Tribhuvan University
Institute of Science and Technology
4 Years Bachelor of Science (B.Sc.) Programme
B.Sc. 3rd Year Zoology

Course Title : Physiology, Genetics and Molecular Biology **Full Marks: 100**
Course No. : Zool.301 **Pass Marks: 35**
Nature of Course : Theory **Year: III**
Instruction Lectures : 150

Objectives of the Course:

At the end of course students will be able to understand:

- Physiological processes in animals
- Details of endocrine glands and their roles
- Various biochemical phenomena in animals
- Embryonic development in animals
- Structure and function of animal cell organelles
- Basic concept of genetics and molecular biology
- Some molecular techniques necessary for carrying out molecular analysis.

Teaching materials required to fulfill the objectives are boards, charts, flex prints, overhead projector (OHP), power-point projector and other basic teaching materials prepared by teachers and as provided by the campuses.

Group A: Physiology (75 lec.)

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lectures	Text/Ref. for the topics (for detail see the list of text & references)
Nutritive substances, Enzymes and Energetics (15 Lectures)	**Biological role of nutritive substances**	Biological role of carbohydrate, lipid, proteins, vitamins, minerals and fibers.	**5**	Chatterjee; Jain et al.; Jordan and Verma; Power and Chatwal.

	Metabolism and metabolic pathways	Metabolic production of ATP, Oxidation-phosphorylation, electron-transport chain, Glycolysis, Kreb's cycle.	**4**	Chatterjee; Jain et al.; Jordan and Verma.
	Bioenergetics	Concept of energy, Thermodynamic principles and importance.	**1**	Jain et al.; Power and Chatwal.
	General properties and mechanism of action of enzymes. Cofactors and Coenzymes. Factors influencing enzyme activity	Coenzymes: Nicotinamide, Flavin, B12, Thiamin, folate etc, Cofactors: Biotin, iron, zinc, copper etc, Active site of enzyme, enzyme reaction rate and modifiers of enzyme activity (Inorganic and organic modifier – enzyme activator and inhibitor).	**5**	Jain et al.; Power and Chatwal.
Digestion (4 Lectures)	**Digestion and absorption of nutrients**	Digestion and absorption of carbohydrates, proteins, lipids, vitamins and minerals.	2	Verma, Agarwal and Tyagi; Eckert and Randall; Rastogi.
	Gastrointestinal secretions and its regulation	Composition, function and regulation of salivary secretion, gastric juice, pancreatic juice, bile and intestinal juice.	2	Verma, Agarwal and Tyagi; Eckert and Randall; Rastogi.
Respiration (8 Lectures)	**Respiratory mechanism**	Mechanism of cutaneous, tracheal, branchial and pulmonary respiration.	3	Jordan & Verma; Rastogi; Young; Kotpal; Khanna; Verma, Agarwal and Tyagi; Eckert and Randall.
	Respiratory pigments	Occurrence, properties and functions of haemoglobin, haemocyanin, chlorocruorin and haemerythrin.	2	Verma, Agarwal and Tyagi; Eckert and Randall; Rastogi
	Respiratory gases	Exchange and transport of oxygen and carbon dioxide.	2	Verma, Agarwal and Tyagi; Eckert and Randall; Rastogi

