MAHARSHI DAYANAND UNIVERSITY ROHTAK

Department of Zoology

Scheme of Examination - Choice - Based Credit System (CBCS)

M.Sc. Zoology w.e.f. Session 2011

Semester	Course No.	Course Title		Credit	Marks
I	Zoo-101.	Biomolecules	CP	4	80
	Zoo-102.	Techniques in Animal Science	CP	4	80
	Zoo-103	Animal Cell Biology	CP	4	80
	Zoo-104	Computer & Biostatistics	CP	4	80
	Zoo-105	Programme elective i. System biology ii. Communication skill in life science	PE	3	80
	Zoo-IA-I	Internal Assessment			20 in each Theory paper
	Zoo-Sem-I	Seminar		2	50
	Zoo-LC-I	Laboratory Course		10	150
	Total Marks (Semester I)				**700**
11	Zoo- 201	Developmental Biology	CP	4	80
	Zoo- 202.	Advanced Physiology	CP	4	80
	Zoo- 203.	Molecular Biology	CP	4	80
	Zoo-204.	Cell function & metabolic regulation	CP	4	80
	Zoo-205.	Programme elective (PE) i. Evolutionary Biology ii. Animal Biotechnology	PE	3	80
	Zoo-IA-II	Internal Assessment			20 in each Theory paper
	Zoo-SS	Self Study		3	50
	Zoo-Sem-II	Seminar		2	50
	Zoo-LC-II	Laboratory Course		10	150
	Total Marks (Semester I1)				**750**
111	Zoo -301	Animal Diversity of invertebrates	CP	4	80
	Zoo -302	Molecular Endocrinology	CP	4	80
	Zoo -303	Immunology	CP	4	80
	Zoo -304	Molecular Cytogenetics	CP	4	80
	Zoo -305	Programme elective i. Population Genetics ii. Environmental Biology	PE	3	80
	Zoo-IA-III	Internal Assessment			20 in each Theory paper
	Zoo-LC-III	Laboratory Course		10	150
	Total Marks (Semester 111)				**650**
1V	Zoo- 401	Animal Diversity of Vertebrates	CP	4	80
	Zoo-402	Microbial Genetics	CP	4	80
	Zoo -403	Biosafety & ethics in science	OE	3	80
	Zoo-404	Dissertation		24	200
	Zoo-IA-IV	Internal Assessment			20 in each Theory paper
	Zoo-LC-IV	Laboratory course		6	100
	Zoo-TT	Tutorial I & II		2	-
	Total Marks (Semester IV)				**600**
	Grand Total				**2700**

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M. Sc. ZOOLOGY w.e.f. session 2011
Semester-I

Course no.: Zoo-101 **MM: 80**
Course Title: Biomolecules **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Biomolecular foundations of biology:
pH, pK, acids, bases, buffers, bonds- Van der Waal's, electrostatic, hydrogen bonding and hydrophobic interaction, free energy, resonance, isomerisation.
Structure of soluble biomolecular pool of cells – aminoacids and peptides; monosaccharides, oligosaccharides and polysaccharides; glycoproteins, peptido-glycans; nucleotides, oligonucleotides, lipids and vitamins.

Unit II

Proteins Structure -primary, secondary, tertiary and quaternary.
Folding, denaturation and function of polypeptides like Ribonuclease A, Myoglobin, Hemoglobin, Chymotrypsin, Lysozyme and Carboxypeptidase.
Conjugated proteins-structure and functions
Analysis of proteins: Western blotting; Reverse turns and Ramachandran plots

Unit III

Nucleic acids: - types, structural organization and helix-coil transition energetics. Physicochemical techniques and macromolecular analysis
Biomolecular interaction: Protein-ligand, protein-protein, nucleic acid-protein and nucleic acid-ligand interactions.

Unit IV

Assembly of macromolecular complexes;- Ribosomes, chromatin, plasma membrane and viruses;
Nanoparticles;
Organisation of animal tissues.

Suggested Reading Material

1. D.Voet and J.G. Voet. Biochemistry, John Wiley & Sons.
2. D. Freifelder. Physical Biochemistry, W.H. Freeman & Company
3. I.H. Segal. Biochemical Calculations, John Wiley & Sons.
4. T.E. Creighton. Proteins-structure and Molecular Properties, W.H. Freeman & Company.
5. D. Freifelder, Essentials of Molecular Biology.
6. K. Wilson and K.H. Goulding. A Biologist's guide to principles and techniques of practical biochemistry.
7. T.G. Cooper. Tools of Biochemistry.
8. Hawk. Practical Physiological Chemistry.
9. R.H. Garrett and CM. Grisham. Biochemistry, Saunders College Publishers.

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Semester-I

Course no.: Zoo-102 **MM: 80**
Course Title: Techniques in Animal Sciences **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Microscopy- Principles of light, phase-contrast, fluorescence, scanning and transmission electron microscopy; X-ray diffraction; pH meter; Fixation and staining of the biological materials.

Units II

Principles and uses of biophysical methods: colorimeter; spectrophotometer; Spectroscopy: Visible, UV, ORD/CD, ESR, NMR, atomic absorption and plasma emission.

Unit III

Principles and applications of tracer techniques in biology; Radiation dosimetry, Radioactive isotopes and half life of isotopes; Effect of radiation on biological system; Autoradiography; Cerenkov radiation; Liquid scintillation spectrometry.
Cryopreservation for cells, tissue, organisms Cryotechniques for microscopy Freeze-drying for physiologically active substances

Unit IV

Separation techniques in biology
Molecular separations by gel-filtration, ion-exchange and affinity chromatography, Thin layer and gas chromatography; High pressure liquid (HPLC) chromatography, Electrophoresis and electrofocussing, Ultracentrifugation (velocity and buoyant density).

Suggested Reading Material

1. Animal Cell Culture - A practical approach, Ed. John R.W. Masters, IRL Press.
2. Introduction to Instrumental analysis, Robert Braun. McGraw Hill International Editions.
3. Shukla and Upadhyaya. Experimental Science
4. Randhir Singh. Practicals in Biochemistry
5. A Biologists Guide to Principles and Techniques of Practical Biochemistry, K. Wilson & K.H. Goulding, ELBS Edn.

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Semester-I

Course no.: Zoo -103 **MM: 80**
Course Title: Animal Cell Biology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Introduction-experimental systems in Cell Biology;
Structure of pro-and eukaryotic cells;
Structure and function of cells and intracellular organelles of both prokaryotes and eukaryotes); Significance of intracellular compartments;
Mechanism of cell division including (mitosis and meiosis) and cell differentiation;
Cell-cell interaction.

