SEMESTER: III

PAPER NUMBER: III A

NAME OF PAPER: Animal Physiology, Endocrinology and Biochemistry (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald K L Tron	1 4	Physiology of digestion and absorption of carbohydrates, proteins and lipids. Vitamins: Types, sources and their significance. Types of heart in vertebrates; Structure of mammalian heart Classification and significance of carbohydrates, proteins and lipids. Amino acids: Essential and non-essential.
Dr. Duwaki Rangad	3	Structure and functions of major endocrine glands: Hypothalamus, pituitary, thyroid, parathyroid, pancreas, adrenals, testis and ovary. Introduction to neuroendocrine system in insects.
Dr. P Wankitlang Shangpliang	2	Structure of mammalian kidney and nephron, Physiology of urine formation. Ultrastructure of skeletal muscle, Mechanism of skeletal muscle contraction. Ultrastructure of neuron, Nerve Impulse Conduction and synaptic transmission; Reflex action.
Mr. Graham B Ranee	5	Enzymes: Properties, classification and nomenclature; Active site and mechanism of enzyme action; Factors affecting enzyme activity; Co-factors and co-enzymes.
Ms. Mebari Vanessa R Dorphang	1 4 5	Respiration: Breathing and gaseous exchange in vertebrate lung. Composition and functions of blood Glycolysis and TCA cycle; Beta-Oxidation of fatty acids. Nucleic acids: Nucleosides, nucleotides and polynucleotide; Double helical structure of DNA and structure of RNA

PAPER NUMBER: III B

NAME OF PAPER: Animal Physiology, Endocrinology and Biochemistry (PRACTICAL)

PRACTICAL

Name of the Teacher	EXPERIMENT NUMBER	Topics
Dr. Ronald K L Tron	1.	Preparation of haemin crystals-from-human blood.
Dr. Ronald K L Tron	2.	Determination of clotting time of human blood.
Ms. Mebari Vanessa R Dorphang	3.	Oxygen consumption in fish with reference to body weight.
Dr. Duwaki Rangad	4.	Study of histology of endocrine glands from permanent slides (pituitary, thyroid, thymus, pancreas, adrenal, testis and ovary).
Dr. Duwaki Rangad	5.	Detection of carbohydrates, lipids and proteins (at least 3 tests each).
Dr. Duwaki Rangad	6.	Estimation of ascorbic acid by titration method.

SEMESTER: IV

PAPER NUMBER: IV A

NAME OF PAPER: Developmental Biology, Ecology, and Economic Zoology (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald K L Tron	1	Gametogenesis: Spermatogenesis and Oogenesis fertilization Parthenogenesis Types of eggs Cleavage and types of cleavage Process of blastulation, fate map, and gastrulation in frogs up to the formation of three germinal layers Metamorphosis in insects and frogs
Mr. Graham B Ranee	2	Ecology: Concepts, subdivisions, scope and importance Levels of organisation in the biosphere Structure of ecosystem - ecological factors (biotic and abiotic) Trophic structure: food chains, food webs, and energy flow trophic relationship - Ecological pyramids Productivity
Dr. P Wankitlang Shangpliang	3	Ecological niche Population: Growth and Regulation Concept of biotic community Species interactions: intra- and inter-specific Resources (renewable and non-renewable) and their management Environmental pollution: Air, Water, and Soil
Ms. Mebari Vanessa R Dorphang	4	Pisciculture: Culturable fish species of India Culture and management of Fish with reference to composite fish culture, Induced breeding Sericulture: Different species of silk moths Life history of Bombyx mori and methods of culture Products of sericulture and economic importance
Dr. Duwaki Rangad	5	Apiculture: Species of honey bees Life history and social organisation Methods of bee-keeping, economic importance Integrated Pest management (Physical, Chemical, Hormonal, Biological)

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PAPER NUMBER: IV B

NAME OF PAPER: Developmental Biology, Ecology, and Economic Zoology (PRACTICAL)

