

Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Biosystematics & Evolution**

**Course No: Zoo 501**

**Nature of the Course: Theory**

**Credits: 3**

**Lecture hrs: 48**

**Full marks: 75**

**Pass marks: 37.5**

**Course Objectives**

- To help students to know the importance of invention of living animals.
- To make students acquaint with basic principles and procedures of describing taxa.
- To help students to know the principles of evolutionary biology.

**Course Contents**

**Biosystematics, Diversity & Phylogeny**

**32 hrs**

- 1. Introduction:** Historical developments and current advancements in taxonomy. Importance of describing the living world. Taxonomic mistakes and bad practices. International Codes of Zoological Nomenclature (ICZN): development, basic principles, interpretation and application. **6 hrs**
- 2. Recognizing & Describing Species:** Species concepts. Process affecting speciation. Taxonomic characters & their analysis: kinds and weighting of characters. Systematic collection and curating of collections (with reference to different animal groups). Species identity and their description: a. using taxonomic literatures, b. using museum collections. Naming species. Type and voucher material. Writing taxonomic description. Kinds of taxonomic publications. Ethics in taxonomy. **10 hrs**
- 3. Beyond Species Description:** Subspecies. Phenotypic plasticity. The genus concept. Taxonomic keys. Evolutionary Systematics. Phenetics. Cladistics. Molecular Systematics. **6 hrs**
- 4. Animal Diversity & Phylogeny:** Origin of Protists. Origin of Parazoa, Mesozoa and Metazoa. Origin of Radiata. Origin of Bilateria from Radiata. Evolutionary history from invertebrates to vertebrates. Evolutionary interrelationships among taxa (Interrelationship of the Pesudocoelomate groups, Affinities and evolutionary significance of protostome phyla, Affinities and evolutionary significance of the deuterostome phyla, Phylogenetic relationship between the coelomate phyla). **10 hrs**

**Evolution**

**16 hrs**

- 1. Introduction:** An overview of evolutionary biology. Evolution and molecular biology- a new synthesis. **2 hrs**
- 2. Geological Timescale:** Major events in evolutionary timescale, Estimating evolutionary time scale, Mass extinction and its consequences. Tree of life. **3 hrs**
- 3. Evolutionary Change and Adaptiveness:** Mechanisms producing genetic diversity. Populations, gene frequencies & equilibrium. Changes in gene frequencies. Structure & interactions of populations. Natural selection & adaptation. Speciation. Rates of evolution. Macroevolutionary change. Macroevolutionary trends, coevolution, species selection. Evolutionary biogeography. Concept of molecular evolution. Measures of genetic relationship among organisms. Molecular phylogeny. Construction of phylogenetic tree. **11 hrs**

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Biosystematics & Evolution**  
**Course No: Zoo 506**  
**Nature of the Course: Practical**

**Credit: 1**  
**Lecture hrs: 45**  
**Full marks: 25**  
**Pass marks: 12.5**

**Course Objectives**

- To impart practical knowledge on biosystematics and evolution.

**Course Contents**

1. Sorting samples (e.g. helminthes, Annelids, arthropods and mollusks or available vertebrates).
2. Grouping selected samples into different morpho-species (e.g. insects, snails, fishes, amphibians, reptiles, birds, mammals etc.) and classifying.
3. Cataloguing samples following teacher's guideline, safe preservation and storing
4. Finding characters and keys, description and diagnosis
5. Writing taxonomic report on collected and identified samples by the students
6. Construction of phylogenetic tree

**Museum and Zoo visit**

Visiting museums (CDZ, NHM, NARC), learning preservation and storing techniques, prepare report on any one species or group of animals about current situation of that group or species.

**Suggested Readings**

- Anderson, T.A. (2001). Invertebrate Zoology (2<sup>nd</sup> edn). Oxford University Press, New Delhi.
- Barrington, E.J.W. (1969). Invertebrate Structure and Functions. English Language Book Society.
- Campbell, N.A and Reece, J.B. (2009). Biology (8<sup>th</sup> edn). Benjamin Cummings Publ. NY, USA
- Dobzhansky, T. (1976). Genetics and Origin of species, Columbia University, USA
- Dobzhansky, T., Ayala, F.J., Stebbins, G.L and Valantine, J.W. (1976). Evolution, Surjeet Publ. New Delhi
- Ferguson A. (1980). Biochemical systematics and evolution, Blackie Publ., London
- Futuyma, D.J. (2005). Evolution, Sinauer Associates, New York
- Hyman, L.H. (1940 –1967). The Invertebrates (6 vols). McGraw-Hill Companies Inc. NY
- ICZN. (1999). International Code of Zoological Nomenclature 4<sup>th</sup> Ed., Adapted by the I.U.B.S. The International Trust for Zoological Nomenclature, London (International Commission on Zoological Nomenclature, 1999).
- Mayr, E. (1969). Principles of Systematic Zoology. McGraw Hill Book Company, Inc., NY.
- Mayr, E. (1997). This is Biology: The Science of Living world. Universities Press Ltd.
- Mayr, E. and Ashlock, A.D. (1991). Principles of Systematic Zoology, McGraw-Hill, Inc. 2<sup>nd</sup> Ed.
- Pat, W. (1996). Invertebrate Relationships-Patterns in Animal Evolution. Cambridge University Press

- Peterson, K.J. and Eernisse, D.J. (2016). The phylogeny, evolutionary developmental biology, and paleobiology of the Deuterostomia: 25 years of new techniques, new discoveries, and new ideas. Organisms Diversity & Evolution. Springer.
- Ridley, M. (1993). Evolution, BlackWell Science Massadusscttes, USA
- Rose, M.R. and Ridley, M. (2003). Evolution (3rd edition), Blackwell Publishers, New York
- Rupert, E.E., Fox, R.S. and Barnes, R.D. (2006). Invertebrate Zoology: A Functional Evolutionary Approach. Thomson/Cole, Singapore
- Simpson, G.G. (1961). Principles of Taxonomy, Columbia University Press, New York/Oxford Book Company, Kolkata/Delhi
- Strickberger, M.W. (2005). Evolution. Jones and Bartett Publishers, London.
- Winston, J.E. (1999). Describing Species, Practical Taxonomic Procedures for Biologists, Columbia University Press, USA.
- Young, J.Z. (1950). Life of Vertebrates. Clarendon Press, Oxford, UK.