Unit II

Biomembranes: Molecular composition and arrangement functional consequences; Model membranes; Liposomes.
Transport across cell membrane-
Diffusion, active transport and pumps, uniports, symports and antiports; Membrane potential; Co-transport by symporters or antiporters; Transport across epithelia.
Cytoskeleton:
Microfilaments and microtubulus-structure and dynamics; Microtubules and mitosis; Cell movements-intracellular transport, role and kinesin and dynein; Cilia and Flagella

Unit III

Cell-Cell signaling:
Signal transduction mechanisms;
Cell surface receptors;
Second messenger system;
MDP kinase pathways;
Signalling from plasma membrane to nucleus.
Cell-Cell matrix, adhesion and communication
Ca++ dependent & independent homophilic cell-cell adhesion; Gap junctions and connexins
Cell matrix adhesion: Integrins, Collagen, Non-collagen components & Cellulose fibril synthesis and orientation

Unit IV

Cell cycle: Cyclines and cyclin dependent kinases and Regulation of CDK-cycline activity
Genetic analysis in Cell Biology: Nucleus; Mitochondria and chloroplasts and their genetic organization;
Biology of cancer, Biology of aging and Apoptosis-definition, mechanism and significance

Suggested Reading Material

1. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Book, Inc., USA.
2. Molecular Biology of the Cell, B.Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts, and J.D. Watson. Garland Publishing Inc., New York.

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Semester-I

Course no.: Zoo-104 **MM: 80**
Course Title: Computer and Biostatistics **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Computer peripherals and hardware description- computer system design, recognition and structure of different components of a computer system and their respective usage. Input/output and storage devices. Introduction of internet.Office application: MS office 2000 including MS word, MS excel and MS power point Overview of Windows XP. Number system and flow charts in computing language. DOS internal and external commands

Generations of programming languages, system and application software; Introduction of programming in BASIC.

Unit II

Collection, classification and tabulation of data. Frequency distribution, Diagrammatic and Graphical presentation of statistical data, Sampling techniques. Central tendency, Dispersion, coefficient of variation; Standard error; Confidence limits; Skewness and Kurtosis Measures of Relationship: Correlation ,Regression, Non-parametric tests

UNIT III

Probability: Approaches to measurement of Probability, Random experiments, sample space, events. Mathematical definition of probability of an event.

Probability distributions: - Distribution of Binomial, Poisson and Normal Distributions and their properties; (including problems).

UNIT IV

Testing of Hypothesis, Chi-square test,'t' and 'f' test. Analysis of variance for one-way classified data, and two-way classified data.

Suggested Reading Material

1. Batschelet, E. Introduction to mathematics for life scientists. Springer-Verlag, Berling.
2. Snedecor, G.W. and W.G. Cochran. Statistical methods. Affiliated East-West Press, New Delhi (Indian ed.).
3. Green, R.H. Sampling design and statistical methods for environmental biologists. John Wiley & Sons, New York.
4. Computer fundamentals: concepts, systems and application by PK Sinha. BPB publications
5. Computer fundamentals (Paperback) by Ashok Arora, Shefali Bansai and Shefali Bansal. Excel Books
6. Discovering computers: fundamentals (paperback) by Gary B. Shelly. Pub: Course technology
7. Discovering computers: fundamentals,4th ed. (Shelly Cashman) (paperback) by Grey B Shelly Thomas J Cashman and Misty E Vermaat. Pub: Course technology
8. Computer fundamentals architechture and organization (paper back) by B Ram. Pub: New age publications (academic)

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Semester-I

Course no.: Zoo -105 (i) **MM: 80**
Course title : Systems Biology [Programme elective] **Time: 3 Hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Systems Microbiology - 'The Cell as a Well-stirred Bioreactor'
Introduction Michaelis-Menten Kinetics
Equilibrium Binding Cooperativity: Michaelis-Menten Kinetics
Lambda Phage Multistability: A Genetic Switch in Lamba Phage
Synthetic Genetic Switches

Unit II

Systems Microbiology - 'The Cell as a Well-stirred Bioreactor'
Stability Analysis
Introduction *E. coli* Chemotaxis
Fine-tuned versus Robust Chemotaxis Models; Wrapping up Chemotaxis
Biological Oscillators; Genetic Oscillators; Biological Oscillators
Stochastic Chemical Kinetics: The Origin and Consequences of Noise in Biochemical Systems

Unit III

Cell Systems Biology - 'The Importance of Diffusion and Gradients for Cellular Regulation'
Introduction Cell Systems Biology: Fick's Laws
Local Excitation: Global Inhibition Theory & Model
Rapid Pole-to-pole Oscillations in *E. coli*
Models for Eukaryotic Gradient Sensing
Modeling Cytoskeleton Dynamics

Unit IV

Developmental Systems Biology - 'Building an Organism Starting From a Single Cell'
Quorum Sensing
Drosophila Development

Suggested Readings:

1. . Alberts, Bruce, et al. *Molecular Biology of the Cell.* 4th ed. New York: Garland Science, 2002.
2. Multistability Hasty, Jeff, Joel Pradines, Milos Dolnik, and J. J. Collins. "Noise-based Switches and Amplifiers for Gene Expression." *Proc. Natl. Acad. Sci. USA* 97, no. 5 (Feb 29, 2000): 2075-80.
3. Isaacs, Farren J., Jeff Hasty, Charles R. Cantor, and J. J. Collins. "Prediction and Measurement of an Autoregulatory Genetic Module." *PNAS* 100, no. 13 (June 24, 2003): 7714-19.
4. Synthetic Genetic Switches Gardner, Timothy S., Charles R. Cantor, and James J. Collins. "Construction of a Genetic Toggle Switch in *Escherichia coli*." *Nature* 403, no. 6767 (January 20, 2000): 339-42.
5. Modeling Escherichia coli chemotaxis Spiro, Peter A., John S. Parkinson, and Hans G. Othmer. "A Model of Excitation and Adaptation in Bacterial Chemotaxis." *Proc. Natl. Acad. Sci. USA* 94, no. 14 (July, 1997): 7263–68.
6. Oscillators Elowitz, Michael B., and Stanislas Leibler. "A Synthetic Oscillatory Network of Transcriptional Regulators." *Nature* 403, no. 6767 (January 20, 2000): 335-8.
   Atkinson, Mariette R., Michael A. Savageau, Jesse T. Myers, and Alexander J. Ninfa. "Development of Genetic Circuitry Exhibiting Toggle Switch or Oscillatory Behavior in *Escherichia coli*." *Cell* 113, no. 5 (May 30, 2003): 597-607.
8. Howard, Martin, Andrew D. Rutenberg, and Simon de Vet. "Dynamic Compartmentalization of Bacteria: Accurate Division in *E. Coli*." *Physical Review Letters* 87, no. 27 (December 31, 2001).
9. Eukaryotic Gradient Sensing Narang, Atul, K. K. Subramanian, and D. A. Lauffenburger. "A Mathematical Model for Chemoattractant Gradient Sensing based on Receptor-regulated Membrane Phospholipid Signaling Dynamics." *Annals of Biomedical Engineering* 29, no. 8 (2001): 677-91.
10. Postma, Marten, and Peter J. M. Van Haastert. "A Diffusion–Translocation Model for Gradient Sensing by Chemotactic Cells." *Biophysical Journal* 81, no. 3 (September, 2001): 1314-23.
11. Modeling Cytoskeleton Dynamics Dogterom, Marileen, and Stanislas Leibler. "Physical Aspects of the Growth and Regulation of Microtubule Structures." *Physical Review Letters* 70, no. 9 (March 1, 1993).
12. Cytrynbaum, E. N., V. Rodionov, and A. Mogilner. "Computational Model of Dynein-dependent Self-organization of Microtubule Asters." *Journal of Cell Science* 117, no. 8 (March 15, 2004): 1381-

