Canal – basic histological organization with reference to transverse section (T.S.) of oesophagus, stomach, duodenum, ileum and rectum of mammal **(3 lectures)**
3.2.4: Glands associated with digestive system - histology with reference to transverse section (T.S.) of salivary glands, liver, pancreas **(3 lectures)**

3.3:

Respiratory organs – transverse section (T.S.) of trachea and lung **(2 lectures)**

Unit 4: General pathology

Learning objectives:

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

Learning outcome:

Learners will gain knowledge of various infective agents and diseases caused by them. Learners will be familiar with various medical terminology pertaining to pathological condition of the body caused due to disease.

4.1: **(2 lectures)**

Infectious diseases: aetiology, infectious agents, viruses - hepatitis, bacteria - tuberculosis, fungi - skin diseases

4.2: Retrogressive changes **(2 lectures)**

Definition, cloudy swelling, degeneration: fatty, mucoid and amyloid (causes and effects)

4.3: Disorders of pigmentation **(1 lecture)**

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

4.4: Necrosis **(1 lecture)**

Definition and causes; nuclear and cytoplasmic changes; Types: Coagulative, Liquefactive, Caseous, Fat and Fibroid

4.5: Gangrene

Definition and types (dry, moist and gas gangrene) **(1 lecture)**

4.6: Circulatory disturbances **(2 lectures)**

Causes and effects of Hyperaemia, Ischaemia, Thrombosis, Embolism, Oedema and Infarction

4.7: Inflammation **(2 lectures)**

Definition and causes (pathogenic and immune), cardinals of inflammation; acute and chronic inflammation

4.8: Applied pathology **(2 lectures)**

Anatomical, clinical and molecular; investigating methods: biopsy and surgery (for pathological examination of tissue)

4.9: Forensic pathology (2 lectures)

Autopsy, post mortem changes - Algor mortis - body cooling, Rigor mortis - stiffening of limbs, state of decomposition - autolysis (process of self-digestion) and putrefaction

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T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 17
Course Code: USZO603

Unit 1: Zoogeography **(15 lectures)**

Learning objectives:
To introduce learners to a branch of science dealing with the geographic distribution of animals.
Learning outcome:
The learners will become acquainted with how and why different animal species are distributed around the globe.

1.1: Introduction **(2 lectures)**
1.1.1: Origin of oceans and continents
1.1.2: Plate tectonics and continental drift

1.2: Distribution of animals in space and time **(5 lectures)**
1.2.1: In space – horizontal or superficial
1.2.2: In time – geological or durational
1.2.3: Patterns of animal distribution – continuous, discontinuous, isolation and bipolarity
1.2.4: Theories of animal distribution

1.3: Barriers of distribution of animals **(3 lectures)**
1.3.1: Topographic, climatic, vegetative, large water masses, land mass, lack of salinity and special characteristic habits like homing instinct, etc.
1.3.2: Means of dispersal – land bridges, natural rafts and drift wood, favouring gales, migration by host, accidental transportation and by human agencies

1.4: Zoogeographical realms **(5 lectures)**
1.4.1: Palearctic, Ethiopian, Oriental, Australian, Neotropical, Nearctic and Antarctic

Unit 2: Toxicology **(15 lectures)**

Learning objectives:
Introduce the learners to 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.
Learning outcome:
The course will prepare learners to develop broad understanding of the different areas and significance of toxicology. Moreover, it will also develop critical thinking and assist students in preparation for employment in pharmaceutical industry and related areas.

2.1: Basic toxicology **(10 lectures)**

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, chronic toxicity, immediate toxicity, delayed toxicity, reversible toxicity, irreversible toxicity, local toxicity, systemic 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 **(5 lectures)**

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 3: Biostatistics **(15 lectures)**

Learning Objectives:

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

Learning 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.

3.1: Probability Distributions **(3 lectures)**

Normal, Binomial, Poisson distribution, Z-transformation, p-value

Probability - Addition and multiplication rules and their applications

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3.2: Measures of Central Tendency and Dispersion **(2 lectures)**

Variance, standard deviation, standard error

3.3: Parametric and non-parametric tests **(4 lectures)**

Parametric tests: two-tailed Z-test and t-test

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

3.4: Regression and Correlation **(3 lectures)**

Simple linear regression: main features, applications
Correlation coefficient and its significance

3.5: Testing of Hypothesis **(3 lectures)**

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

Unit 4: Bioinformatics **(15 lectures)**

Learning objectives:
To introduce learners to bioinformatics – a computational approach to learning the structure and organization of genomes, phylogeny, metabolism and immunology.
Learning outcome:
The learners will become aware of the computational point of view of studying the genomes.