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Cell and Developmental Biology**  
**Course No: Zoo 502**  
**Nature of the Course: Theory**

**Credits: 3**  
**Lecture hrs: 48**  
**Full marks: 75**  
**Pass marks: 37.5**

**Course Objectives**

- To impart advance knowledge molecular and functional aspects of cell Biology
- To provide fundamentals of embryonic development of animals

**Cell Biology**

**24 hrs**

1. **Cell membrane transport mechanism:** Transport of micro-molecules and ions: pores, carrier proteins and channels. Transport of macromolecules: endocytosis and exocytosis. **4 hrs**
2. **Cell metabolism:** Oxidation, mechanism of ATP synthesis. **3 hrs**
3. **Cell adhesion and communication:** Ca<sup>++</sup> dependent and independent adhesion, gap junctions, extracellular matrix and Cell – matrix interaction, cell growth and oncogenic transformation. **5 hrs**
4. **Cytoskeleton and cell movements:** Structure and diversity of microtubules, intracellular transport via microtubules, actin and myosin filaments in cell movements. **4 hrs**
5. **Cell cycle regulation, differentiation and apoptosis:** Cell cycle control points, cell cycle inducers, stem cell differentiation and cell death pathways. **3 hrs**
6. **Cell signaling:** Signal molecules, membrane receptors, second messengers. Role of signal molecules in gene activations. Signaling pathways- MAP kinase, NF-kB, and Hedgehog, Interaction between signaling pathways. **5 hrs**

## **Developmental Biology**

**24 hrs**

1. **Introduction:** Origin of developmental biology-cell theory, mosaic and regulative development. **2 hrs**
2. **Early embryonic development:** Gametogenesis (spermatogenesis and Oogenesis), fertilization, embryonic development, patterning and placentation. **8 hrs**
3. **Organogenesis:** Development of ectodermal organ (central nervous system), mesodermal organ (Heart) and endodermal organ (accessory organs of alimentary organs). **8 hrs**
4. **Post embryonic development:** Embryonic cell growth and differentiation, metamorphosis, regeneration. **4 hrs**
5. **Embryonic stem cells and their applications** **2 hr**

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Cell and Developmental Biology**

**Course No: Zoo 507**

**Nature of the Course: Practical**

**Credit: 1**

**Lecture hrs: 45**

**Full marks: 25**

**Pass marks: 12.5**

### **Course Objective**

- To impart advance practical knowledge on cell and developmental Biology

### **Course Contents**

#### **Cell Biology**

1. Cell culture techniques
2. Cell growth
3. Cell culture proliferation using MTT assay.
4. Quantification of cells by Trypan blue exclusion dye
5. Cell counting and cell viability-Titrations/Microscopy/Hemocytometer
6. Adhesion and suspension cell culture technique
7. Characterization of haematopoietic cells in mice

#### **Developmental Biology**

1. Study of regeneration in Hydra
2. Diagnostic features of the early stages of developing Chick embryo
3. Preparation of different stages of chick embryo from blastoderm to subsequent changes.
4. Developing stages of fish embryo.
5. Ablation and regeneration of fish tail

### **Suggested Readings**

Alberts, B., Bray, D., Lewis, J., Raff, M., Roberts, K. and Wattson, J.D. (2008). Molecular Biology of the Cell, Garland Science, Taylor & Francis Group, New York, USA.

Balinsky, B.I. (2004). An Introduction to Embryology, (5<sup>th</sup> Ed.) Thompson Asia Pte. Ltd, Singapore

Berridge, M.J. (2009). Cell Signaling Biology, Portland Press Limited.

Berril, N.J. and Karp, G. Development Biology. McGraw Hill New York.

- De Robertis, D.P. and De Robertis E.M.F.Jr.(1998). Cell and Molecular Biology, 8th Ed. B.I. Waverly Pvt. Ltd., New Delhi.
- Gilbert, S.F. (2006). Developmental Biology, (8th Ed., 2006) Sinauer Associates Inc., Massachusetts, USA.
- Kalthoff (2000). Analysis of Biological Development (2nd Ed., 2000), McGraw-Hill Science, New Delhi.
- Lodish, H., Berk, A., Kaiser, C.A., Krieger, M., Bretscher, A., Ploegh, H., Amon, A., Martin, K.C. (2007). Molecular Cell Biology, W.H. Freeman and Company, New York, USA
- Sperelakis, (2001). Cell Physiology Source Book : A Molecular approach Academic Press, New Academic Press, New
- Wolpert, L. (2006). Principles of Developmental Biology, (3rd Ed., 2006), Oxford University Press, New Delhi, INDIA.

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Tribhuvan University  
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**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Biochemistry and Immunology**  
**Course No: Zoo 503**  
**Nature of the Course: Theory**

**Credits: 3**  
**Lecture hrs: 48**  
**Full marks: 75**  
**Pass marks: 37.5**

**Course Objectives**

- To acquaint students with basic knowledge of biochemistry.
- To provide knowledge of the immune system and its medical application.

**Course Contents**

**Biochemistry**

**24 hrs**

1. **An overview of biochemistry:** Molecular organization of biological systems. Important elements and their chemical speciation in the human body, Properties of water, pH, Buffers, Cellular environment and applicability of basic laws of chemistry and thermodynamics. **3 hrs**
2. **Amino acids:** Structure, classification and Properties; Molecules derived from amino acids. **2 hrs**
3. **Proteins-** Functions and diversity, structure and conformation, fibrous and globular proteins, conjugated proteins, protein folding and denaturation, Purification and characterization, Protein synthesis. **4 hrs**
4. **Carbohydrates:** Classification, structure, general properties and functions of monosaccharides, disaccharides, polysaccharides. Structure and biological functions of glycosaminoglycans, proteoglycans and glycoproteins. **3 hrs**
5. **Lipids:** General properties, classification, nomenclature and biological role of lipids. Structure, properties and functions of fatty acids, triacylglycerols, glycerophospholipids, Sphingolipids, cerebrosides; Steroids. **3 hrs**
6. **Enzymes:** General properties, function, classification, nomenclature, Enzyme kinetics, Factors affecting enzyme action, Mechanism of enzyme action, inhibition, regulation and control of enzymes activity. **4 hrs**
7. **Metabolism:** An introduction to information metabolism; Integration of metabolism; Biosynthesis of carbohydrate, lipid, and amino acids; Regulation of metabolism. **3 hrs**
8. **Hormones and Vitamins:** General function and classification of hormones, mechanisms of hormone action. Structure and classification of vitamins. **2 hrs**