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Semester- I

Course no.: Zoo -105 (ii) [Programme elective] **MM: 80**
Course Title: Communication skills in Life Science **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I
Scientific and technical writing: Preparation of scientific report, Thinking and planning, Information, ideas, order of writing, Paragraph writing proper use of verb, Nouns, pronouns, tense, use of MS office, excel, powerpoints for preparing a scientific report.

Unit II
Scientific presentation: Preparation of presentation, Order of material, Use of web information in presentation, Ethical/copyright issues in presentations, Title, objective, methodology and results presentation, Different ways to make impressive presentations.

Unit III
Oral presentations: General gesture for presentations, Speed, loudness, clarity during presentations, use of appropriate vocabulary during presentation, General discussions, scientific presentation, Sharing view and ideas.

Unit IV
Use of web to collect specific informtaion, Scientific paper and review writing, Correspondence with editors and reviewers, appropriate citations, copyright and Ethical issues in paper drafting, Acknowledgment, Keywords, Use of appropriate citations, usage of different softwares for manuscript preparation, usage of line-,bar-graphs, charts to describe the results.

Suggested readings: -

1. Rastogi, B.C., Bioinformatics, Concept, Skills & Applications, CBS Publications.
2. Richard Ellis, Communication Skills: Stepladders to sucess for professional,Gutenberg Press, Malta.
3. John W. Davis, Communication skills: aguide for engineering and applied science students, Prantics Hall, 2001.
4. Gupta S., Communication skills and Functional Grammer, University Science Press, New Delhi 110002.
5. Llyod M., Bor R., Communication skills for medicine, Elsevier press, Churchill Liverstone Elsevier.

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Semester- I

Course no.: Zoo-LC-I **M.M. : 150**
Course Title : Laboratory Course **Time : 6 Hrs.**

Tentative list of the proposed experiments

- To separate and identify sugar by TLC
- To prepare casein from milk
- To plot the calibration curve for protein estimation by Lowry method
- To plot standard curve for estimation of carbohydrate by anthrone method
- Estimation of creatinine in blood
- Colorimetric estimation of DNA and RNA321
- Separation and identification of amino acids by paper chromatography
- To study the effect of auxochromes on the absorption properties of chromophore using spectrophotometer
- To study the effect of pH on absorption properties of chromophore using spectrophotometer
- To study effect of solvent polarity on the absorption properties of chromophore using spectrophotometer
- Measurement of H_2 ion concentration in given sample with the help of pH meter
- Apply gravimetric methods to estimate the amount of sulphate in a given sample
- To determine standard plate count out of water, air and soil sample
- Ouchterlony double diffusion (antigen-antibody pattern)
- To analyse the given sample by SDS PAGE
- To perform gel chromatography for analysis of given sample
- Separation of molecules using ion exchange chromatography
- Separation and identification of amino acids by radial chromatography
- To study different stages of mitosis in onion root tips
- To perform protein estimation test with the help of Bradford method
- Estimation of DNA by diphenylamine reaction
- Determination of RNA by orcinol method
- Isolation of DNA of tissue
- Discuss the problems based on central tendency mean, median, mode, geometric mean, range and standard deviation
- Correlation and regression analysis
- Graphical representation of data
- Parametric and non parametric tests
- Study computer hardware and its parts
- Application of MS office in interpretation of biological data
- Programming in BASIC/C
- Biological Data Base assessment tools
- Analysis of biological information by any bioinformatics tool
- Preparation of presentation on suggested topic
- Reveiew writing on suggested topic
- Assessing and compilation of scientific data various parameters
- Microbial culture
- Microbial growth measurement methods
- Aseptic techniques in culture
- Effect of various parameters on culture
- Movements models in early life

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Semester-II

Course no.: Zoo -201 **MM: 80**

Course Title: Developmental Biology **Time: 3hrs**

Note: There shall be nine questions in total. One question is compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Animal development:
Developmental patterns in metazoans
Development in unicellular eukaryotes
Molecular basis of spermatogenesis
Oogenesis

Unit II

Molecular basis of multicellularity:
Fertilization
Cleavage types and significance
Comparative account of Gastrulation
Fate maps

Unit III

Early vertebrate development:
Neurulation and ectoderm
Mesoderm and endoderm
Cytoplasmic determinants and autonomous cell specification:
Cell commitment and differentiation
Cell specification in nematodes
Germ cell determinants
Germ cell migration
Progressive cell - Cell interaction and cell specification fate

Unit IV

Genetics of pattern formation
Caenorhabditis: Vulva formation
Drosophila:
Maternal genes and formation of body axis
Segmentation genes
Homeotic genes function
Imaginal disc development
Vertebrates
Axes formation and HOX genes
Limb formation in chick
Proximate tissue interactions
Genetics of axis specification in Drosophila
Tetrapod limb and eye development

Suggested Reading Material

1. S.F. Gilbert. Developmental Biology. Sinauer Associates Inc., Massachusetts.
2. Ethan Bier. 'The Coild Spring'. Cold Spring Harbor Laboratory Press, New York.
3. Sastry KV and Shukla V. Text Book of Development Zoology, Rastogi Publication, Meerut

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Semester-II

Course no.: Zoo-202 **MM: 80**
Course Title: Advanced Physiology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Digestive system:
Feeding mechanisms and regulation
Physiology of mammalian ingestion, digestion, absorption, assimilation and egestion;
Dentition in mammals

Unit II

Respiratory system:
Respiratory organs and respiratory pigments;
Control of respiration;
Structure of heart and blood vessel;
Circulation and composition of body fluids and their regulation;
Blood coagulation.