PRACTICAL

Name of the Teacher	EXPERIMENT NUMBER	Topics
Dr. Ronald K L Tron	1.	Study of the types of eggs in vertebrates
Dr. Duwaki Rangad	2.	Study of larval forms (crustacean, molluscan, and echinoderm) from permanent slides
Dr. Duwaki Rangad	3.	Study of the stages of development of frog from permanent slides in whole mount/sections (cleavage, blastula and gastrula).
Dr. P Wankitlang Shangpliang	4.	Preparation of permanent slides of non-chordate larval forms (Mysis, Nauplius, Mosquito larva).
Dr. Ronald K L Tron	5.	Study of metamorphosis in amphibia (using charts/models).
Dr. P Wankitlang Shangpliang & Dr. Duwaki Rangad	6.	Estimation of dissolved oxygen in water samples.
Dr. P Wankitlang Shangpliang & Dr. Duwaki Rangad	7.	Estimation of Carbon dioxide in water samples
Dr. P Wankitlang Shangpliang & Dr. Duwaki Rangad	8.	Estimation of total alkalinity in water samples.
Ms. Mebari Vanessa R Dorphang & Mr. Graham B Ranee	9.	Qualitative study of plankton from freshwater samples.
Ms. Mebari Vanessa R Dorphang	10.	Study of life cycle of silk moth.
Dr. Duwaki Rangad	11.	Study of different castes of honey bee.
Dr. Duwaki Rangad & Ms. Mebari Vanessa R Dorphang	12.	Identification of Indian Major Carps and Common Exotic Carps.

SEMESTER: V

PAPER NUMBER: V A

NAME OF PAPER: Functional Anatomy, Zoogeography, and Adaptations (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald K L Tron	4	Amphibia: Parental care. Reptilia: Poisonous and non-poisonous snakes, poison apparatus and mechanism of biting. Aves: Flight adaptations and migration in birds. Mammalia: Affinities of Monotremata and Marsupialia; Dentition in mammals. Comparative anatomy of kidney in vertebrates.
	5	Adaptations in vertebrates: Aquatic adaptations
Dr. Duwaki Rangad	1	Porifera: Canal and skeletal systems.
	2	Onychophora: General organization and affinities.
	3	Hemichordata: Affinities of *Balanoglossus*. Protochordata: Affinities of *Amphioxus* Retrogressive metamorphosis in *Ascidia*.
	5	Adaptations in vertebrates: Desert adaptations
Dr. P Wankitlang Shangpliang	1	Cnidaria: Polymorphism in *Siphonophora*, Corals and coral reefs.
	2	Arthropoda: Types of mouthparts and feeding in insects; Vision in insects. Mollusca: Torsion and detorsion in Gastropoda. Echinodermata: Comparative study of water vascular systems.
	5	Adaptations in vertebrates: Arboreal adaptations
Mr. Graham B Ranee	1	Annelida: Excretory system
	5	Zoogeography: Concepts and zoogeographic realms. Patterns and regulation of behaviour: genetic and hormonal; Colouration and mimicry. Adaptations in vertebrates: Arboreal adaptations
Ms. Mebari Vanessa R Dorphang	1	Protozoa: Locomotion and nutrition. Morphological and physiological adaptations of parasitic helminthes.
	3	Agnatha: Comparative study of *Petromyzon* and *Myxine*. Pisces: Scales and fins in fishes; Accessory respiratory organs; Migration in fishes. Dipnoi: General characters and affinities.
	5	Adaptations in vertebrates: Deep-sea adaptations

PAPER NUMBER: V B

NAME OF PAPER: Functional Anatomy, Zoogeography, and Adaptations (Practical)

PRACTICAL

Name of the Teacher	Unit	Topics
Mr. Graham B Ranee & Dr. P Wankitlang Shangpliang	1.	Dissection: Nervous system in prawn/earthworm.
Ms. Mebari Vanessa R Dorphang	2.	Dissection: Accessory respiratory organs in teleost.
Dr. Ronald K L Tron	3.	Dissection: Digestive system in albino rat/albino mouse/chicken.
Dr. Ronald K L Tron	4.	Dissection: Reproductive system in albino rat/albino mouse/chicken.
Dr. P Wankitlang Shangpliang	5.	Mounting (Permanent): Cyclops
Dr. P Wankitlang Shangpliang	6.	Mounting (Permanent): Setae of earthworm
Dr. P Wankitlang Shangpliang	7.	Mounting (Permanent): Spicules of sponge
Dr. P Wankitlang Shangpliang	8.	Mounting (Permanent): Scales (cycloid, ctenoid, and placoid) of fishes
Dr. P Wankitlang Shangpliang	9.	Mounting (Permanent): Feathers of birds (filoplumes, down feathers, barbs, and barbules)
Dr. Duwaki Rangad	10.	Study of Permanent Slides and Specimens: Histology: T/S of stomach, intestine, liver, kidney, spleen, and gonads of fish/Aves/mammals
Dr. Duwaki Rangad	11.	Study of Permanent Slides and Specimens: Permanent slides of representatives from Protozoa to Echinodermata (sections and whole mounts)
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang	12.	Study of Permanent Slides and Specimens: Adaptative modifications of beak and feet in birds using charts and models

PAPER NUMBER: VI A

NAME OF PAPER: Cell and Molecular Biology, and Genetics (Theory)