## **Immunology**

**24 hrs**

1. **Introduction to immune system:** Basic concepts in immunology; Organs, cells and molecules of the immune system; Innate and acquired immunity. **3 hrs**
2. **Receptors:** T and B-cell receptors; receptor ligand interactions, signal transduction in B cells, T-cell receptor and signaling; Receptors of innate immunity; Toll-like receptors and sensing of Pathogen-associated molecular patterns (PAMPs), signal transduction, opsonization, Fc receptors. **3 hrs**
3. **Nature of antigen and antibody:** Antigens, antigenicity, and immunogenicity. Epitopes, haptens, adjuvants and mitogens. Classification, structure and functions of immunoglobulins, concept of isotypic, allotypic and ideotypic variants, Antigen-antibody interactions. **3 hrs**
4. **Generation of Diversity in immune system:** Clonal selection theory – concept of antigen specific receptor. Organization of immunoglobulin genes: generation of antibodies diversities, T-cell receptor diversity. Activation, differentiation and development of T- and B-cells. **4 hrs**
5. **Immune effector Mechanisms:** Kinetics of primary and secondary immune responses, complement activation and its biological consequences, cytokines and co-stimulatory molecules, antigen processing and presentation. **4 hrs**
6. **Major histocompatibility complex (MHC) genes and products:** Polymorphism of MHC genes, role of MHC antigens in immune responses, MHC antigens in transplantation. **3 hrs**
7. **Tolerance vs activation of immune system:** Immune tolerance, hypersensitivity (Types I, II, III, IV). **2 hrs**
8. **Disorders of immune responses:** Autoimmunity, congenital immunodeficiencies, acquired immunodeficiencies. **2 hrs**

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**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Biochemistry and Immunology**

**Course No: Zoo 508**

**Nature of the Course: Practical**

**Credit: 1**

**Lecture hrs: 45**

**Full marks: 25**

**Pass marks: 12.5**

### **Course Objective**

- To provide students with practical knowledge and hands-on experience with some of the most common experimental methods used in biochemical and immunological research.

### **Course Contents**

1. Buffers and salts: Preparation of normal, molar and percent solutions of different salts, Preparation of buffers in the laboratory over a pH range (2 to 11); Use of pH meters
2. Detection and Estimation of biomolecules: detection and quantitative estimation of carbohydrates, amino acids, proteins and fats.
3. Estimation of total protein from tissues of animal model.

4. Electrophoresis and Western Blotting. SDS-PAGE analysis of proteins. Visualization of protein bands by Coomassie and silver staining. Western blot analysis of the proteins using antibodies (immunoblotting).
5. Isolation and purification of proteins.
6. Enzyme purification and determination of enzyme kinetics.
7. Effects of different factors in enzyme activity.
8. Sub-cellular fractionation of liver homogenate by differential centrifugation method and identification of the organelles by measuring marker enzymes.
9. Preparation of Giemsa stained slide of tissue from spleen, an organ of immune system, of animal model (Balb/c mice/rabbit).
10. Agglutination. Hemagglutination assay
11. Production and collection of polyclonal antisera from animal model against Ag.
12. Purification of IgG by column chromatography
13. Dissection of primary and secondary immune organs from mice:
14. Detection of targeted Ag/Ab by Western Blot technique.
15. Preparation and study of phagocytosis by splenic/peritoneal macrophages.
16. Detection of Antibody against hapten carrier conjugate applying ELISA
17. Study of tissues of immune system by Immunohistochemistry.

### **Suggested Readings**

Abbas, A.K., Lichtman, A.K., Pober, J.S. Cellular and molecular immunology (Fifth edition). SC Publication.

Berg, J., Tymoczko, J. and Stryer, L. Biochemistry, Publisher: W. H. Freeman, New York.

Boyer, R. F. (2001). Modern Experimental Biochemistry (3<sup>rd</sup> edition). Benjamin Cummings Publication.

Delvin, T.(eds) (1997).Textbook of biochemistry with clinical correlations. Willey-Liss Publications.

Elgert: Immunology understanding the immune system, John Willy & Sons, Inc. Publication, New York, 1996.

Goldsby, R.A., Kindt, T.J., Osborne, B.A.. Kuby immunology. WH Freeman and Company. New York.

Herbert, R.B. (1989). The Biosynthesis of Secondary metabolites (2<sup>nd</sup> edition). Chapman and Hall.

Holme, D. and Peck, H. (1998). Analytical Biochemistry (3<sup>rd</sup> edition). John Wiley and Sons Inc.

Janeway, C.A., Travers, P.,Walport,M., Capra, J.D. Immunobiology (6<sup>th</sup> Edition). Garland Science, New York.

Mathews et al.: Biochemistry (3<sup>rd</sup> Ed.), Benjamin/Cummings Publishing, 1990

Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell V.W. (1999). Harper's Biochemistry (25<sup>th</sup> edition) (Lange Series). McGraw-Hill Company.

Paul, W.E. Fundamentals of immunology. Raven Press New York.

Roitt, I., Brostoff, J., Male, D. Immunology. HP Limited. NY.  
 Stryer, L.W.H. (1995). Biochemistry, Freeman and Company, New York.  
 Voet, D. and Voet, J.D. (2004). Biochemistry. John Wiley and Sons Inc.  
 Walsh, G. Proteins Biochemistry and Biotechnology. JW and Sons LTD.  
 Zubay, G.L., Wm. C. (1996). Biochemistry. Brown Publishers.  
 Relevant review articles/research papers/handouts provided in the course.

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Animal Anatomy & Physiology**  
**Course No: Zoo 504**  
**Nature of the Course: Theory**

**Credits: 3**  
**Lecture hrs: 48**  
**Full marks: 75**  
**Pass marks: 37.5**

**Course Objectives**

- To impart knowledge in comparative anatomy and development systems of animals.
- To make familiar with the functions of various organs.
- To provide an understanding of currently established interdisciplinary approaches used in the study of animal anatomy and physiology.

**Course Contents**

**Animal Anatomy** **8 hrs**

1. Tissue organization in animals.
2. Comparative histoarchitecture: muscles, intestine, liver, pancreas, trachea, lungs, kidney, testis, ovary, uterus, blood vessel, brain, spinal cord, lymph node, tonsil, thymus, spleen, retina, cartilage and bone.
3. Jaw suspension.
4. Comparative account of lateral line system.