Unit III

Excretion and osmoregulation:
Patterns of nitrogen excretion among different animal groups;
Physiology of excretion;
Osmoregulation in different mammalian groups;

Unit IV

Muscle and Receptor physiology:
Receptor physiology -
Mechanoreception
Photoreception
Chemoreception
Equilibrium reception
Muscles: structure and function;
Neuromuscular transmission and nerve conduction.

Suggested Reading Material

1. Eckert, R. Animal Physiology: Mechanisms and Adaptation. W.H. Freeman and Company, New York.
2. Hochachka, P.W. and'Somero, G.N.Biochemical Adaptation. Princeton, New Jersey.
3. Hoar, W.S. General and Comparative Animal Physiology, Prentice Hall of India.
4. Schiemdt Nielsen. Animal Physiology: Adaptation and Environment. Cambridge.
5. Strand, F.L. Physiology: A regulatory Systems Approach. Macmillan Publishing Co., New York.
6. Pummer, L. Practical Biochemistry, Tata McGraw-Hill.
7. Prosser, C.L. Environmental and Metabolic Animal Physiology. Wiley-Liss Inc., New York.
8. Willmer, P.G. Stone, and I. Johnston. Environmental Physiology. Blackwell Sci. Oxford, UK, 644pp.
9. Newell, R.C. (ed.) 1976. Adaptation to environment. Essays on the physiology of marine animals. Butterworths, London, UK, 539pp.
10. Townsend, C.R. and P. Calow. Physiological Ecology: An evolutionary approach to resource use. Blackwell Sci. Publ., Oxford, UK.
11. Alexander, R.M.N. Optima for animals. Princeton Univ. Press, Princeton, NJ.
12. Johnston, I.A., & A.F. Bennett (eds.). Animals and Temperature: Phenotypic and evolutionary adaptation. Cambridge Univ. Press, Cambridge, UK.
13. Louw, G.N. Physiological animal ecology. Longman Harloss, UK.
14. Sastry KV and Shukla V. Text Book of Physiology and Biochemistry, Rastogi Publication, Meerut

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Semester-II

Course no.: Zoo -203 **MM: 80**
Course Title: Molecular Biology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

History and Scope of Molecular Zoology

DNA replication: Prokaryotic and eukaryotic DNA replication, Mechanics of DNA replication, Enzymes and accessory proteins involved in DNA replication

Unit II

Transcription: Prokaryotic and Eukaryotic transcription; RNA polymerases; General and specific transcription factors; Regulatory elements and mechanisms of transcription regulation

Post-transcriptional modifications in RNA: 5'-Cap formation; Transcription termination; 3'-end processing and polyadenylation; Splicing, Editing; Nuclear export of mRNA; mRNA stability and Transcriptional and post-transcriptional gene silencing.

Unit III

Translation: Prokaryotic and eukaryotic translation; The translational machinery; Mechanisms of initiation, elongation and termination; Regulation of translation; Genetic code and Co- and post-translational modifications of proteins

Unit IV

Recombination and repair: Holiday junction, gene FLP/FRT and Cre/lox recombination; RecA and other recombinases and DNA repair mechanisms.

Biomaterials and their significance

Suggested Reading Material

1. Molecular Biology of the Gene, J.D. Watson, N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. The Benjamin/Cummings Pub. Co., Inc., California.
2. Molecular Cell Biology, J. Darnell, H. Lodish and D. Baltimore Scientific American Books, Inc., USA.
3. Molecular Biology of the Cell, B. Alberts, D. Bray, J. Lewis, M. Raff, K. Roberts and J.D. Watson. Garland Publishing Inc., New York.
4. Gene VI, Benjamin Lewin, Oxford University Press, U.K.
5. Molecular Biology and Biotechnology. A comprehensive desk reference, R.A. Meyers (Ed.), VCH Publishers, Inc., New York.
6. Molecular Cloning: a Laboratory Manual, J. Sambrook, E.F. Fritsch and T. Maniatis, Cold Spring Harbor Laboratory Press, New York.
7. Introduction to Practical Molecular Biology, P.D. Dabre, John Wiley & Sons Ltd., New York.
8. Molecular Biology LabFax, T.A. Brown (Ed.), Bios Scientific Publishers Ltd., Oxford

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Semester-II

Course no.: Zoo -204 **MM: 80**
Course Title: Cell Function and Metabolic Regulation **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Structure of atoms, molecules and chemical bonds;
Energy metabolism (concept of free energy); Thermodynamic principles in biology; Energy rich bonds; Weak interactions; Coupled reactions and oxidative phosphorylations; Group transfer; Kinetics, dissociation and association constants; Biological energy transducers; Bioenergetics and steady-state conditions of living organisms.
Degradation of palmitic acid, phenylalanine, tryptophan and nucleotides in animals.

Unit II

Glycolysis and TCA cycle; Glycogen breakdown and synthesis; Interconversion of hexoses and pentoses.
Energy metabolism and high energy compounds:
Redox potentials
Mitochondrial electron transport chain
Oxidative phosphorylation

Unit III

Storage and utilization of biological energy
Biosynthesis of triglycerides; Cholesterol; Phospholipids; Prostaglandins; Sterols.
Biosynthesis of urea, proline, aspartic acid, Uridylic acid, adenylic acid, glucose, glutathione.

Unit IV

Classification and nomenclature of enzymes; Regulation of enzymatic activity; Active sites; Coenzymes: Activators and inhibitors, isoenzymes, allosteric enzymes; Ribozyme and abzyme.
Enzyme Kinetics (negative and positive cooperativity);
Metabolic engineering;
Immobilised enzymes and their applications.

Suggested Reading Material

1. D. Voet and J.G. Voet. Biochemistry, J. Wiley & Sons.
2. R.L. Foster, Nature of Enzymology.
3. Lodish et al. Molecular Cell Biology.
4. Annual Reviews of Biochemistry.
5. Garett and Grisham, Biochemistry.