4.1: Introduction **(2 lectures)**

4.1.1: Introduction to Bioinformatics and Bioinformatics web resource (NCBI, EBI, ExPASy, OMIM, PubMed, OMIA)
4.1.2: Applications of Bioinformatics

4.2: Databases – Tools and their uses **(4 lectures)**

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, Pfam/ Prodom, Structure databases and bibliographic databases

4.3: Sequence alignment methods **(4 lectures)**

4.3.1: BLAST, FASTA
4.3.2: Significance of sequence alignment
4.3.3: Pairwise sequence alignment (Needleman & Wunsch, Smith & Waterman methods)
4.3.4: Multiple sequence alignment (PRAS, CLUSTALW)

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

4.4.1: Evolutionary studies: Concept of phylogenetic trees, Parsimony and Bayesian approaches, synonymous and non-synonymous substitutions, 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

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T. Y. B. Sc. Zoology
Semester VI (Theory)

Course 18
Course Code: USZO604

Unit 1: Environment management (15 lectures)

Learning objectives:
To introduce the learners to understand the importance of factors governing environment and its management.
Learning outcome:
Learners will be able to understand the different factors affecting environment, its impact and laws governing environmental management.

1.1: Natural resources and their classification (2 lectures)
Forest resources, water resources (surface and ground), mineral resources, food resources, energy resources: Renewable and non-renewable resources

1.2: Exploitation and modification of natural resources (2 lectures)
Impact on climate, flora, fauna & mineral resources

1.3: Sustainable development (3 lectures)
Ex-situ conservation (zoos, botanical gardens, cryogenics, seedbank, germplasm, gene bank), in-situ conservation (Bio-reserves, Sanctuaries & National parks)

1.4: Waste Management (2 lectures)
3 Rs (Reduce, Reuse & Recycle) of solid waste, e-waste, hazardous waste

1.5: Water management (2 lectures)
Rain water harvesting, watershed management, effluent treatment, recycling plants, control and treatment of water

1.6: Laws governing environment (4 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), ISO18001
Role of government, NGOs, International treaties and conventions in environmental protection & conservation

Unit 2: Wildlife Management **(15 lectures)**

Learning objectives:
To introduce the learners to the importance of wildlife conservation.

Learning outcome:
Learners will be able to understand the wildlife habitat projects for animal protection.

2.1: Habit, habitat, territory & niche of animals **(3 lectures)**
Herbivores, carnivores; solitary, pack and herd

2.2: Threats to wildlife **(6 lectures)**
Diseases (zoonosis and reverse zoonosis), competition, hunting, poaching, encroachment, deforestation, tourism, overgrazing, human animal conflict and climate change

2.3: Techniques and methods of wildlife conservation **(6 lectures)**
Wildlife Census, conservation of wildlife - frozen zoo, schedules, rules, national and international conservation bodies; IUCN UNDP, FAO, ESA, INCPEN, CITES, CEEDS,WWF

Unit 3: Bioethics, Bioprospecting and Zoopharmacognosy **(15 lectures)**

Learning objectives:
To introduce the learners to understand the concept of ethics and prospecting in biology and importance of pharmacognosy.
Learning outcome:
Learners will be able to understand paradigms of discovery and commercialization of biological resources and knowledge gained by self medication by animals.

3.1: Bioethics **(4 lectures)**
Intellectual property rights and patenting, forms of protection, patents, copyrights, trade secrets, trademarks, patenting biological materials, live forms, genes and DNA sequences

3.2: Bioprospecting **(4 lectures)**
Traditional, modern bioprospecting, Chemical prospecting, Genetic prospecting, Bionic prospecting, Economic value and benefit sharing, Bioprospecting and conservation, pros and cons of bioprospecting

3.3: Zoopharmacognosy **(7 lectures)**
3.3.1: Definition, history and types
3.3.2: Self-medication and its mechanism
3.3.3: Methods of self-medication through - Ingestion – ants and mammals, Geophagy – invertebrates and birds
3.3.4: Absorption and adsorption
3.3.5: Topical application – birds and mammals

3.3.6: Applications of zoopharmacognosy - Social and transgenerational zoopharmacognosy
3.3.7: Value to humans

Unit 4: General Entomology (15 lectures)

Learning objectives:
To introduce the learners about the importance of insects and their application in different fields of human life.
Learning outcome:
Learners will be able to understand the role of useful and harmful insects in human life.