THEORY

Name of the Teacher	Unit	Topics
Mr. Graham B Ranee	1	Genome organization in virus, bacteria, and eukaryotes. Central dogma of molecular biology; DNA replication in prokaryotes; transcription and translation in prokaryotes; Genetic code. Regulation of gene expression in prokaryotes: *lac* operon
Ms. Mebari Vanessa R Dorphang	2	Fine structure of gene: Cistron, recon and muton. Split genes and overlapping genes; Transposons. Gene mutation: Types and mutagenic agents; DNA damage and repair. Detection of mutation in *Drosophila* (Muller's *ClB* method).
Dr. Ronald K L Tron	3	Extra-nuclear inheritance: kappa particles in *paramecium*. Sex-linked inheritance in *Drosophila* (eye colour) and man (colour blindness); Dosage compensation and Lyon's hypothesis. Non-disjunction of sex chromosomes in *Drosophila*; Human karyotype; Sex determination in man; Genetic disorders in man – Down's, Turner's and Klinefelter's syndromes; Phenylketonuria, Haemophilia.
Dr. P Wankitlang Shangpliang	4	Humoral and cell-mediated immunity; Characteristics of antigens; Antibodies: Structure, classes and functions; Antigen-antibody interaction; Major histocompatibility Complex, Introduction to Cytokines.
Dr. Duwaki Rangad	5	Principles and applications of biological techniques: Light and electron microscopy; Centrifugation; Chromatography (paper, gel filtration and ion-exchange).

PAPER NUMBER: VI A

NAME OF PAPER: Cell and Molecular Biology, and Genetics (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald K L Tron	1.	Separation and identification of amino acids by paper chromatography.
Dr. P Wankitlang Shangpliang	2.	Demonstration of antigen-antibody interaction *in vitro*: Single radial immune-diffusion in agarose gel.
Ms. Mebari Vanessa R Dorphang	3.	Study of nucleic acids from models/charts.
Mr. Graham B Ranee	4.	Colorimetric estimation of DNA and RNA.
Dr. Duwaki Rangad	5.	Preparation and identification of meiotic stages from grasshopper testis.
Dr. Ronald K L Tron	6.	Karyotyping of normal human chromosomal complement from supplied photographic plates.
Dr. Ronald K L Tron	7.	Karyotyping of chromosomal complement of Down's/Turner's/Klinefelter's syndrome from supplied photographic plates.
Ms. Mebari Vanessa R Dorphang	8.	Demonstration of electrophoretic separation of DNA/protein.

SEMESTER: VI

PAPER NUMBER: VII A

NAME OF PAPER: Biochemistry, Animal Physiology, and Endocrinology (Theory)

THEORY

Name of the Teacher	Unit	Topics
Mr. Graham B Ranee	1	Chemical foundations of physiology Concept of normal, molar, and molal solutions Acis, bases, pH and buffer Diffusion and osmotic pressure Enzyme kinetics, Michaelis-Menten equation and its relation to enzyme activity Significance of Km and Vmax Enzyme inhibition (reversible and irreversible)
Ms. Mebari Vanessa R Dorphang	2 3	Carbohydrates: Linear and ring form monosaccharides (pentose and hexose) Polysaccharides (starch, glycogen and hyaluronic acid) Structure and functions of haemoglobin Blood coagulation: coagulation factors and mechanism Cardiac cycle Blood pressure and its regulation Mechanism of gaseous exchange through gills and lungs Osmoregulation in fish
Dr. P Wankitlang Shangpliang	3	Glycogenesis and Glycogenolysis Electron transport system and Oxidative phosphorylation Amino acids, peptides and proteins: Levels of organization Transamination, deamination and urea cycle
Dr. Duwaki Rangad	4	Neurosecretory cells Types of hormones: neurohormones, endocrine and paracrine hormones, placental hormones, hormones of GI tract, pheromones Biosynthesis of thyroid hormone Mechanism of hormone action: peptide and steroid hormones
Dr. Ronald KL Tron	5	Reproductive cycles: estrous and menstrual in mammals Hormonal regulation of spermatogenesis and oogenesis in humans IVF and embryo transfer technology Pregnancy hormones and lactation Contraceptive methods for males and females

PAPER NUMBER: VII B

NAME OF PAPER: Biochemistry, Animal Physiology, and Endocrinology (Practical)