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Semester-II

Course no.: Zoo-205 (i) **MM: 80**
Course Title: Evolutionary Biology (Programme elective) **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Genetics of speciation and Molecular Evolution:
Phylogenetic and biological concept of species
Patterns and mechanisms of reproductive isolation
Models of speciation (Allopatric, sympatric, parapatric)
Gene Evolution
Evolution of gene families

Unit II

Origin of theories of life
Phylogenetic gradualism and punctuated equilibrium
Major trends in the origin of higher categories
Micro-and Macro-evolution

Unit III

Molecular phylogenetics:
How to construct phylogenetic trees?
Phylogenetic inference- Distance methods, parsimony methods.
Immunological techniques
Amino acid sequences and phylogeny
Nucleic acid phylogeny-DNA-DNA hybridizations, Nucleotide sequence comparisons and homologies
Molecular clocks

Unit IV

Metapopulations
Monitoring natural populations
Why small populations become extinct?
Loss of genetic variations
Conservation of genetic resources

Suggested Reading Material

1. Dobzhansky, Th. Genetics and Origin of Species. Columbia Unvieristy Press.
2. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
3. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
4. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
5. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
6. King, M. Species Evolution-The role of chromosomar change. The Cambridge University Press, Cambridge.
7. Merrel, D.J. Evolution and Genetics. Holt, Rinchart and Winston, Inc.
8. Smith, J.M. Evolutinary Gentics. Oxford University Press, New York.
9. Strikberger, M.W. Evolution. Jones and Bartett Publishers, Boston London

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Semester - II

Course no : Zoo -205 (ii) **MM: 80**
Course Title: Animal Biotechnology (Programme elective) **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Cell and tissue culture in animals: Media preparation and sterilization; Inoculation and growth monitoring; Biochemical mutants and their use; cell harvesting methods; Primary culture; Cell line; Cell clones; Cell proliferation measurements and Cell viability testing; Micropropagation; Haploidy; Protoplast fusion and somatic hybridization; Cybrides.

Unit II

Principles and methods of genetic engineering and Gene targeting; Applications in agriculture, health and industry.
Antisense and Ribozyme technology: Molecular mechanisms of antisense molecules; Inhibition of splicing, polyadenylation and translation; Disruption of RNA structure and capping; Biochemistry of ribozyme; hammerhead, hairpin and other ribozymes; Strategies for designing ribozymes; Application of antisense and ribozyme technologies

Unit III

Biochemistry and molecular biology of cancer; Genetic and metabolic disorders; Hormonal imbalances.
Drug metabolism and detoxification; Genetic load and genetic counseling.
Gene transfer methods in animals; Transgenic biology; Allopheny; Hybridoma technology.

Unit IV

Industrial processes: Production of organic acids, amino acids, proteins, antibiotics and pharmaceuticals
Bioreactors: designing and operation
An introduction to Genomics, Proteomics, Computational Biology, Biosensors, Biofuels & Biopesticides.

Suggested Reading Material

1. Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
2. Fairbanks, D.J. and W.R. Anderson. Genetics - The Continuity of Life. Brooks/Cole Publishing Company ITP, NY, Toronto.
3. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An introduction to genetic analysis. W.H. Freeman and Company, New York.
4. Lewin, B. Genes. VII. Oxford University Press, Oxford, New York, Tokyo.
5. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.

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Semester- II

Course no.: Zoo-LC-II **M.M. : 150**
Course Title : Laboratory Course **Time : 6 Hrs.**
List of the proposed experiments

- Media preparation and sterilization
- Inoculation and growth monitoring
- Animal tissue culture
- Plasmid isolation
- Restriction digestion
- Ligation
- Genomic DNA extraction
- Analysis of isozymes/ proteins on SDS page
- To dissect out *Drosophila* larvae to prepare the polytene chromosome slide and arm identification
- To prepare the permanent slide of insect larvae and its study
- To dissect out Drosophila larvae and to take out the imaginal discs
- To study the effect of temperature on life cycle of *Drosophila melanogas*
- To study different developmental stages with the help of charts
- To study the effect of varying pH on salivary amylase
- To determine the effects of varying temperatures on the activity of salivary amylase
- To study the rate of respiration by aquatic animals
- To determine the concentration of free CO_2 in variety of given samples
- Determination of dissolved O_2 of given samples by Wrinklers method
- Isolation of monocytes
- To study hematological parameter in blood
- To study the effect of osmolarity of solution on RBC
- To study the knee jerk reflex in man
- To test the urine for urea,proteins,ketones and sugar
- Separation and identification of amino acids by vertical paper chromatography
- Separation and identification of amino acids by radial chromatography
- To separate and identify the sugar by thin layer chromatography
- To perform extraction of nucleic acids
- To perform isolation of DNA
- To separate DNA sample by agarose gel electrophoresis
- To perform western blotting to analyse the given protein sample
- DNA gel extraction
- To determine the protein concentration in the given albumin by Biuret method
- To plot the calibration curve for glucose with the help of spectrophotometer
- Qualitative estimation of salivary amylase
- To investigate the effect of temperature on enzyme catalysed reaction
- To investigate the effect of varying pH on the activity of salivary amylase
- Quantitative estimation of protein ,glucose, DNA and RNA
- Purification of carbohydrates/protein /lipids by column chromatography
- To prepare the phylogenetic tree
- To study genetic variability with the help of thumb impression (Dermatography)
- To determine the Tm of the DNA sample
- To test the genetic variability by PTC test
- To study genetic variability in human population
- To show reproductive isolation in *Drosophila* species
- To perform Immunoelectrophoresis
- To perform Countercurrent Immunoelectrophoresis
- Wild life/ conservation report

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Semester-III

Course no.: Zoo-301 **MM: 80**

Course Title: Animal diversity of Invertebrates **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Definition and basic concepts of biosystematics and taxonomy

Species concepts - species category, different species concepts; sub-species and other infra-specific categories.

Principles and theories of biological classification, hierarchy of categories.

Unit II

Classification of Non-chordates (Protozoa to helminthes): Salient Features and classification up to classes with reference to diversity in animal form and function, like:

i. Habit and habitat
ii. Support and Movement
iii. Nutrition
iv. Gas exchange & transport
v. Excretory organs
vi. Sensory system
vii. Reproductive patterns
viii. Development and Larval characters.

General account: Aquiferous and skeleton system in Porifera; Polymorphism in cnidarians; parasitic adaptations in helminthes; Larval form and their significance.

Unit III

Classification of Non-chordates (Arthropoda to Echinodermata): Salient Features and classification up to classes with reference to diversity in animal form and function, like:

i. Habit and habitat
ii. Support and Movement
iii. Nutrition
iv. Gas exchange & transport
v. Excretory organs
vi. Sensory system
vii. Reproductive patterns
viii. Development and Larval characters.

General account: Larval form and their significance in Arthropoda to Echinodermata; Coelom; Torsion and detorsion in Mollusca; Ambulacral system;

Unit IV

Brief accounts of life history, mode of infection and pathogenicity of the following pathogens with reference to man prophylaxis and treatment:

(a) Pathogenic protozoans: Trypanosoma, Leishmania and Plasmodium.

(b) Pathogenic helminths: Fasciolopsis, Schistosoma and Wuchereria.

Molecular, cellular and physiological basis of host-parasite interactions i.e. changes in organs.