4.1: Introduction (1 lecture)
Definition, distinguishing features of insects, harmful and useful insects

4.2: Importance & Scope of Entomology, Branches of Entomology (1 lecture)
Agricultural, Medical, Forest, Forensic & Industrial

4.3: Metamorphosis in insects (3 lectures)
Definition, types, hormones

4.4: Insect pheromones, bioluminescence, sound production (3 lectures)
Definitions, types, significance

4.5: General body structure of insects (3 lectures)
a) Mouth parts - cutting, chewing, lapping, sucking, sponging
b) Modification of legs in insects - e.g. honey bee, cockroach, beetle

4.6: Significance of insects as biological tool (4 lectures)
Biological weapon; tissue culture; gene study; Productive insects - honey bee, silk worm, lac insect; insect products; insects pests (general): bollworm, rice weevil, tribolium, flour moth, locust

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T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 15
Course Code: USZO601

1. Levels of organization
Minor Phyla

a. Acoelomate:
Phylum Acanthocephala (Spiny headed worms), e.g. Echinorhyncus

b. Coelomate:
Phylum Chaetognatha (Arrow worms), e.g. Sagitta

2. Taxonomy of phylum Chordata

a. Subphylum Urochordata (Sea squirts)
1. Class Larvaceae, e.g. Oikopleura
2. Class Ascidiacea, e.g. Ciona/ Herdmania
3. Class Thaliacea, e.g. Salpa/ Doliolum

b. Subphylum Cephalochordata:
Class Leptocardii, e.g. Branchiostoma (Amphioxus)

c. Subphylum Vertebrata:
I. Group Agnatha
1. Class Ostracodermi, e.g. Pharyngolepis
2. Class Cyclostomata, e.g. Petromyzon

II. Group Gnathostomata
i. Superclass - Pisces:
1. Class Placodermi (Armoured fishes), e.g. Bothriolepis
2. Class Elasmobranchi (Chondrichthyes), e.g. Rhinobatos
3. Class Holocephali (Chimaera), e.g. Rabbit fish / Rat fish
4. Class Dipnoi (Lung fishes), e.g. Protopterus (African lungfish)
5. Class Teleostomi, e.g. Latimera (Coelacanth), Catfish

ii. Superclass - Tetrapoda :
1. Class Amphibia
a. Order Apoda, e.g. Siphonops/ Ichthyophis
b. Order Anura, e.g. Alytes (Midwife toad)
c. Order Urodela, e.g. Triton (Semi-aquatic salamander)
2. Class Reptilia:
a. Order Synapsida, e.g. Dimetrodon
b. Order Parapsida, e.g. Chasmosaurus (Dinosaur)
c. Order Anapsida, e.g. Geochelone (Indian star tortoise)
d. Order Diapsida, e.g. Mabuya (Skink)

3. Class Aves:
    a. Subclass Archaeornithes, e.g. Archaeopteryx
    b. Subclass Neornithes
        - Superorder Paleognathae (Flightless birds), e.g. Emu, Penguin
        - Superorder Neognathae (Flying birds), e.g. Flamingo, Vulture
4. Class Mammalia:
    a. Subclass Prototheria (Egg laying mammals), e.g. Duck-billed platypus
    b. Subclass Theria
        - Infraclass- Metatheria (Marsupials/ Pouched mammals), e.g. Dasyurus (Tiger cat)
        - Infraclass – Eutheria (Placental mammals), e.g. Gangetic Dolphin, Gorilla

3. Study of endoskeleton of shark:

a. Axial (skull and vertebral column)
b. Appendicular (pelvic and pectoral fins, pelvic and pectoral girdle)

Note: Visit to local fish market to study available vertebrates

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T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 16
Course Code: USZO602