**Animal Physiology** **40 hrs**

1. **Digestive:** Secretory physiology of alimentary tract and digestive glands. Gastro-intestinal motility. Principles of digestion and absorption of nutrients. Ruminant and non-ruminant digestive patterns. Metabolism (carbohydrate, protein and fat) and regulation of body heat. **3 hrs**
2. **Respiratory:** Respiratory pigments - structure, properties and functions (through different phylogenetic groups); Transport of respiratory gases in blood and body fluids. Regulation of respiration. Respiratory response to extreme conditions (hypoxia, diving, exercise). Respiratory adaptations of animals inhabiting O<sub>2</sub> deficient environment. **4 hrs**
3. **Cardio-vascular:** Haemopoiesis. Comparative structures of cells in circulation (invertebrates and vertebrates). Circulation in invertebrates and vertebrates. Electrical properties of the heart. Cardiac cycle. Regulation of heart pumping and pacemaker, arterial and venous blood flow, and blood pressure. Circulatory shock. Foetal circulation. **5 hrs**
4. **Homeostasis:** Excretion, osmoregulation, Kidney functions and diversity. Counter current multiplier and exchanger. Renin-angiotensin system. Micturation. Renal regulation of acid-base balance. Diuretics.



- Thermoregulation – Thermogenesis, Thermoregulation in homeotherms, poikilotherms and hibernation. Thermal neutral zone. Acclimatization. **5 hrs**
5. **Neurophysiology:** Motor areas of the brain. Physiology and neuronal pathway of vision and hearing. Electroretinogram. Light and dark adaptation. Insect eyes and theories of mosaic vision. Production and reception of sound in insects. Motor neurophysiology. Somatic sensation. Echolocation. Endogenous and exogenous biological rhythm. **5 hrs**
6. **Reproductive:** Hormonal control of spermatogenesis. Signal transduction pathway in acrosome reaction. Hormonal regulation of ovulation, development of mammary gland, pregnancy, parturition and lactation. Physiology of placenta. Seasonal breeders and continuous breeders. **3 hrs**
7. **Endocrine:** Hormones – classification, chemical nature, structure, biosynthesis and mechanism of action (Feedback and molecular aspect). Hormone receptors and signal transduction mechanisms. Invertebrate endocrinology - a comparative account (annelida and arthropoda), chemistry of invertebrate hormones. Neuroendocrine control of metamorphosis in insects and amphibians. Hypothalamic regulation of pituitary secretion. Paradigms of thyroid hormone action in poikilotherms and homeotherms. Hormonal regulation of energy metabolism. Hormonal antagonism. Pheromones as means of communication. Chromatophores, melanogenesis and regulation of their function among animals. **13 hrs**
8. **Muscular:** Electrophysiology and biochemistry of muscular contraction (skeletal, visceral and cardiac). Neuronal control of muscle contraction. Adaptations of muscles for various activities. **2 hrs**

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**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Animal Anatomy & Physiology**  
**Course No: Zoo 509**  
**Nature of the Course: Practical**

**Credit: 1**  
**Lecture hrs: 45**  
**Full marks: 25**  
**Pass marks: 12.5**

**Course Objectives**

- To impart practical knowledge on comparative vertebrate anatomy.
- To provide students with the recent technique applicable in the field of animal physiology.

**Course Contents**

**Animal Anatomy**

1. Comparative study of histology of vertebrate organs: skeletal, smooth and cardiac muscles, skin, intestine, liver, pancreas, gills, trachea, lungs, kidney, testis, ovary, placenta, blood vessel, brain, spinal cord, lymph node, tonsil, thymus, spleen, retina.
2. Comparative study of bones of vertebrates (axial and appendicular).
  - Study of skull of poisonous and non-poisonous snakes, turtles, alligator, gavialis.
  - Study of skull of birds to show palate types.
  - Study of skull of dog and rabbit.
3. Microtomy: Tissue fixation, dehydration, clearing, infiltration, embedding for paraffin method, sectioning, mounting, staining (differential and specific).

4. Histochemical detection of carbohydrates by periodic acid Schiff's reagent.
5. Histochemical detection of proteins by mercury bromophenol blue.
6. Histochemical detection of lipid by Sudan black B.

### **Animal Physiology**

1. Study of estrus cycle in rat – vaginal smear method.
2. Determination of respiratory quotient of an air breathing animal at different temperature.
3. Estimation of rate of oxygen consumption by aquatic animals under oxygen deficiency.
4. Measurement of the rate of contraction and relaxation of muscles using kymograph.
5. Recording of ECG.
6. Measurement of blood pressure at different conditions.
7. Determination of the total number of human RBCs, WBCs and platelets.
8. Measurement of haemoglobin.
9. Determination of clotting time of blood.
10. Measurement of human blood sugar.
11. Estimation of urea, sugar, protein in urine.
12. Glycogen estimation from animal tissues/liver.
13. Enzymatic/acid hydrolysis of glycogen from the tissue/liver sample.
14. Test of carbohydrate (Mollisch's test, Barfoed's test, Benedict's tests, Fehling's test, Iodine test).
15. Test of protein (protein precipitation, ninhydrin reaction, biuret reaction, Xanthoproteic reaction)
16. Test of lipids (solubility test, reaction with Sudan IV, Saponification).

### **Suggested Readings**

- Nelson K.S. (ed) *Animal Physiology: Adaptation and Environmental*, Cambridge University Press, Cambridge, UK
- Babsky, E.B. (1970). *Human Physiology*, Mir Publishers.
- Elliott and Elliott .*Biochemistry and Molecular Biology*, Oxford University Press, New York, USA (Indian edition)
- Brown, R. (1994). *An Introduction to Neuroendocrinology*, Cambridge University Press, Cambridge, UK
- Chatterjee, C.C. (1998). *Human Physiology Vol. I & II*. Medical Allied Agency, Calcutta.
- Dantzler, W.H. (ed.) *Comparative Physiology (Handbook of Physiology)* Vol. 1, 2. Oxford University Press, New York, USA
- Bentley, P.J. *Comparative Vertebrate Endocrinology*, Cambridge University Press, UK
- Echert, R. and Randall, D. (1987). *Animal Physiology* CBS Pub. & Distributors, Delhi.
- Hoar, W.S. (ed) *General and Comparative Animal Physiology*, Prentice Hall, India
- Goodrich, E.S. (1958). *Structure and Development of Vertebrates*, Dover, New York.
- Gorbman and Bern (1974). *A Text Book of Comparative Endocrinology*, Wiley Eastern Ed., New Delhi.
- Guyton, A.C. and Hall, J.E. (2003). *Medical Physiology (Last Ed.)*, Indian Print. Saunders.
- Hand Book of Physiology*, American Physiological Society, Oxford University Press, Section 7: Multiple volumes set.
- Murray, Granner and Rodwell. *Harper's Illustrated Biochemistry*, (27th Ed.), McGraw Hill, New York, USA
- Hill, Wyse & Anderson (2004). *Animal Physiology*
- Hurkat, P.C. and Mathur, P.N. (1976). *Textbook of Animal Physiology*, S. Chand & Co. (P.) Ltd., NewDelhi
- Langley, L.L. (1971). *Physiology of Man*, Vanmost and Reinhold, New York.
- Wilson and Walker. *Practical Biochemistry – Principles and Techniques*, Cambridge University Press, Cambridge, UK