List of Recommended Books

1. Kettle, D.S: Medical Veterinary Entomology (CAB International).
2. Cheng, T.C: General Parasitology, (Academic Press).
3. Boolotian and Stiles: College Zoology (Macmillan)
4. Campbell: Biology (Benjamin)
5. Marshall and Williams: Text Book of Zoology
6. Wolfe: Biology the Foundations (Wadsworth)'
7. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
8. Prescott: Cell (Jones & Bartlett).
9. M.Kato. The Biology of Biodiversity, Springer.
10. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
11. E.O. Wilson. Biodiversity, Academic Press, Washington.
12. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company
13. E. Mayer. Elements of Taxonomy.
14. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
15. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

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Semester-III

Course no.: Zoo-302 **MM: 80**

Course Title: Molecular Endocrinology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Definition and scope of endocrinology; Structure of various endocrine glands; Hormones: Classification, structure and function; Ontogeny and phylogeny of endocrine glands.

Unit II

Chemical nature of hormones
Purification and characterization of hormones
Production of hormones by biochemical and rDNA technologies

Unit III

Hormone action and regulation
Hormone receptors - identification, quantitation purification and physico-chemical properties
Membrane receptors - structure and signal transduction mechanisms
G-proteins
Nuclear receptors - structure and function. Orphan receptors
Metabolic and developmental hormones

Unit IV

Biosynthesis and secretion of hormones
Biosynthesis of steroid hormones *de novo.*
Biosynthesis and amino-acid derived small size hormones (eg:_T_4, Epinephrine, etc.).
Biosynthesis and simple peptide hormones-Pre and Prohormones.
Neuroendocrine regulation

Suggested Reading Material

1. E.J.W. Barrington. General and Comparative Endocrinology, Oxford, Clarendon Press.
2. P.J. Bentley. Comparative Vertebrate Endocrinology. Cambridge University Press.
3. R.H. Williams. Text Book of Endocrinology, W.B. Saunders
4. C.R. Martin. Endocrine Physiology. Oxford Univ. Press.
5. A. Gorbman et al. Comparative Endocrinology, John Wiley & Sons
6. Benjamin Lewin, Genes VII, Oxford University Press.
7. L.P. Freedman. Molecular Biology of Steroid and Nuclear Hormone Receptors, Birkhauser.
8. Guyton. A text Book of Human Physiology
9. G. Litwack. Biochemical Actions of Hormones, Academic Press.

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Semester-III

Course no.: Zoo-303 **MM: 80**
Course Title: Immunology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Antigen; Structure and functions of different clauses of immunoglobulins; Primary and secondary immune response; Organization and structure of lymphoid organs, Cells of the immune system and their differentiation and Lymphocyte traffic; Innate and Acquired Immunity; Humoral and cell mediated immunity.

Unit II

Major Histocompatibility Complex in mouse and HLA system in human: MHC haplotypes, Class I and class II molecules, Cellular distribution, Peptide binding, Expression and diversity and Disease susceptibility and MHC/HLA.

Mechanism of immune response and generation of immunological diversity; Genetic control of immune response, Effector mechanisms; Applications of immunological techniques.

Unit III

Complement System; Cytokines: Structures and functions, Cytokine receptors and Cytokines and Immune response and Immunological tolerance; Hypersensitivity and immune responses to infection agents especially intracellular parasites.

Unit IV

Disorders of immune system, self tolerance and autoimmunity

Immunosuppression, immunodeficiency involving only B cells, only T cells, Severe combined immunodeficiency (SCID), AIDS

Primary antigen, antibody reactions, radioimmunoassay, ELISA, secondary antigen-antiobody reaction, precipitations and agglutinations, immunoelectrophoresis.

Suggested Reading Material

1. Kuby. Immunology, W.H. Freeman, USA.
2. W. Paul. Fundamentals of Immunology.
3. Totora et al. Microbiology
4. Pelczar. A text book of microbiology
5. I.M. Roitt. Essential Immunology, ELBS Edition.

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Semester-III

Course no.: Zoo-304 **MM: 80**
Course Title: Molecular Cytogenetics **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Biology of Chromosomes:

Molecular anatomy of eukaryotic chromosomes
Metaphase chromosome: Centromere, Kinetochore, Telomere and its maintenance
Heterochromatin and Euchromatin
Giant chromosomes: Polytene and lampbrush chromosomes.

Sex chromosomes, sex determination and dosage compensation in *C. elegans*, *Drosophila* & Humans

Unit II

Imprinting: Genes, chromosomes and genomes.

Cytogenetic implications and consequences of structural changes and numerical alterations of chromosomes.

Human Cytogenetics:

Techniques in human chromosome analysis - molecular cytogenetic approach.
Human Karyotype - banding - nomenclature
Numerical and structural abnormalities of human chromosomes - syndromes.
Mendelian and chromosome based heritable diseases in humans.

Unit III

Molecular mapping of genome

Genetic and physical maps
Physical mapping and map-based cloning
Choice of mapping population; Simple sequence repeat loci
Southern and flourescence *in situ* hybridization, DNA finger printing, Flow cytometry
Automated karyotyping, Chromosome painting for genome analysis
Chromosome microdissection and microcloning

Unit IV

Molecular markers in genome analysis:

RFLP, RAPD and AFLP analysis
Molecular markers linked to disease resistance genes
Application of RFLP in forensic, disease prognosis, genetic counseling, pedigree, varietal analysis

Genome analysis - *Humans*, *Drosophila*, yeast, and microbial genomes.

Suggested Reading Material

1. Atherly, A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics - The Continuity of Life. Brooks/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons. Inc., NY.
5. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An introduction to genetic analysis. W.H. Freeman and Company, New York.
6. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
7. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY.
8. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.

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Semester-III

Course no.: Zoo-305 (i) **MM: 80**
Course Title: Population Genetics **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Concept of evolution: Darwinism and Neo-Darwinism
Hardy-Weinberg law of genetic equilibrium
A detailed account of destabilizing forces: (i) Natural selection (ii) Mutation (iii) Genetic drift (iv) Migration (v) Meiotic drive

Unit II

Quantifying genetic variability
Genetic structure of natural populations
Phenotypic variation
Models explaining changes in genetic structure of populations
Factors affecting human disease frequency
Mendelian basis of transmission of disease

Unit III

Molecular population genetics
Patterns of change in nucleotide and amino acid sequences
Ecological significance of molecular variations
Emergence of Non-Darwinism-Neutral Hypothesis

Unit IV

Genetics of quantitative traits in populations
Analysis of quantitative traits
Quantitative traits and natural se
Estimation or heritability
Genotype-environment interactions
Inbreeding depression and heterosis
Molecular analysis of quantitative traits
Phenotypic plasticity

Suggested Reading Material

1. Dobzhansky, Th., F.J. Ayala, G.L. Stebbines and J.M. Valentine. Evolution. Surjeet Publication, Delhi.
2. Futuyama, D.J. Evolutinary Biology, Suinuaer Associates, INC Publishers, Dunderland.
3. Haiti, D.L. A Primer of Population Genetics. Sinauer Associates, Inc, Massachusetts.
4. Jha, A.P. Genes and Evolution. John Publication, New Delhi.
5. King, M. Species Evolution-The role of chromosomal change. The Cambridge University Press, Cambridge.
6. Dobzhansky, Th. Genetics and Origin of Species. Columbia University Press.