	Regulation of respiration	Neuronal control-central regulation, control by chemoreceptors, local regulation of ventilation and perfusion.	1	Jordan & Verma; Young; Kotpal; Verma, Agarwal and Tyagi; Eckert and Randall; Rastogi
Circulation (8 Lectures)	**Blood groups**	Blood groups: ABO system, Rh system, concept of other blood groups.	2	Bijlani; Verma, Agarwal and Tyagi; Guyton and Hall; Stanfield and Germann ; Rastogi.
	Haemostasis and blood coagulation	Process of haemostasis, Coagulation factors, coagulation pathways-intrinsic, extrinsic/common, intravascular clotting or thrombosis, anticoagulants, factors preventing coagulation.	2	Bijlani; Verma, Agarwal and Tyagi; Eckert and Randall; Guyton and Hall; Stanfield and Germann.
	Conduction system of the heart	Pacemaker, conduction fibers, spread of excitation between cells, initiation and conduction of impulse.	2	Stanfield and Germann; Rastogi; Eckert and Randall; Guyton and Hall;
	Cardiac output and its control	Cardiac output, control of cardiac output-extrinsic factors (hormone, neuronal inputs etc), intrinsic factor (autoregulation or local regulation).	2	Stanfield and Germann; Rastogi; Eckert and Randall.
Excretion (5 Lectures)	**Excretion and excretory products in animals**	Excretory devices in invertebrates and vertebrates, Types of excretory products, patterns of excretion.	1	Jordan & Verma; Young; Kotpal; Verma, Agarwal and Tyagi; Eckert and Randall.
	Mechanism of urine formation	Glomerular filtration, selective reabsorption, tubular secretion, plasma clearance, micturition.	2	Stanfield and Germann; Rastogi; Bijlani; Verma, Agarwal and Tyagi;

				Eckert and Randall; Guyton and Hall.
	Role of kidney in the maintenance of electrolyte balance and pH	Concept of balance, factors affecting the plasma composition, sodium balance, calcium balance, potassium balance, water balance, interactions between fluid and electrolyte regulation, buffering of hydrogen ions.	2	Stanfield and Germann; Rastogi; Bijlani; Verma, Agarwal and Tyagi; Eckert and Randall; Guyton and Hall.
Nervous System (6 Lectures)	**Nerve cells and electrical signaling**	Nerve cells, establishment of the resting membrane potential, electrical signaling through changes in membrane potential, maintaining neuronal stability.	3	Stanfield and Germann; Eckert and Randall; Guyton and Hall.
	Synaptic transmission and neuronal integration	Concept and types of the synapse, transmission at electrical and chemical synapses, neurotransmitter substances, process of summation.	3	Stanfield and Germann; Eckert and Randall; Guyton and Hall.
Endocrine System (12 Lectures)	**Primary endocrine glands, respective hormones and their functions.**	Pituitary: Adenohypophysis –Anatomy, major hormone secreted and their function. Neurohypophysis – Anatomy, major hormone secreted and their function. Thyroid: Anatomy, major hormone secreted and their function. Parathyroid: Anatomy, major hormone secreted and their function. Adrenal: Anatomy, major hormone secreted and their function. Islets of Langerhans: histology of pancreas showing Islets of Langerhans, major hormone secreted and their function. Thymus and Pineal body: Anatomy, major hormone secreted and their function.	3 2 1 2 1 1	Chartterjee 2005; Jordan and Verma

		Gonads: Testes and Ovary - Anatomy, major hormone secreted and their function.	2	
Sensory System (6 Lectures)	**General principles of sensory physiology -vision, hearing and balance, taste, smell and touch**	Receptor cells, sensory pathways, mechanism of sensation of vision, hearing and balance, taste, smell and touch.	6	Eckert and Randall; Guyton and Hall.
Reproduction and Development (11 Lectures)	**Female reproductive cycle (Ovarian and uterine cycles in Human)**	Phases of ovarian cycle-the follicular phase and the luteal phase; The uterine cycle- menstrual phase, proliferative phase, secretory phase, hormonal changes during the menstrual cycle.	2	Stanfield and Germann; Bijlani, Guyton and Hall
	Gametogenesis	Spermatogenesis and oogenesis.	2	Guyton and Hall, Stanfield and Germann; Bijlani.
	Types of eggs	Types of eggs on the basis of amount of yolk, distribution of yolk, presence and absence of hard shell and development.	2	Balinsky; Dhami and Dhami; Jordan and Verma; Goel and Sastri; Kotpal.
	Mechanism of fertilization	Process of fertilization-contact of egg's first barrier by the sperm, digestion of the zona pellucida, fusion of plasma membrane, entering into the cytoplasm of the egg, joining the nuclei.	1	Stanfield and Germann; Bijlani.
	Embryonic development	Patterns of cleavage, blastulation, gastrulation and neurulation in human.	4	Balinsky; Dhami and Dhami; Jordan and Verma; Goel and Sastri; Kotpal.