Prosser, C.L. and Brown, F.A. (1965). Comparative Animal Physiology W. B. Saunders, Philadelphia  
 Randall Burggren & French (2005). Animal Physiology  
 Seelay, R.R., Stephens, T.D. and Tate P. (1992). Anatomy and Physiology, Mosby-year book, Inc.(2nd Ed.)  
 Strand, F.L. (1965). Modern Physiology, MacMillan, New York.  
 Norris, D.O. Vertebrate Endocrinology, Elsevier Academic Press,

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Tribhuvan University  
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**M. Sc. Zoology (Semester System)**  
**SEMESTER I**

**Course Title: Neuronal and Behavioural Biology**

**Credits: 3**

**Course No: Zoo 505**

**Lecture hrs: 48**

**Nature of the Course: Theory**

**Full marks: 75**

**Pass marks: 37.5**

**Course Objectives**

- To provide basic knowledge of neurobiology
- To acquaint the students with characteristic behavioural aspects of animal life

**Course Contents**

**Neurobiology**

**24 hrs**

1. **Organization of the nervous system:** Brain structure, cerebrospinal fluid. Cells and connection of the nervous system: Neurons, Glial cells, Synapses, Neural network, Blood-brain barrier. **3 hrs**
2. Neurotransmitters and Neuropeptides. **3 hrs**
3. Neural regulation of complex functions e.g. sensation - modalities, pain, touch. **2 hrs**
4. Cognitive Development, Spatial Cognition; the Prefrontal Cortex and Executive Brain Functions; Consciousness. **3 hrs**
5. Biorhythm and its regulatory genes /Circadian Timekeeping; Sleep, Dreaming and Wakefulness; Reward, addiction, and Emotion. **3 hrs**
6. Neurogenesis, Neuronal Ageing and death. **3 hrs**
7. Aspects of neuronal disorders/ Neuropathology; Strokes and excitotoxicity and NMDA receptors, Depression, Schizophrenia, Epilepsy, Parkinson's disease, Alzheimer's disease, Huntington's disease. **5 hrs**
8. Neuroeconomics, New vistas in neural modeling and interfacing brain and machine. **2 hrs**

**Behavioral Biology**

**24 hrs**

1. Principles, mechanisms and development of animal behavior. **3 hrs**
2. **Stimuli and communication:** stimuli; sensory capacity; pattern recognition; communication; animal signals; mimicry, deception, threat display and honesty; Honey-bee dance; monkeys call. **3 hrs**
3. **Motivation and decision making:** Decision making on time budget; mechanism of decision making; behavior analysis of sequence and its physiological explanations; motivation; conflict and stress. **3 hrs**

4. **Learning and memory:** Sensitization and habituation; Associative learning; learning ability, special type of learning (Bees, birds, primates); animal learning; higher forms of learning; comparative study; animal thinking and reflections; nature of memory. **3 hrs**
5. **Evolution:** Adaptiveness of behavior; optimality and behavior; keen selection and inclusive fitness; conflict and infanticide (mammals); co-operation. **2 hrs**
6. **Migration:** hypothesis; costs- benefits, territoriality and reproductive success; effect of territoriality, resource-holding power, asymmetry hypothesis. **2 hrs**
7. Ecology of Feeding Behavior; food location; finding prey, optimality theory, optimal foraging and predation, defense strategies against predators, Territoriality and Group foraging. **2 hrs**
8. Ecology of mating systems, reproductive tactics; monogamy; mammals, birds, extrapair copulation, polyandry, polygyny, female defense polygyny, female choice. **2 hrs**
9. **Ecology of Parental care:** female association; gamete released; fish male paternity, offspring recognition, tolerance of siblings; adoption. **2 hrs**
10. **Human behaviors in an evolutionary approach:** Adaptationist, human sexual behavior, sperm competition, female-male choice. **2 hrs**

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**SEMESTER I**

**Course Title: Neuronal and Behavioural Biology**  
**Course No: Zoo 510**  
**Nature of the Course: Practical**

**Credit: 1**  
**Lecture hrs: 45**  
**Full marks: 25**  
**Pass marks: 12.5**

**Course Objective**

- To develop experimental skill on Neuronal and Behavioural biology

**Course Contents**

1. Foraging behavior– Insects, birds, mammals.
2. Quantifying aggressive behavior in primates.
3. Focal behavioural sampling, scan sampling and Ad libitum sampling practice on primates.
4. Neurotoxicological studies using animal models
5. Study of neurodegenerative models, e.g., nerve injury models
6. Assessment of neuromuscular function/performance using Grip Strength Meter
7. Studies on learning behavior using mazes
8. Dissection of nervous system of rat/ and or any mammal as an experimental model.
9. Perfusion techniques
10. Processing and handling of tissue for microanatomy of brain: Nissl/Silver techniques
11. Determination of pain sensitivity in rat/mice using Tail-Flick Analgesia meter and Paw test apparatus
12. Study of neuronal disorders
13. Study of neuronal death using neuronal cells

**Suggested Readings**

Alcock, J. Animal Behaviour : An Evolutionary approach. Sinauer Assoc. Sunderland, Massachsets, USA.  
 Bradbury, J.W. and S.L. Vehrencamp. Principles of Animal Communication. Sinauer Assoc. Sunderland, Massachsets, USA.



Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Molecular Biology and Genetics**  
**Course No: Zoo 551**  
**Nature of the Course: Theory**

**Credits: 3**  
**Lecture hrs: 48**  
**Full marks: 75**  
**Pass marks: 37.5**

**Course Objectives**

- To impart advance knowledge of present day in molecular and cell Biology.
- To provide knowledge on some important aspects of Genetics.