PRACTICAL

Name of the Teacher	EXPERIMENT NUMBER	Topics
Dr. Ronald KL Tron	1.	WBC count in human blood.
Dr. Ronald KL Tron	2.	RBC count in human blood.
Dr. Duwaki Rangad	3.	Estimation of Glucose by colorimetric method.
Ms. Mebari Vanessa R Dorphang and Mr. Graham B Ranee	4.	Estimation of Protein by colorimetric (Lowry's/Biuret) method.
Dr. Ronald KL Tron	5.	Estimation of Haemoglobin in human blood.
Ms. Mebari Vanessa R Dorphang and Mr. Graham B Ranee	6.	Study of human salivary amylase activity in relation to temperature.
Dr. Ronald KL Tron	7.	Dissection and display of pituitary and gonads in a Teleost.
Dr. Ronald KL Tron	8.	Dissection and display of endocrine glands in albino mouse/rat.
Dr. Ronald KL Tron	9.	Microtomy: Preparation of histological slides of vertebrate tissues - liver, kidney, gonads, intestines, and adrenal.

PAPER NUMBER: VIII A

NAME OF PAPER: Developmental Biology, Environmental Biology and Biotechnology (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald KL Tron	1	Patterns of cleavage: Morphogenetic movements (epiboly, invagination, ingression, involution and delamination) Embryonic induction and Concept of Organizer Gastrulation in chick up to formation of three germinal layers
Dr. Duwaki Rangad	2	Foetal membranes and the types of placentae in mammals Organogenesis of the vertebrate eye Regeneration in invertebrates and vertebrates Teratogenesis and developmental birth defects Concept of ageing
Dr. P Wankitlang Shangpliang	3	Salient features of aquatic and terrestrial ecosystems Liebig's Law of Limiting factors and Shelford's Law of Tolerance; Biogeochemical cycles: Carbon, Phosphorus, and Nitrogen cycles; Ecological succession; Major biomes
Ms. Mebari Vanessa R Dorphang	4	Environmental concerns: Radioactive pollution Biological indicators; Biomagnification Anthropogenic activities and environment: Ozone depletion, greenhouse effects and global warming; Acid rains Wildlife conservation: In situ (sanctuaries, national parks and biosphere reserves) and ex situ (botanical and zoological gardens, germplasm bank)
Mr. Graham B Ranee	5	Biotechnology and genetic engineering: introduction to genetic engineering; Restriction enzymes; Cloning vectors: plasmids, cosmids, and λ phages; Shuttle vectors, Expresson vectors Introduction into host cells: Transformation, transduction Particle gun; Southern blotting, PCR, DNA fingerprinting Genomic libraries and cDNA library; Application of recombinant DNA technology; Ethical issues and biosafety regulations

PAPER NUMBER: VIII B

NAME OF PAPER: Developmental Biology, Environmental Biology and Biotechnology (Practical)

PRACTICAL

Name of the Teacher	EXPERIMENT NUMBER	Topics
Dr. P Wankitlang Shangpliang **&** Dr. Duwaki Rangad	1.	Permanent preparation of whole mount of chick embryo.
Dr. Duwaki Rangad	2.	Study of regeneration in Hydra/Planaria.
Dr. P Wankitlang Shangpliang **&** Dr. Duwaki Rangad	3.	Study of whole mount/sections of different development stages of chick embryo from permanent slides.
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang	4.	Community analysis
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang	5.	Qualitative analysis of aquatic communities from different water bodies.
Dr. P Wankitlang Shangpliang **&** Dr. Duwaki Rangad	6.	Estimation of total hardness of water samples.
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang	7.	Quantitative estimation of plankton.
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang	8.	Analysis of community similarities and species diversity indices.

SEMESTER: FYUG PROGRAMME SEMESTER I

PAPER NUMBER: ZOO-100 (MAJOR)

NAME OF PAPER: ZOO-100 Taxonomy and Animal Diversity

THEORY & PRACTICAL

Name of the Teacher	Unit	Topics
Ms. Mebari Vanessa R Dorphang	1	Taxonomy: Definition of taxonomy, phylogeny, systematics, category, taxon, classification, nomenclature; Biological species concept; Taxonomic hierarchy; Binominal nomenclature Seven-kingdom classification of organisms according to Michael A. Ruggiero *et.al.*, (2015) which include Archaea, Bacteria, Protozoa, Chromista, Fungi, Plantae, and Animalia. Salient features and classification of kingdom Protozoa up to phylum with example of representatives from each phylum. Protozoa: Paramaecium - Morphology and reproduction
Dr. Duwaki Rangad	1 3	Salient features and classification of the following phyla up to class with example of representatives from each class: Porifera, Cnidaria, and Platyhelminthes. Porifera: *Sycon* - Morphology and canal system. Cnidaria: *Obelia* - Morphology and reproduction. Platyhelminthes: *Taenia solium* – Morphology and the life cycle. Hemichordata: Morphology of *Balanoglossus*. Cephalochordata: Morphology of *Amphioxus*. Urochordata: Morphology of *Ascidia*. Salient features and classification of the following phyla up to class with example of representatives from each class: Hemichordata
Mr. Graham B Ranee	2	Salient features and classification of the following phyla up to class with example of representatives from each class: Nematoda, Annelida, Onychophora, Arthropoda, and Mollusca. Nematoda: *Ascaris lumbricoides* – Morphology and the life cycle.
Dr. P Wankitlang Shangpliang	2 3	Annelida: Leech - Morphology and urogenital system. Arthropoda: Prawn - Morphology and Reproductive systems. Mollusca: *Pila* - Morphology and Nervous Systems. Echinodermata: *Asterias* - Morphology and water vascular system. Salient features and classification of the following phyla up to class with example of representatives from each class: Echinodermata