Group B: Cell Biology, Genetics and Molecular Biology (75 lec.)

Group B1: Cell Biology

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lec.	Text/Ref. for the topics
Cell Biology (22 Lectures)	**Cell**	General organization of Prokaryotic and Eukaryotic	2	Rastogi; Verma & Agarwal.
	Cell membrane	Molecular organization, membrane transport principles.	2	Rastogi; Verma. & Agarwal.
	Cytoskeleton and Cell Motility	Microtubules, microfilaments, intermediate filament, Cilia and flagella.	2	Rastogi; Verma & Agarwal.
	Structure and functions	Endoplasmic Reticulum, Golgi Complex, Lysosome, Peroxisome, Mitochondria, and Ribosomes	10	Rastogi; Verma & Agarwal.
	Nucleus	Structure of nuclear envelope, nucleoplasm, chromatin fibres and nucleolus. Nucleo-cytoplasmic interrelationship.	2	Rastogi; Verma & Agarwal.
	Chromosomes and Chromatin	Nomenclature, karyotype and giant chromosomes. heterochromatin and euchromatin.	2	Rastogi; Verma & Agarwal.
	Cell cycle and Cell division	Cell cycle, mitosis and meiosis.	2	Rastogi; Verma & Agarwal.

Group B2: Genetics

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lec.	Text/Ref. for the topics
Genetics (19 Lectures)	**Mendelian and Non-Mendelian Inheritance**	Concept of Mendelian and Non-Mendelian Inheritance. Laws of inheritance.	2	Verma & Agarwal; Singh.
	Genetic Interaction	Gene, Alleles, Dominant and recessive.	2	Verma & Agarwal; Singh.
	Multiple Alleles	Blood groups in human (ABO and Rh).	2	Rastogi; Verma & Agarwal; Singh.
	Linkage and Crossing over	Theories, types and significance.	2	Verma & Agarwal; Singh.
	Sex-Linked Inheritance	Characteristics, X, Y and X-Y linked genes inheritance, Non–disjunction as proof of chromosomal basis of heredity.	3	Verma & Agarwal; Singh.
	Sex determination	Sex determination in animals.	1	Verma & Agarwal; Singh.
	Chromosomal Variations	Chromosomal aberration Euploidy, monoploidy, polyploidy nullisomy, trisomy, double trisomy and tetrasomy, mutations and their types.	2	Verma & Agarwal; Singh.
	Human Genetics	Pedigree analysis, human traits, sex-linked diseases, disorders due to mutant genes, Eugenics, and Euphenics.	4	Verma & Agarwal; Singh.
	Genetic Engineering and Gene Therapy	Introduction and their applications.	1	Rastogi.

Group B3: Molecular Biology

Unit	Sub-unit	Description of content of the sub-unit (depth)	Lec.	Text/Ref. for the topics
Molecular Biology (34 Lectures)	**Nucleic acids**	Structure and composition of DNA, DNA Replication**:** DNA polymerase- properties and mechanism of action. Semi-discontinuous, uni-directional and bi-directional DNA replication. DNA replication mechanisms in prokaryotes and eukaryotes. Structure and composition of RNA, RNA Processing: Processing of messenger RNA (mRNA), ribosomal RNA (rRNA), and transfer RNA (tRNA).	10	Rastogi; Verma & Agarwal.
	GeneticCode and Central Dogma	Characteristics and Wobble hypothesis; Concept of Central Dogma.	3	Rastogi; Verma & Agarwal.
	Transcription, Translation and Protein Synthesis	Differences between replication and transcription. RNA polymerase in prokaryotes- properties and organization of promoters. Mechanism of prokaryotic and eukaryotic transcription. Mechanisms of translation (initiation, elongation and termination), Translation process in prokaryotes and eukaryotes. Post-modification of released protein.	9	Rastogi; Verma & Agarwal.
	Gene Expression, Regulation and Control	Gene expression, regulation and control in prokaryotes and Eukaryotes, Transcriptional, translational and posttranslational modification system. Control at hormonal level	7	Rastogi; Verma & Agarwal.
	Techniques of Molecular Biology	Introduction and applications: Polymerase chain reaction (PCR), DNA fingerprinting, gene cloning, DNA sequencing, Blotting and Enzyme linked immunoserbent assay (ELISA).	5	Rastogi; Verma & Agarwal.