**Molecular Biology**

**24 hrs**

1. **Introduction:** Molecular biology, Relationship to other biological sciences. **1 hr**
2. **Central Dogma of Molecular Biology and protein synthesis:** General transfers of biological sequential information in DNA, **Mechanism of protein synthesis:** Replications, Transcription, Translation, Special transfers of biological sequential information in reverse transcription, RNA Replications, Translation, Posttranslational modification. **4 hrs**
3. **Recombinant DNA technology:** Recombinant DNA, Restriction enzymes used in Recombinant DNA technology, Gene transfer methods and transgenic animal, Applications of transgenic animal production. **3 hrs**
4. **DNA Repeats:** Types of DNA repeats (repeated sequences) and position of Satellite DNA, Mobile DNA (Transposons), Classes of Transposons, Evolutions of Transposons. **2 hrs**
5. **Genetic map and Restriction map:** Definition of genetic and restriction map and their differences. **1 hr**
6. **Molecular techniques:** Molecular cloning, Polymerase Chain Reaction (PCR), PCR-RFLP, PCR-RAPD, Gel electrophoresis, Macromolecule blotting and probing (Southern blotting, Northern blotting, Western blotting and Eastern blotting), Microarrays, Allele-specific oligonucleotide Probe, Sequencing, Gene therapy, type of cloning. **2 hrs**
7. **Forensic science:** DNA profiling and its uses, DNA markers used in forensic investigation. **2 hrs**

**Genetics**

**24 hrs**

1. **Introduction:** History and growth of modern genetics, Heredity and variation. Growth of human genetics. **3 hrs**
2. **Mendelian genetics:** Mendelism, Principle of heredity, Mono and di-hybridizations, Autosome and sex-linked gene, Linkage and crossing over, Rediscovery of Mendelism. **3 hrs**
3. **Cytogenetics:** Chromosomal aberrations, Determination of sex, Karyotyping, Application of karyotyping, Sex chromatin and Lyon's hypothesis, and Classification of human chromosomes. **3 hrs**
4. **Molecular genetics:** Chemical structure and molecular structure of DNA and RNA, Gene, Genetic code, Transcription and translation, Protein synthesis, Regulation of gene expression, Gene mutation. **3 hrs**
5. **Extranuclear genetics:** Cytoplasmic inheritance (Non-Mendelian inheritance), Gene conversion, Male sterility in plants, Infectious heredity, Maternal effects, Genomic imprinting, Mosaicism, DNA Trinucleotide repeats. **3 hrs**

6. **Population Genetics:** Concept of gene pools, Gene and genotype frequencies, Hardy-Weinberg Principle, Hardy-Weinberg Equilibrium, Forces affecting Hardy-Weinberg Equilibrium. **3 hrs**
7. **Biochemical Genetics:** Modified version of one gene and one enzyme hypothesis, Inborn errors of metabolism, Hemoglobins and hemoglobinopathies. **2 hrs**
8. **Microbial Genetics:** Genetics of microorganisms (bacteria, archaea, fungi, protozoa and viruses), applications of microbial genetics. **2 hrs**
9. **Immunogenetics: Immunity**, structure of antibody (immunoglobulin), Diversity of antibody, Immunodeficiency, transplantation of tissues. **2 hrs**
10. **Cancer genetics:** Characteristics of cancer cells, type of tumours, Cell cycle and cancer, Causes of cancer. **2 hrs**
11. **Developmental genetics:** Embryonic development and molecular mechanism, Normal and abnormal sexual differentiation. **2 hrs**
12. **Applied genetics:** Approach to genetic counseling: Indications for genetic counseling, Genetic counseling team, Genetic counseling facilities, The goals of genetic counseling, Genetic counseling process, Problems in genetic counseling. Genetic screening definition, criteria for genetic screening, Genetic screening as multistep process, Ethical and legal concerns regarding genetic screening, Accuracy of genetic profile from genetic screening. **2 hrs**

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Molecular Biology and Genetics**  
**Course No: Zoo 554**  
**Nature of the Course: Practical**

**Credit: 1**  
**Lecture hrs: 45**  
**Full marks: 25**  
**Pass marks: 12.5**

**Course Objective**

- To impart practical knowledge on Molecular Biology and Genetics

**Course Contents**

1. Preparation of Buffers and media.
2. Precautions for handling of DNA (RNA, Protein).
3. Isolating and purifying DNA.
4. Electrophoresis of DNA
5. Analyzing DNA
6. Amplification of DNA
7. Cloning of DNA
8. Labeling of DNA and Oligo-nucleotides.
9. Blotting and Probing: Western blotting.
10. Study and preparation of short human community/family based survey report on human genetic traits based on phenotypes.
11. Screening of enzymatic activities of some genetic traits relevant to Nepali populations

## **Suggested Readings**

- Bhatnagar, S.M., Kothari, M.L. & Mehta, L.A. (1995). Essentials of Human Genetics. Published by Orient Longman Ltd, Kamani Marg, Ballard Estate, Bombay 400 038, India.
- Dhar, P.K. (1997). Human Genetics. Published by Jaypee Borthers, Medical Publishers (P) Ltd, New Delhi 110 002, India.
- Dudek, R.W. (1999). High-Yield Cell and Molecular Biology. Lippincott Williams and Wilkins, A Wolters Kluwer Company, 351 West Camden Street, Baltimore, Maryland 21201-2436 USA.
- Friedman, J.M., Dill, F.J., Hayden, M.R., McGillivray, B.C. (1996). Genetics, 2<sup>nd</sup> edition. B.I. Waverly Pvt. Ltd, New Delhi, India.
- Gangane, S.D. (1992). Human Genetics. Published by B.I. Churchill Livingstone Pvt. Ltd, New Delhi, India.
- Kanakraj, P. (2001). A Text Book of Animal Genetics. International Book Distributing Company, Lucknow, U.P. India.
- Kumar, H.D. (1997). Molecular Biology and Biotechnology. Published by Vikas Publishing House Pvt. Ltd, New Delhi-110 051, India.
- Kowles, R. (2001). Solving Problems in Genetics. Published by Springer-Verlag and printed by Hamilton Printing Co. Rensselaer, NY, USA.
- Mandal, S. (1996). Fundamentals of Human Genetics. Published by New Cenral Book Agency (P) Ltd. 8/1 Chntamoni Das Lane, Calcutta 700 009, India.
- Pal, G.P. (2003). Basics of Medical Genetics. AITBS Publishers and Distributors, J-5/6, Krishna Nagar, Delhi-110051, India.
- Rastogi, S. C. (2001). Cell and Molecular biology. Published by New Age International (P) Limited, New Delhi, Bangalore, Calcutta, Chennai, Guwahati, Hyderabad, Lucknow, Mumbai, India.
- Strachan, T. and Read, A.P. (1996). Human Molecular Genetics. Bios Scientific Publishers Limited, 9 Newtec Place, Magdalen Road, Oxford OX4 1RE, UK.
- Singh, B.D. (2006). Fundamentals of Genetics. Kalyani Publishers, Ludhiana, New Delhi, Noida (UP), India.
- Turner, P.C., McLennan, A.G, Bates A.D. and White, M.R.H. (1998). Instant Notes in Molecular Biology. Viva Books Private Limited, New Delhi, Mumbai and Chennai, India.
- Verma, P.S. and Agarwal, V.K. (2012). Cell Biology, Genetics, Molecular Biology, Evolution and Ecology. Published by S.Chand & Company LTD, Ram Nagar, New Delhi-110055, India.
- Winter, P.C., Hickey, G.I. and Fletcher, H.L. (2000). Instant Notes in Genetics. Bios Scientifica Publishers Ltd, 9 Newtec Place, Magdalen Road, Oxford OX4 1RE, UK.