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Semester - III

Course no : Zoo -305 (ii) **MM: 80**

Course Title: Environmental Biology **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Interactions between environment and biota; Concept and types of ecosystem, Stability and complexity of ecosystems; Productivity and biodegradation in different ecosystems; Limiting factor; food chain and energy flow, productivity and biogeochemical cycles (N_2, P, C and S); Ecological pyramids and recycling; Community structure and organisation;

Unit II

Wild life: Speciation and extinctions; Magnitude and distribution of biodiversity, economic value, wildlife biology, conservation strategies, cryopreservation and sustainable development. Animal trafficking and poaching.

Unit III

Environmental pollution. Global environmental change; biodiversity, status, monitoring and documentation; Major drivers of biodiversity change, biodiversity management approach.

Microbiology of water, air, soil and sewage

Unit IV

Characterisitic of population: population growth curves

Concept of metapoulations: demes and dispersals and interdemic extinctions

Age structured population

Biogeographical realms of India

Suggested Reading Material

1. Jorgensen, S.E. Fundamentals of ecological modeling. Elsevier, New York.
2. Lendren, D. Modelling in behavioral ecology. Chapman & Hal, London, UK.
3. Sokal, R.R. and F.J. Rohlf. Biometry. Freeman, San Francisco.
4. Odum : Ecology (Amerind)
5. Odum : Fundamentals of Ecology (W.B. Saunders)
6. Ricklefy : Ecology, (WH Freeman)
7. Turk and Turk : Environmental Science (W.B. Saunders)
8. JP Yadav A text book of Environmental Education, GVS publisher, New Delhi

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Semester- III

Course no.: Zoo-LC-III **M.M. : 150**
Course Title : Laboratory Course **Time : 6 Hrs.**

Tentative list of the proposed experiments

- To study and classify representative animal specimen belonging to protozoans to echinodermata with charts and available materials.
- To show the dissection of the representative animals like leech, pila and grasshopper for their anatomical studies of various systems with the help of CD.
- To study the microscopic fauna from various samples
- To study the life cycle of parasites
- To prepare the dichotomous key of the Porifera
- To prepare the dichotomous key of the Coelenterata
- To prepare the dichotomous key of the Arthrophoda
- To prepare a phylogenetic tree on the basis of taxonomic characteristics of annelida
- To prepare phylogenetic tree on the basis of taxonomic character revealing their heirarchial position of Echinodermata
- To prepare phylogenetic tree on the basis of taxonomic character revealing their heirarchial position of Mollusca
- To identify different endocrine glands with the help of charts
- To study endocrine glands of animals with the help of charts
- To calculate gonadosomatic index
- To study the endocrine glands in the animal with the help of CD and charts
- To study the effect of insulin on glucose concentration
- To demonstrate quantitative human TSH in serum or plasma samples
- To determine dissolved O_2, free CO_2, BOD, COD, salinity and hardness content in polluted and control samples
- To study presence of pollutants specific microbes in samples
- To determine physiochemical characteristics of polluted water and soil
- To study concentration of air pollutant with the help of high volume sampler in the air
- To study concentration of air pollutant with the help of personal sampler around the person
- Spirometric analysis of pollution impact and its implications
- Observation of sex chromatin (Barr bodies) in buccal epithelial cells of human female
- To study the effect of UV rays on the *Drosophila melanogaster*
- To analyse the restriction pattern by agarose gel electrophoresis and to map restriction plasmid sites on plasmid DNA
- To prepare ligation lambda/E CORI digest using T_4 DNA ligase and amylase ligated sample by agarose gel electrophoresis
- To study normal human karyotype
- To study chromosomal abnormalities
- To study the various human pedigrees
- Gene mapping by TPT cross
- Study of chromosomes slides (autosomes and sex chromosomes)
- To study primary and secondary sexual characteristics
- To find the blood group of own blood
- To find the Rh factor of own blood group
- To estimate the amount of Hb present in human blood
- To estimate the TLC present in $1mm^3$ volume
- Quantitative assay of precipitation
- Rocket immunoelectrophoresis
- Separation of lymphocytes
- Sandwich enzyme linked immunosorbant assay
- Haemagglutination test
- To prepare food material for *Drosophila* culture and maintenance of its population
- To study the genetic variability in human population
- To dissect out the *Drosophila* larva to prepare the polytene chromosome slide
- To identify male and female *Drosophila melanogaster*
- To solve numerical based problems on Hardy Weinberg law
- To study life cycle of *Drosophila melanogaster*
- To demonstrate reproductive isolation in *Drosophila* species in hybridization experiments

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Semester-IV

Course no.: Zoo-401 **MM: 80**
Course Title: Animal diversity of Vertebrates **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Taxonomic keys-different kinds of taxonomic keys, their merits and demerits.
Process of typification and different Zoological types.
International code of Zoological Nomenclature (ICZN) - its operative principles, interpretation and application of important rules, Zoological nomenclature; formation of scientific names of various taxa.

Unit II

Trends in biosystematics:
Chemotaxonomy
Cytotaxonomy
Molecular taxonomy
Taxonomic procedures-taxonomic collections, preservation, curetting process of identification.
Taxonomic characters: different kinds and their significance
Systematic publications: - different kinds of publications.

Unit III

Principles of classification
Classification of Chordates (Hemi-chordates to amphibians): Salient Features and classification up to classes with reference to diversity in animal form and function, like:
Habit and habitat, Support and Movement, Nutrition
Gas exchange & transport
Excretory organs Sensory system Reproductive .
patterns Development and Larval characters
General account: Dipnoi; Migration of fishes; Parental care in fishes and amphibians;

Unit IV

Principles of classification
Classification of Chordates (reptilians to mammals): Salient Features and classification up to classes with reference to diversity in animal form and function, like:
Habit and habitat, Support and Movement, Nutrition
Gas exchange & transport, Excretory organs,
Sensory system, Reproductive patterns
Development and Larval characters.
Flight adaptation in birds;
Migration of birds. Evolution of
Horse and man.