Dr. Ronald K L Tron	3	Cyclostomata: *Petromyzon*– Morphology Pisces: *Labeo* - Morphology and respiratory systems. Mammalia: Rabbit - Morphology, digestive, circulatory and nervous systems Salient features and classification of the following phyla up to class with example of representatives from each class: Chordata.
Dr. P Wankitlang Shangpliang, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang	4 (PRACTICAL)	Dissection of prawn - nervous system Dissection of prawn - statocysts Dissection of *Channa*/*Labeo*/common carp - digestive system Dissection of *Channa*/*Labeo*/common carp - reproductive system
Dr. P Wankitlang Shangpliang, Dr. Duwaki Rangad, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang		General protocol for preparation of permanent mount Permanent mount of *Obelia* colony, parapodium of *Nereis*, gemmules of sponge, and cycloid scale of fish
Dr. P Wankitlang Shangpliang, Dr. Duwaki Rangad, Dr. Ronald KL Tron, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang		a) Protozoa whole mount (2) b) Porifera (2) c) Cnidaria (3) d) Platyhelminthes (2) e) Nematoda (1) f) Annelida (3) g) Onychophora (1) h) Arthropoda (5) i) Mollusca (5) j) Echinodermata (3) k) Hemichordata (1) l) Cephalochordata (1) m) Urochordata (1) n) Agnatha (1) o) Pisces (4) p) Amphibia (3) q) Reptilia (3) r) Aves (2) s) Mammalia (3)

PAPER NUMBER: VAC-104

NAME OF PAPER: Environmental Science (Theory)

THEORY

Name of the Teacher	Unit	Topics
Dr. Ronald KL Tron (Group 2), Dr. Duwaki Rangad (Group 10), Dr. P Wankitlang Shangpliang (Group 8 & 10), Mr. Graham B Ranee (Group 8 & 10), Ms. Mebari Vanessa R Dorphang (Group 2)	1	Definition, Components of Environment; Natural resources (Renewable and Non-renewable) their conservation and management Forest resources, Water resources, Mineral resources, Energy resources, Land resources. Soil erosion and desertification.
FACUTLY, DEPT. OF EVS	2	Concept, Structure and Functions. Food Chain and Food web. Energy flow in an ecosystem and biogeochemical cycle. Biodiversity: definition and concepts, biodiversity hot-spots. Conservation of biodiversity: In-situ and ex-situ conservation."
	3	Definition, causes, effects and control measures for Air pollution, Water pollution, Soil pollution, Noise pollution; Important issues of environmental pollution: Climate change (Greenhouse effect & Global warming), acid rain, ozone layer depletion; Environmental Legislation: Salient features of Environmental Protection Act, Air (Prevention & Control of Pollution) Act, Water (Prevention & Control of Pollution) Act; Sustainable development; Role of Information Technology in Environment, Environmental ethics and movements.

PAPER NUMBER: MDC-115

NAME OF PAPER: Introductory Life Sciences (Theory)

THEORY

Name of the Teacher	Unit	Topics
BOTANY FACULTY	1	Patterns of cleavage: Morphogenetic movements (epiboly, invagination, ingression, involution and delamination) Embryonic induction and Concept of Organizer Gastrulation in chick up to formation of three germinal layers
BIOCHEMISTRY FACULTY	2	Structure and function of prokaryotic and eukaryotic cells Introduction to biomolecules (Nucleic acid & Proteins) Introduction to biomolecules (Carbohydrates and Lipids) Basic concept of genes and their role in inheritance
BOTANY FACULTY	3	General features of life form and their classification (up to Kingdom) Bio-resources and their economic importance (Microbes & Plants) Ecology and Biodiversity
Dr. P Wankitlang Shangpliang & Dr. Ronald KL Tron	3	Bio-resources and their economic importance (Animal)
Mr. Graham B Ranee		Concepts of evolution
Ms. Mebari Vanessa R Dorphang & Dr. Duwaki Rangad		Wildlife Management