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Biostatistics & Bioinformatics**

**Course No: Zoo 552**

**Nature of the Course: Theory**

**Credits: 3**

**Lecture hrs: 48**

**Full marks: 75**

**Pass marks: 37.5**

**Course Objectives**

- To make the students acquaint with the use of Biostatistics in research.
- To make the students acquaint with the use Bioinformatics

**Biostatistics**

**32 hrs**

1. **Introduction and concepts:** Introduction to biostatistics and scopes with examples of small data sets. Frequency distribution (Introduction, univariate frequency distribution, bivariate frequency distribution, frequency distribution table, and application). Presentation of data (Tabular presentation and graphical presentation of data – bar diagram, histograms, pie chart, line graphs and examples). **2 hrs**
2. **Measures of Central Tendency:** Introduction, Mean, Median, and Mode and Construction of formula and use with examples. **2 hrs**
3. **Measures of Dispersion:** Introduction, Deviation/mean deviation, Variance and standard deviation and construction of formula, calculation steps with examples. **2 hrs**
4. **Probability:** Introduction to probability, Measure of probability, Laws of probability, Probability distribution (Binomial, Poisson, Normal) and application with examples. **3 hrs**
5. **Sampling:** Introduction/definition, types, techniques (non-probability and probability sampling), sampling size and design with examples), Sources of Bias. **1 hr**
6. **Correlation and Regression:** Introduction, scatter diagram method, Karl Pearson's coefficient of correlation (properties, assumptions, interpretation, computation), correlation in bivariate frequency table, Rank correlation method (limitation, computation), linear & non-linear regression, lines of regression, coefficient of regression, and uses with examples. Multiple Regression: Introduction and use. **5 hrs**
7. **Hypothesis testing:** Introduction/definition and inferential statistics, types, different tests, types of errors, Parametric and Non-parametric tests and examples. **1 hr**
8. **Chi-square test:** Introduction, components of the test, Construction of formula; test conditions, Degree of freedom, P value/Confidence level, Calculated value, Tabulated value, Decision rules and decision, and Application. Contingency Table- types and examples. **2 hrs**
9. **Student t-test:** Introduction, components of the test, Construction of formula; Assumptions, Degree of freedom, P value/Confidence level, Calculated value, Tabulated value, Decision rules and decision, and Application. **2 hrs**
10. **F-test:** Introduction, Components, Construction of formula; Assumptions, Degree of freedom, P value/Confidence level, Calculated value, Tabulated value, Decision rules and decision, and Application. **2 hrs**
11. **Experimental Design and Analysis of Variance (ANOVA):** Introduction, Classification, types – Simple design CRD, RBD, LSD, simple factorial), Complex Design (Split Plot Design, Balanced Incomplete Block Design, Nested Design), Preparation for experimental designs (requirements),

ANOVA Models – One way Model, Two way Model and Three way Model and their constructions with description of each term, Work out examples for each model with steps. **8 hrs**

12. **Multivariate analysis:** Introduction and available software packages and use (what, when and why use it). **1 hr**

### **Bioinformatics**

**16 hrs**

1. **Bioinformatics:** Important contributions, Aims and tasks of Bioinformatics, Applications of Bioinformatics, Challenges and opportunities. **1 hr**
2. **Databases, Tools and their Uses:** Importance of databases, Nucleic acid sequence databases, Protein sequence databases, Structure databases, Use of databases. **3 hrs**
3. **Sequence Alignment:** Algorithm, Goals and types of alignment, Sequence alignment methods, Pairwise alignment, Multiple sequence alignment. **3 hrs**
4. **Predictive methods using DNA and Protein sequences:** Gene prediction strategies: Gene predictions programs, Protein prediction strategies: Protein prediction program Molecular visualization. **2 hrs**
5. **Homology, Phylogeny and Evolutionary Trees: Homology and Similarity, Phylogeny and Relationship:** Approaches used in Phylogenetic Analysis, Phylogenetic trees, Tree-building methods; **Molecular approaches to Phylogeny, Phylogenetic Analysis databases.** **3 hrs**
6. **Drug Discovery and Pharminformatics: Discovering drug:** Target identification and validation, Identifying the lead compound, Optimization of lead compound. **Pharminformatics: Chemical libraries. Search Programs.** **2 hrs**
7. **The need and Scopes of Bioinformatics in Nepal: Introduction, Potential areas of bioinformatics in Nepal:** Building databases for biodiversity, Databases for literature references, Drug design and protocol development, Medical and public health informatics, Virtual lab/e-lab development, Agro-informatics, Bioinformatics for biotechnology laboratories, Forensic science, and academic institutions. **2 hrs**

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Biostatistics & Bioinformatics**

**Course No: Zoo 555**

**Nature of the Course: Practical**

**Credit: 1**

**Lecture hrs: 45**

**Full marks: 25**

**Pass marks: 12.5**

### **Course Objective**

- For better understanding of the topics of Zoo 552.

### **Course Contents**

1. Data generation (using creative techniques) and analysis (central tendency, dispersion, correlation and regression, chi-square test, t test and f test (one example of each model) manually.
2. Statistical analysis of each unit using EXCEL and available software packages
3. All theory and practical should go hand in hand for each chapter. It should be more demonstrative classes, the computer networking, biological databases and concerned bioinformatics software should be used in accordance with the need.