1. Effect of 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. Study of separation of LDH isozymes by agarose gel electrophoresis
6. To study the effect of enzymes in detergents
7. Study of mammalian tissues:
   i. V. S. of Skin
   ii. V.S. of Tooth
   iii. T.S. of Stomach
   iv. T.S. of Ileum
   v. T.S. of Liver
   vi. T.S. of Pancreas
   vii. T.S. of Lung
8. i. Identification of following diseases or conditions (from slides or pictures) – Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis
   ii. Vidal's Test
   iii. Study and interpretation of pathological reports: Blood, Urine and Stool (feces)

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 17
Course Code: USZO603

1. To estimate phosphate phosphorus from sample water
2. To estimate BOD from sample water
3. To estimate COD from sample water
4. To estimate Nitrite Nitrogen and Nitrate Nitrogen from sample water
5. To study the intensity of sound by Decibel meter & prepare a survey report
6. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
7. To study the effect of CCl_4 on the level of enzyme activity in liver on aspartate and alanine amino transferase (*in vitro* approach)
8. To study the effect of paracetamol on the level of enzyme activity in liver on aspartate and alanine amino transferase (*in vitro* approach)

9. Following biostatistics practicals will be done using data analysis tool of Microsoft Excel (DEMONSTRATION in regular practicals) & manually:
    1. From the given data derive mean, standard deviation
    2. Correlation, regression analysis using given data
    3. Problems based on Z test
    4. Problems based on t test
    5. Problems based on Chi square test
    6. Problems based on ANOVA
10. Exploring the integrated database system at NCBI server and querying (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT)
11. Exploring tools on ExPASy (Querying a nucleotide sequence, querying a protein sequence, use of operators (AND, OR & NOT)
12. Exploring BLAST tool (nucleotide sequence comparison)
13. Exploring Uniprot tool (protein sequence comparison)
14. Exploring bibliographic database PubMed (Data mining - Downloading a research paper on subject of interest, use of operators (AND, OR & NOT)
15. Indicate the distribution of genus/species/subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution
16. Indicate the realms and the fauna found in that realm on the given world map, justify

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 18
Course Code: USZO604

1. To estimate phosphate phosphorus from sample water
2. To estimate COD, BOD from sample water
3. To estimate Nitrite Nitrogen and Nitrate Nitrogen from sample water
4. To study the intensity of sound by Decibel meter
5. To study acidity and alkalinity of sample water by methyl orange and phenolphthalein
6. To observe the animals in the chart and place them in endangered, vulnerable category
7. To study different types of mouth parts: cutting, chewing, lapping, sucking, sponging
8. To study metamorphosis in insects: ametabolic - lepisma, hemimetabolic - cicada, holometabolic - butterfly, mosquito
9. To study mechanism of bioluminescence in insects (Need to design practical)
10. Insect pests and control: rice weevil, flour moth, aphids, tribolium

Note : short and long excursions / study tours / field visits / industrial visits in every semester, at least one of which shall be financially affordable to every student in the class; and that assessment and marks of field trips shall be solely based upon such where no student was restrained for financial limitations

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 11
Course Code: USZO501

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Identify and describe- **06**
a. Symmetry / Coelom/ Segmentation / Cephalization (Any two)
b. Observe the animal (photo/existing preserved specimen) and state its phylum giving reasons

Q.2 Identify and classify giving reasons- **12**
a. Protozoa / Porifera / Cnidaria
b. Platyhelminthes / Nemathelminthes
c. Annelida / Arthropoda
d. Mollusca / Echinodermata

Q.3 Identify, classify and describe - **03**
a. Phylum Hemichordata

Q.4 Identify and describe- **09**
a. Locomotion / Reproduction in Protozoa
b. Canal system in Sponges / Metamorphosis in insects
c. Spicules in sponges / Planktonic crustaceans

Q.5 Field Report and Viva based on theory paper **10**

Q.6 Journal **10**

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 12
Course Code: USZO502

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Enumeration of erythrocytes - Total count **15**