SEMESTER: FYUG PROGRAMME SEMESTER I

PAPER NUMBER: ZOO-100 (MINOR)

NAME OF PAPER: ZOO-100 Taxonomy and Animal Diversity

THEORY & PRACTICAL

Name of the Teacher	Unit	Topics
Ms. Mebari Vanessa R Dorphang	1	Taxonomy: Definition of taxonomy, phylogeny, systematics, category, taxon, classification, nomenclature; Biological species concept; Taxonomic hierarchy; Binominal nomenclature Seven-kingdom classification of organisms according to Michael A. Ruggiero *et.al.*, (2015) which include Archaea, Bacteria, Protozoa, Chromista, Fungi, Plantae, and Animalia. Salient features and classification of kingdom Protozoa up to phylum with example of representatives from each phylum. Protozoa: Paramaecium - Morphology and reproduction
Dr. Duwaki Rangad	1 3	Salient features and classification of the following phyla up to class with example of representatives from each class: Porifera, Cnidaria, and Platyhelminthes. Porifera: *Sycon* - Morphology and canal system. Cnidaria: *Obelia* - Morphology and reproduction. Platyhelminthes: *Taenia solium* – Morphology and the life cycle. Hemichordata: Morphology of *Balanoglossus*. Cephalochordata: Morphology of *Amphioxus*. Urochordata: Morphology of *Ascidia*. Salient features and classification of the following phyla up to class with example of representatives from each class: Hemichordata
Mr. Graham B Ranee	2	Salient features and classification of the following phyla up to class with example of representatives from each class: Nematoda, Annelida, Onychophora, Arthropoda, and Mollusca. Nematoda: *Ascaris lumbricoides* – Morphology and the life cycle.
Dr. P Wankitlang Shangpliang	2 3	Annelida: Leech - Morphology and urogenital system. Arthropoda: Prawn - Morphology and Reproductive systems. Mollusca: *Pila* - Morphology and Nervous Systems. Echinodermata: *Asterias* - Morphology and water vascular system. Salient features and classification of the following phyla up to class with example of representatives from each class: Echinodermata

Dr. Ronald K L Tron	3	Cyclostomata: *Petromyzon*– Morphology Pisces: *Labeo* - Morphology and respiratory systems. Mammalia: Rabbit - Morphology, digestive, circulatory and nervous systems Salient features and classification of the following phyla up to class with example of representatives from each class: Chordata.
Dr. P Wankitlang Shangpliang, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang	4 (PRACTICAL)	Dissection of prawn - nervous system Dissection of prawn - statocysts Dissection of *Channa*/*Labeo*/common carp - digestive system Dissection of *Channa*/*Labeo*/common carp - reproductive system
Dr. P Wankitlang Shangpliang, Dr. Duwaki Rangad, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang		General protocol for preparation of permanent mount Permanent mount of *Obelia* colony, parapodium of *Nereis*, gemmules of sponge, and cycloid scale of fish
Dr. P Wankitlang Shangpliang, Dr. Duwaki Rangad, Dr. Ronald KL Tron, Mr. Graham B Ranee, Ms. Mebari Vanessa R Dorphang		a) Protozoa whole mount (2) b) Porifera (2) c) Cnidaria (3) d) Platyhelminthes (2) e) Nematoda (1) f) Annelida (3) g) Onychophora (1) h) Arthropoda (5) i) Mollusca (5) j) Echinodermata (3) k) Hemichordata (1) l) Cephalochordata (1) m) Urochordata (1) n) Agnatha (1) o) Pisces (4) p) Amphibia (3) q) Reptilia (3) r) Aves (2) s) Mammalia (3)

SEMESTER: FYUG PROGRAMME SEMESTER II

PAPER NUMBER: ZOO-150 (MAJOR)