Suggested Reading:

1. Boolotian and Stiles: College Zoology (Macmillan)
2. Campbell: Biology (Benjamin)
3. Marshall and Williams: Text Book of Zoology
4. Wolfe: Biology the Foundations (Wadsworth)'
5. Parker & Haswell: Text Book of Zoology Vol.II (Macmillan)
6. Prescott: Cell (Jones & Bartlett).
7. M.Kato. The Biology of Biodiversity, Springer.
8. J.C. Avise. Molecular Markers, Natural History and Evolution, Chapman & Hall, New York.
9. E.O. Wilson. Biodiversity, Academic Press, Washington.
10. G.G. Simpson. Principle of animal taxonomy, Oxford IBH Publishing Company.
11. E. Mayer. Elements of Taxonomy.
12. E.O. Wilson. The Diversity of Life (The College Edition), W.W. Northern & Co.
13. B.K. Tikadar. Threatened Animals of India, ZSI Publication, Calcutta.

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Semester-IV

Course no.: Zoo-402 **MM: 80**
Course Title: Microbial Genetics **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Structure, classification, reproduction and physiology of bacteria, viruses and protozoa (a general accounts only).

Bacteria: transformation, transduction, conjugation and Bacterial chromosome.

Bacteriophages: Types, structure and morphology of T_4 phage.

Unit II

Somatic cell genetics

Cell fusion, cybrids and hybrids - agents and mechanism of fusion

Heterokaryon - Selecting hybrids and chromosome segregation Radiation hybrids, hybrid panels and gene mapping

Cytogenetic effects of ionising and non-ionising radiations.

Unit III

Regulation of gene expression in prokaryotes and eukaryotes; Attenuation and antitermination; Operon concept; DNA methylation; Heterochromatization; Regulatory sequences and transacting factors.

Unit IV

Genome analysis

C-value paradox, detailed account of various models of prokaryotic genomes, viral genome and organization of genes in organelle genomes.

Transposable elements in prokaryotes and eukaryotes. Role of transposable elements in genetic regulation. Gene therapy

Suggested Reading Material

1. Atherly, A.G., J.R. Girton and J.F. McDonald. The Science of Genetics. Saunders College Publishing, Harcourt Brace College Publishers, NY.
2. Brooker, R.J. Genetics: Analysis and Principles. Benjamin/Cummings, Longman Inc.
3. Fairbanks, D.J. and W.R. Anderson. Genetics - The Continuity of Life. Brooks/Cole Publishing Company ITP, NY, Toronto.
4. Gardner, E.J., M.J. Simmons and D.P. Snustad. Principles of Genetics. John Wiley and Sons. Inc., NY.
5. Totora et al. Microbiology
6. Griffiths, A.J.F., J.H. Miller, D.T. Suzuki, R.C. Lewontin and W.M. Gelbart. An introduction to genetic analysis. W.H. Freeman and Company, New York.
7. Lewin, B. Genes. VI. Oxford University Press, Oxford, New York, Tokyo.
8. Pelczar. A text book of microbiology
9. Snustad, D.P. and M.J. Simmons. Principles of Genetics. John Wiley and Sons. Inc., NY.
10. Watson, J.D., N.H. Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner. Molecular Biology of Genes. The Benjamin/Cummings Publishing Company Inc., Tokyo.

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Semester-IV

Course no.: Zoo-403 **MM: 80**
Course Title: Biosafety & ethics in science **Time: 3hrs**

Note: There shall be nine questions in total. One question will be compulsory (short answer type) covering the entire syllabus and remaining eight questions will be set two from each unit. Students are required to attempt one from each unit.

Unit I

Properties of Radiation, Mechanism of Radioactive Decay, Beta & Gamma emission, Interactions of beta and gamma radiation with matter, electron capture, Decay schemes and energy level diagrams. The laws of Radioactive Decay. Physical, biological and effective half lives, Radionuclide hazards.

Unit II

Radiation measurement – monitoring, Personal monitoring: TLD's film. Contamination monitoring: Survey instruments, wipe tests, Accidents and emergencies, Spills & Personnel contamination.

Unit III

Medical emergencies: including death of patient, Loss of radioactive sources. Internal exposure – contamination control; External exposure – shielding, distance, time; Safe handling of radioactive sources. Activity in body fluids – urine, blood, breast, milk, etc.

Unit IV

Ethical: somatic and germ line gene therapy, clinical trials, the right to information,ethics committee function. Biosafety containment facilities, biohazards, genetically modified organisms (GMOs), living modified organisms (LMOs)

Suggested Readings:-

1. Radioisotope Gauges for Industrial Process Measurements (Measurement Science and Technology) by Geir Anton Johansen and Peter Jackson (Jul 26, 2004).
2. Radioisotope Laboratory Techniques by R. A. Faires, etc. and G. G. J. Boswell (Dec 1980).
3. Radiotherapy in Practice: Radioisotope Therapy by Peter J. Hoskin (Mar 22, 2007).
4. Radioisotopes in Biology (Practical Approach Series) by Robert J. Slater (Feb 1, 2002).
5. Clinical Use of Radioisotopes by william beierwaltes (1957) .
6. Biological Safety: Principles And Practices (Biological Safety: Principles & Practices) by Diane O., Ph.D. Fleming and Debra Long Hunt (Aug 30, 2006).
7. Biosafety in the Laboratory: Prudent Practices for Handling and Disposal of Infectious Materials by National Research Council (U. S.) (Dec 1989) .
8. Genetically Modified Organisms: A Guide to Biosafety (Cabi) by George T Tzotzos (May 1995).
9. Biotechnology, Biosafety, and Biodiversity: Scientific and Ethical Issues for Sustainable Development by Sivramiah Shantharam, Jane F. Montgomery and Satellite Symposium on Biotechnology and Biodiversity (Apr 1999).

MAHARSHI DAYANAND UNIVERSITY ROHTAK
DEPARTMENT OF ZOOLOGY
M. Sc. ZOOLOGY w.e.f. session 2011
Semester- IV

Course no.: Zoo-LC-IV **M.M. : 150**
Course Title : Laboratory Course **Time : 6 Hrs.**

Tentative list of the proposed experiments

- Study and classify specimen up to order of various phyla of vertebrates with the help of charts
- To show the dissection of the representative animals like herdmania, scoliodon, rat and lizard, for their anatomical studies of various systems with the help of CD.
- Study of accessories bladders in fishes with the help of CD
- Economic note on specific animal
- To prepare the taxonomic key on the basis of given characteristics
- To study distribution patterns of different species by random sampling method
- Microbiological studies of various samples
- To study microbes as bioindicators
- Gene mapping
- DNA and RNA estimation
- To perform transformation
- Effect of ultraviolet light on *E. coli* culture
- Utilisation of microscope for assessing population in fresh water and other samples
- Counting of bacteria by using culture media and standard plate count method
- Environment impact assessment report of various hazardous materials
- Project report on
    a. Radioactivity: hazards, disposal and precautions
    b. Biosafety: Incineration etc

Note: Besides these any other additional experiment relevant to the syllabi in all semesters or as feasible depending on resources.