## Suggested Readings

- Andrew, J., Cammon, Mc, Harvey S. (1988). Dynamics of Proteins and Nucleic acids. Cambridge University Press.
- Attwood, T.K. & Parry-Smith, D.J ((1999 and 2014). Introduction to Bioinformatics (Cell and Molecular Biology in Action Series) published by Prentice Hall, edited by DR. Ed Wood, Department of Biochemistry and Molecular Biology, University of Leeds, UK.
- Bailey, N.T.J. (1995). Statistical Methods in Biology, London
- Baldi, P and Brunak, S. (2003). Bioinformatics: The Machine Learning Approach. Published by Affiliated East-West Press Pvt. Ltd, 105 Nirmal Tower, 26 Barakhamba Road, New Delhi 110 001.
- Bergeron, B. (2006). Bioinformatics Computing. Published by Prentice Hall of India Pvt. Ltd, New Delhi-110 001.
- Bishop, O.N. (1984). Statistics for Biology, Longmann, New York.
- Gupta, S.C. (2014). Fundamentals of Statistics Latest Ed., Indira Gupta (Ed.) Himalayan Pub. House Bombay, India.
- Harisha, S. (2007). Fundamentals of Bioinformatics. I.K, International Publishing House Pvt Ltd, New Delhi, Bangalore and Mumbai, India.
- Hicks, R.C. (1982).Fundamental Concepts in the Design of Experiments. Holt. Rinehart and Winston, NY
- Ignacimuthu, S, (2006). Basic Bioinformatics, Narosa Publishing House Pvt Ltd, 22 Daryaganj, Delhi Medical Association Road, New Delhi 110 002.
- Kothari, C.R. (1990). Research Methodology, Second Ed. VishwaPrakashan, India.
- Lesk, A.M. ((2003). Introduction to Bioinformatics. Oxford University Press, UK, printed in India by Gopsons, Noida 201301, Published by Manzar Khan, Oxford University Press, YMCA Library Building, Jai Singh Road, New Delhi 110001.
- Pangeni, R.P. (2007). Concept on Bioinformatics. Published by Sukunda Pustak Bhawan, Bhotahity, Kathmandu, Nepal.
- Pevsner, J. (2003). Bioinformatics & Functional Genomics. John Wiley and Sons.
- Rastogi, S.C, Mendiratta, N., Rastogi, P. (2004). Bioinformatics, Methods and Applications. PHI Publication.
- Singh, M.L. (1998). Understanding the Research Methodology Statistical Methods
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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Fundamentals of Ecology**  
**Course No: Zoo 553**  
**Nature of the Course: Theory**

**Credits: 3**  
**Lecture hrs: 48**  
**Full marks: 75**  
**Pass marks: 37.5**

**Course Objectives**

The purpose of this module is to introduce students the fundamental principles of the ecology at the individual, population, community and ecosystem level.

**Course Contents**

1. **Organisms and their Environment:** Ecology, branches and its scopes; Adaptation: tolerance and homeostasis; Climates: climates, microclimates and vegetation zonation; Water: water cycles, plant and animal response to moisture; Temperatures: Temperature and metabolism, plant and animal response to temperatures; Nutrients: Sources, Nutrients response of plants and consumers, Soils: Profile, properties, Genesis, development and classification of soils. **12 hrs**
2. **Population Ecology:** Population dynamics, density dependence and density independent forces, stochasticity (demographic and environmental), exponential population growth, logistic population growth, Exponential vs logistic growth, Life history strategy. **7 hrs**
3. **Habitat and Niche:** Habitat and microhabitat, Ecological Niche, Niche dimension, Niche overlap, Competitive exclusion and Niche dynamics, Ecological equivalents, Character displacement, Sympatry, Allopatry. **5 hrs**
4. **Community Ecology:** Biotic community concept, Community characteristics, Community structure, Edge community and community boundary, Island Community, Community patterns: diversity and stability. Analysis of community structure: Gradient analysis and ordination, Community classification, Disturbance and dynamics in ecological community. **8 hrs**
5. **Ecosystem Ecology:** Structure; Ecosystem Processes; Ecosystem Services; Fresh Water Ecosystems: Lentic Ecosystem (Physical characteristics, structure, function and nutrient dynamics), Lotic Ecosystem (Structure, function, river continuum); Forest Ecosystem (Physical characteristics, structure, function and nutrient dynamics). **7 hrs**
6. **Ecology of Industrial Invasion:** Eutrophication and its Remediation; Acidification; Biodegradation and Bioremediation. **3 hrs**
7. **Biodiversity:** Concept and threats; Biodiversity indicators: structure and function of indicators, surrogate species, taxon based indicators; Biodiversity extinction and conservation approaches; Overview of world's biome. **6 hrs**

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Tribhuvan University  
**Institute of Science and Technology**  
**M. Sc. Zoology (Semester System)**  
**SEMESTER II**

**Course Title: Fundamentals of Ecology**  
**Course No: Zoo 556**  
**Nature of the Course: Practical**

**Credit: 1**  
**Lecture hrs: 45**  
**Full marks: 25**  
**Pass marks: 12.5**

**Course Objective**

- For better understanding of the topics of Zoo 553.

**Course Contents**

1. Determination of abiotic factors in terrestrial ecosystems
2. Assessment of the soil texture, soil organic matter, pH and conductivity.
3. Measurement of the community structure using quadrat method by establishing minimum size and minimum number of quadrats
4. Determination of abundance and population density of animals and plants species.
5. Determination of community structure and assessment of cover and basal area of species present and determine the IVI (Importance Value Index) of the species
6. Understand the concept of community coefficient by comparing the frequency of two communities
7. Determination of the pattern of biomass allocation in a grassland community.
8. Determination of the physico-chemical parameters of aquatic ecosystems.

**Suggested Readings**

- Begon, M. and Mortimer, M. 1995. Population ecology: a unified study of animals and plants. Blackwell Publishing Ltd., Oxford.
- Cain, M.L., Bowman, W.D. and Hacker, S.D. 2014. Ecology. Sinauer.
- Chapin, S.F., Matson, P.A. and Mooney, H.A. 2002. Principles of terrestrial ecosystem ecology. Springer.
- Krebs, C.J. Ecology: The Experimental Analysis of Distribution and Abundance. Benjamin Cummings, San Francisco.
- Manuel, C. & Molles Jr 2008. Ecology, Concepts and Applications. McGraw Hill,
- Odum, E.P. Fundamentals of Ecology, W. B. Saunders Company, Philadelphia and London.
- Smith, R.L. and Smith, T.M. Ecology and Field Biology. Harper Collins.
- Smith, T.M. and. Smith, R.L. 2012. Elements of Ecology. Boston, Pearson Education, Inc.

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