NAME OF PAPER: ZOO-150 FUNCTIONAL AND COMPARATIVE ANATOMY

THEORY & PRACTICAL

Name of the Teacher	Unit	Topics
Ms. Mebari Vanessa R Dorphang	1 2	Protozoa: Locomotion and nutrition. Urochordata: Retrogressive metamorphosis in *Ascidia*. Pisces: Scales and fins in fishes; Accessory respiratory organs.
Dr. Duwaki Rangad	1 2	Porifera: Canal system and skeletal systems. Hemichordata: Affinities of *Balanoglossus*. Cephalochordata: Affinities of *Amphioxus*.
Mr. Graham B Ranee	1 2	Annelida: Excretory system. Arthropoda: Comparative study of respiratory systems. Agnatha: Comparative study of *Petromyzon* and *Myxine*.
Dr. P Wankitlang Shangpliang	1 2	Cnidaria: Polymorphism in Siphonophora; Corals and coral reefs. Mollusca: Torsion and detorsion in Gastropoda. Echinodermata: Comparative study of water vascular system.
Dr. Ronald K L Tron	3	Amphibia: Comparative study of the morphological features of the three orders. Reptilia: Venomous and non-venomous snakes; Poison apparatus and mechanism of biting. Aves: Comparative study of Flight and flightless birds. Mammalia: Affinities of Monotremata, Affinities of Marsupialia, and dentition in mammals. Comparative anatomy of kidney in vertebrates. Comparative anatomy of heart in vertebrates. Comparative anatomy of respiratory organs (skin, gills, lungs, and air sacs) in vertebrates.
Dr. Ronald KL Tron	4 (PRACTICAL)	**1. Dissection** a) Accessory respiratory organs in teleost fish; b) Dissection of *Channa*/*Labeo*/common carp - Afferent branchial vessels
Dr. P Wankitlang Shangpliang		**2. Permanent mounting** a) Setae of earthworm; b) Scales (placoid and ctenoid) of fish; c) Feathers {down, filoplume, contour (showing barb and barbules)} of birds.
Dr. Duwaki Rangad		**3. Study of permanent sections** a) Histological study of tissues: epithelia, connective, muscle,

		and nervous; b) Histological study of stomach, intestine, kidney, liver, lungs, testis, and ovary of vertebrate; c) Transverse sections of: Ascaris male and female; Earthworm through typhlosolar region; Amphioxus through branchial region.
Mr. Graham B Ranee & Ms. Mebari Vanessa R Dorphang		**4. Osteology** a) Study of skull of rabbit/guinea pig b) Study of pelvic and pectoral girdle c) Study of humerus, radius-ulna, femur, tibio-fibula of rabbit/guinea pig; d) Study of vertebrae: Atlas, axis, and typical vertebra of rabbit/guinea pig.

SEMESTER: FYUG PROGRAMME SEMESTER III

PAPER NUMBER: ZOO-200 (MAJOR)

NAME OF PAPER: ZOO-200 INTRODUCTORY CELL BIOLOGY AND GENETICS

THEORY & PRACTICAL

Name of the Teacher	Unit	Topics
Ms. Mebari Vanessa R Dorphang	1	Basic structure of prokaryotic and eukaryotic cells. Ultrastructural characteristics and functions: Plasma membrane, mitochondria, endoplasmic reticulum, golgi complex, ribosomes, centrioles, and lysosomes Introduction to cytoskeletal components: Microtubules, microfilaments, and intermediate filaments. Ultrastructural characteristics and functions: Nucleus, nuclear envelope, and nucleolus.
	2	Chromatin structure and function: Definition and overview; Chromatin structure and function; Euchromatin and heterochromatin; Levels of chromatin organization: Nucleosome, linker DNA and histone proteins, 30-nm fibre, looped domains level, chromosome level.
Dr. Duwaki Rangad	3	Introduction to DNA as genetic material. Central dogma of molecular biology: Replication, transcription, and translation. Mendelian genetics: Mendel's experiments and principles of inheritance; Concept of genotype, phenotype, dominance, recessiveness, back cross and test cross. Codominance and incomplete dominance; Multiple alleles - ABO Blood groups in humans; Gene Interactions: Definition of epistasis and types (complementary, supplementary, inhibitory, and duplicate).
Mr. Graham B Ranee	3	Introduction to DNA as genetic material. Central dogma of molecular biology: Replication, transcription, and translation. Mendelian genetics: Mendel's experiments and principles of inheritance; Concept of genotype, phenotype, dominance, recessiveness, back cross and test cross. Codominance and incomplete dominance; Multiple alleles - ABO Blood groups in humans; Gene Interactions: Definition of epistasis and types (complementary, supplementary, inhibitory, and duplicate). Lethal Genes: Tay-Sachs disease and sickle cell anemia

Dr. P Wankitlang Shangpliang	3	Pleiotropy: Effects of single genes on multiple traits
Dr. Ronald K L Tron	3	Chromosomal theory of inheritance. Linkage: Types of linkage and crossing over. Chromosomal aberrations: Structural aberrations - Deletion, duplication, inversion, and translocation; Numerical aberrations- Euploidy and aneuploidy. Sex determination: Chromosomal, genic balance theory, environmental factors.
Ms. Mebari Vanessa R Dorphang	4 (PRACTICAL)	Study of cell organelles from model/charts
Dr. Duwaki Rangad		Preparation and study of different stages of mitosis in onion root tip.
		Preparation (demonstration only) and study of different stages of meiosis from grasshopper testis using permanent slides
Dr. P Wankitlang Shangpliang		Study of chromosome types from slides/photographs
Dr. Duwaki Rangad & Ms. Mebari Vanessa R Dorphang		Preparation and study of polytene chromosomes from Chironomus larva
Dr. Ronald KL Tron		Determination and study of multiple alleles (ABO blood groups in man)
Mr. Graham B Ranee & Dr. Ronald KL Tron		Study of phenotypic variations in natural population (at least three characters- rolling tongue, ear lobe, ABO blood groups, Rh blood group, etc.)