Text Books

Balinsky, B.I. 1970. An Introduction to Embryology. W.B. Saunders, London.
Chatterjee C.C. 2005. Human Physiology. Medical allied agency Mahatma Gandhi road, Calcutta.
Dhami, P.S. and Dhami, J.K. A Textbook of Zoology, vol. II & III. latest ed., Pradeep Pub., New Delhi.
Jain J.L, Jain S and Jain N 2005. Fundamentals of Biochemistry**.** S. Chand & Company. Ram Nagar, New Delhi
Jordan, E.L. and Verma, P.S. Chordate Zoology & Animal Physiology. latest ed., S. Chand, New Delhi.
Kotpal, R.L. Modern Textbook of Zoology: Vertebrates. latest ed., Rostogi Pub., Meerut India.
Rastogi, S. C. 2001. Cell and Molecular biology. New Age International (P) Limited,Publishsers: New Delhi, Banglore, Calcutta, Chennai,Lucknow, Mumbai, India.
Rastogi, S.C. Text Book of Physiology.Willey Eastern Ltd.
Singh, B.D. 2006. Fundamentals of Genetics. Kalyani Publishers, Ludhiana, New Delhi,Noida (UP), India.
Verma, P.S. and Agarwal, V.K. 2012. Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. Published by S.Chand & Company LTD,New Delhi India.
Verma, P.S, Agarwal, V.K., and Tyagi B.S. Animal Physiology, S. Chand & Co, New Delhi.

References

Bijlani, R.L.(Ed.) Understanding Medical Physiology, Jaypee Brothers, Medical Publishers (P.) LTD. India.
Eckert, R. and Randall, D. Animal Physiology, CBS Publishers and Distributers, India.
Goel, K.A. and Sastri, K.V. 1998. A Text Book of Animal Physiology. Rastogi Pub., Meerut.
Guyton, A.C. and Hall, J.E. Textbook of Medical Physiology, Elsevier.
Hill R., Wyse G, and Anderson M., Animal Physiology, Third Edition, Sinauer Associates, Inc.
Hoar, William S. General and Comparative Physiology. Prentice Hall.
Jeremy, M. Berg and John L. Lubert Stryer. Biochemistry. 5th ed. W.H. Freeman & Company, New York.
Knut Schmidt- Nielson. Animal Physiology. Cambridge Univ. Press.
Knut Schmidt-Nielsen. 1973. Animal Physiology. Foundations of Modern Biology Series. Prentice Hall.
Nelson, David L. and Cox, Michael M. 1982. Lehninger Principles of Biochemistry. 4th ed.Pub. Prentice- Hall of India Private Limited New Delhi.
Powar, C.B. and Chatwal, G.R. Biochemistry. Himalaya Pub.House, Mumbai, latest ed.
Randall, D.,Burggern, W. and French, K. Eckert Animal Physiology. WH Freeman & Co.
Satyanarayan, U. Biochemistry. Books and Allied (P) Ltd., Kolkata, India.
Stanfield, C.L. and Germann, W.J. Principles of Human physiology, Third edition, Pearson International Edition.
Turner, P.C., McLennan, A.G., Bates, A.D. and White, M.R.H .1998. Instant Notes in Molecuar Biology. Viva Books Pvt.Limited, New Delhi, Mumbai and Chennai, India.
Vander, Sherman and Luciano. Human Physiology. McGraw- Hill.
Winter, P.C., Hickey, G.I. and Fletcher, H.L (2000): Instant Notes in Genetics. Bios Scientific Publishers Ltd, 9 Newtec Place, Magdalen Road, Oxford 0X4 IRE, UK.
Yapp, W.B. 1970. An Introduction to Animal Physiology. Oxford at the Clarenden Press.