OR

Q.1 Enumeration of leucocytes - Total count

OR

Q.1 Differential count of leucocytes

Q.2 Estimation of serum /plasma total proteins by Folin's method **10**

OR

Q.2 Estimation of serum/plasma total triglycerides by Phosphovanillin method

Q.3 Estimation of haemoglobin by Sahli's acid haematin method **10**

OR

Q.3 Estimate Erythrocyte Sedimentation Rate by suitable method

OR

Q.3 Determination of serum LDH

Q.4 Latex agglutination test - Rheumatoid Arthritis **05**

Q.5 Viva voce **05**

Q.6 Journal **05**

T. Y. B. Sc. Zoology
Semester V (Practical)

Course 13 and Course 14
Course Code: USZO503 and USZO504

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Isolation & Estimation of RNA by Orcinol method **15**

OR

Q.1 Isolation & Estimation of DNA by Diphenylamine method

OR

Q.1 Trypsinization and vital staining using Trypan blue stain

Q.2 Separation of proteins by SDS-PAGE from the given sample **10**

OR

Q.2 Demonstrate transfer of liquids between burners aseptically

OR

Q.2 Demonstrate packaging of glassware for sterilization

Q.3 Problems in genetics (Idiogram - 2 marks, Calculations - 3 marks) **05**

Q.4 Identification **15**
Spot a) Based on histology
Spot b) Based on histology
Spot c) Based on osteology - human axial skeleton
Spot d) Based on osteology - human appendicular skeleton
Spot e) Based on chick embryology

Q.5 Submission of report (based on human traits following Mendelian inheritance) **05**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 15
Course Code: USZO601

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 a. Identify, classify and describe **06**
(Any one example from Urochordates/ Cephalochordates / Ostracodermi / Cyclostomata/ Minor Phyla)
b. Observe the animal (photo/existing preserved specimen) and state its class giving reasons
(Any one example from superclass Pisces and Tetrapoda)

Q.2 Identify and classify giving reasons - **15**
a. Pisces
b. Amphibia / Reptilia
c. Aves / Mammalia

Q.3 Identify, sketch and label/ Identify and label marked portion in given diagram - **09**
a. Skull or Vertebra of shark
b. Fin of shark (Pectoral / Pelvic)
c. Girdle of shark (Pectoral / Pelvic)

Q.4 Field Report and Viva based on theory paper **10**

Q.5 Journal **10**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 16
Course Code: USZO602

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Demonstrate the effect of _____ on the activity of acid phosphatase **15**
(Substrate concentration/pH variation/Enzyme concentration/Inhibitor concentration)

Q.2 Study of separation of LDH isozymes by agarose gel electrophoresis **10**

OR

Q.2 To study the effect of enzymes in detergents

OR

Q.2 Perform Vidal's Test and give the clinical significance of the result

Q.3 Identify and describe a, b, c, d, e **15**

a and b - Study of mammalian tissues (V. S. of Skin, V.S. of Tooth, T.S. of Stomach, T.S. of Ileum, T.S. of Liver, T.S. of Pancreas T.S. of Lung)

c and d - Identification of following diseases or conditions (from slides or pictures) – Melesma, Vitiligo, Psoriasis, Bed sores, Necrosis, Oedema, Malaria, Filariasis, Leishmaniasis

e – Interpret the pathological report – blood / urine / stool

Q.4 Viva voce **05**

Q.5 Journal **05**

T. Y. B. Sc. Zoology
Semester VI (Practical)

Course 17 and Course 18
Course Code: USZO603 and USZO604

Skeleton of Practical Examination Question Paper

Time: 9:30 a.m. to 2:30 p.m. **Total Marks: 50**

Q.1 Demonstrate the effect of CCl_4 on the level of enzyme activity of aspartate/alanine amino transferase in liver (*in vitro* approach) **15**

OR

Q.1 Demostrate the effect of paracetamol on the level of enzyme activity of aspartate/ alanine amino transferase in liver (*in vitro* approach)

Q.2 Estimate Phosphate Phosphorus/ Nitrite Nitrogen and Nitrate Nitrogen /acidity /alkalinity /COD /BOD from sample water **10**

OR

Q.2 Demonstrate the use of bioinformatics tools to explore DNA, Protein sequence

Q.3 Indicate the distribution of genus/species/subspecies in the given world map w.r.t. to its realm and comment on the pattern of distribution **05**

OR

Q.3 Indicate the realms and the fauna found in that realm on the given world map, justify

Q.4 Problems in Biostatistics **06**

Q.5 Identification **06**
Spot a) Based on types of mouth parts
Spot b) Based on types of metamorphosis
Spot c) Based on insect pest