PAPER NUMBER: ZOO-201 (MAJOR)

NAME OF PAPER: ZOO-201 INTRODUCTORY BIOCHEMISTRY AND IMMUNOLOGY

THEORY & PRACTICAL

Name of the Teacher	Unit	Topics
Dr. Duwaki Rangad	1	Carbohydrates Monosaccharides: Reducing and non-reducing sugars, Chiral centre, Fischer Haworth projections (glucose and fructose), anomers. Disaccharides: glycosidic linkage and examples. Polysaccharides: Glycogen & Starch and Glycoconjugates - Hyaluronic acid. Lipids Classification, structure and biological importance of lipids; Saturated and unsaturated fatty acids, TAG, phospholipids, glycolipids, and steroids. Vitamins: Types, sources and functions.
Ms. Mebari Vanessa R Dorphang	1	Amino acids and proteins Amino acids: Structure, classification and general properties of a-amino acids; physiological importance of essential and non-essential a-amino acids; Peptides and proteins: Peptide linkage, dipeptides – Glutathione; Polypeptides – Insulin; Simple and conjugate proteins. Chemical structure of DNA and RNA: Nucleosides, nucleotides and polynucleotides.
Mr. Graham B Ranee	3	Introduction to Enzymes: Properties of enzymes; Co-factors, ribozymes, isozymes, proenzymes, and allosteric enzymes. Nomenclature and classification; Enzyme-substrate complex: Lock and key model and induced fit model, role of active sites and catalytic residues in substrate binding and catalysis; Physicochemical factors affecting enzyme activity. Principles of biophysical chemistry: Critical attributes of water that facilitate life. Normality, molarity and molality of solutions; Acids and bases; pH and buffers; Henderson-Hasselbalch equation; Buffers in biological systems.
Dr. P Wankitlang Shangpliang	3	Introduction to immunology: Immunity- types (innate and adaptive, natural and artificial, passive and active, humoral and cell mediated). Components of innate immunity: Physical barriers (skin, mucous membranes) and chemical barriers (acidic pH, enzymes) in innate immunity; Cellular components Neutrophils, macrophages, dendritic cells, natural killer (NK) cells, and their

		roles in innate immune responses. Adaptive immunity: Introduction to adaptive immunity and its key featuresspecificity, diversity, memory, and tolerance. Organs of immune systems; Hematopoiesis; Cells involved in immunity and APCs. Molecules involved in immunity: Immunoglobulins – basic structure, types and their function; Cytokines – Properties, types and their function; MHC – basic structure, types and their function. Antigen: Characteristics and types (endogenous and exogenous); Haptens, adjuvants, epitope; Antigenicity and immunogenicity; Factors influencing immunogenicity; antigen - antibody interaction (precipitation, agglutination and complement fixation)
Dr. Ronald K L Tron	3	Metabolism: Catabolism and anabolism, stages of catabolism, compartmentalization of metabolic pathways; Errors in metabolism – phenylketonuria. Stabilizing interaction of proteins and nucleic acid electrostatic interaction, hydrophobic interactions, disulphide bridges, and hydrogen structure: Van der Waal's bonding. Protein structure and levels of organization: Primary, secondary, tertiary, and quaternary structure.
Dr. Duwaki Rangad & Ms. Mebari Vanessa R Dorphang	4 (PRACTICAL)	Detection of Carbohydrates, lipids and proteins (at least three tests)
Ms. Mebari Vanessa R Dorphang		Study of DNA and RNA structure from charts/models/videos
Dr. Duwaki Rangad		Estimation of Ascorbic acid by titration method
Mr. Graham B Ranee		Study of human salivary amylase activity in relation to temperature
Mr. Graham B Ranee		Study of human salivary amylase activity in relation to pH
Dr. Ronald KL Tron		Demonstration of lymphoid organs from charts/models/videos
Dr. P Wankitlang Shangpliang		Study of sections of spleen, thymus and lymph nodes through slides or photographs.
Dr. Ronald KL Tron		Temporary preparation of stained blood film to study various types of blood cells.

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Dr. Ronald K L Tron
(Signature of HOD)