Q.6 Submission of report (based on sound/ noise measurements using sound meter) and journal (Report submission – 3 marks; Journal – 5 marks) **08**

TYBSc proposed practical pattern for revised syllabus in the subject of Zoology

For students opting for 6 units of Zoology to be effective from academic year 2017-2018

Practical pattern for Semester V

Course Code	Practicals	Marks
US ZO P05	Practicals based on US ZO 501 (Paper 1)	50
US ZO P05	Practicals based on US ZO 502 (Paper 2)	50
US ZO P06	Practicals based on US ZO 503 and US ZO 504 (Papers 3 and 4)	50
US ZO P06	Project component * (kindly refer to the note below for details)	50
		Total marks = 200

Details of Project component* for Semester V are as follows:

1. In semester V the students will submit an outline / scheme of the project proposal.
2. Actual execution/practical work of this project to be done only in semester VI.
3. The project proposal will be prepared by a group of students (not more than 5 in a group).
4. The project proposal will involve study of topic (covered in the UG syllabi) / interdisciplinary topic.
5. Each group to be mentored by one teacher from the department.
6. The concerned teacher will mentor the group by giving orientation/instructions about writing the project proposal.
7. The outline / scheme of the project proposal will include literature search/survey, introduction, objectives, purpose and rationale, materials and methods, expected outcomes/results, relevance of the project and bibliography.
8. The student will prepare a hard copy of the project proposal which will have titles discussed in point no. 7.

Evaluation of Project Proposal during practical examination for Semester V will be as follows:

1. Although the students would have prepared the project proposal as a group in Semester V, however, they are expected to submit the project proposal individually.
2. Each student will submit a project proposal (hard copy) during practical examination.
3. The soft copy of this project proposal can be kept in the department for documentation and record.
4. The project proposal will be evaluated by **internal examiner** (preferably the mentor) and external examiner as per the evaluation criteria given below:

Title	Marks
Literature search/survey	04 marks
Objectives, Purpose and Rationale	04 marks
Materials and Methods	04 marks
Expected outcome/ hypothesis	03 marks
Work plan with milestones/ Timeline	03 marks
Overall approach and conduct	07 marks
Total	**25 marks**

- The **external examiner** will evaluate the hard copy of the project proposal as per the evaluation criteria given below:

Title	Marks
Literature search/survey	04 marks
Objectives, Purpose and Rationale	04 marks
Materials and Methods	04 marks
Expected outcome/ hypothesis	03 marks
Bibliography	03 marks
Viva voce based on the proposal	07 marks
Total	**25 marks**

Practical pattern for Semester VI

Course Code	Practicals	Marks
US ZO P07	Practicals based on US ZO 601 (Paper 1)	50
US ZO P07	Practicals based on US ZO 602 (Paper 2)	50
US ZO P08	Practicals based on US ZO 603 and US ZO 604 (Papers 3 and 4)	50
US ZO P08	Project component * (refer to the note below for details)	50
		Total marks = 200

Details of Project component* for Semester VI are as follows:

1. In semester VI the students will actually execute their respective project submitted in Semester V.
2. Actual execution may involve laboratory/table work and or field work and or survey as per the specifications mentioned in their project proposal.
3. The mentor for the respective group will keep a track of the actual execution of the project.
4. After completion of the practical work the student will prepare a '**Dissertation**' which will have an abstract/synopsis, brief introduction, materials and methods, observations, interpretation of results, conclusion and discussion, future plans/extension of work.
5. The student will also give a '**Power point presentation**' about the project (not more than 7 slides and not more than 7 minutes per presentation).

Evaluation of Project Proposal during practical examination for Semester VI will be as follows:

1. The external examiner will evaluate the '**Dissertation**' carrying **30** marks as per the evaluation criteria given below:

Title	**Marks**
Abstract/synopsis	05 marks
Materials and Methods	05 marks
Observations	05 marks
Interpretation of results	05 marks
Conclusion and Discussion	05 marks
Relevance of work	05 marks
Total	**30 marks**

2. The external examiner will evaluate the '**Power point presentation**' carrying **20** marks as per the evaluation criteria given below:

Title	**Marks**
Content of the presentation	05 marks
Quality of the presentation	05 marks
Presentation skills	05 marks
Viva /Question- Answer session	05 marks
Total	**20 marks**

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