MAHARAJA SURAJMAL BRIJ UNIVERSITY, BHARATPUR

(A State Govt. University)

Chak Sakeetra, Kumher – 321201 (Rajasthan)

SYLLABUS

M.Sc. ZOOLOGY

(Semester Scheme)

I, II, III & IV Semester Examination

Post Graduate Curriculum Framework based on

Choice Based Credit System (CBCS)

&

New Education Policy – 2020

(Academic Session 2024-25)

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MAX.MARKS: 100 **PASS MARKS: 40**
THEORY PAPER DURATION: 3HRS **PRACTICAL: 6HRS**

SCHEME OF EXAMINATION AND CREDITS

1. Student will require to earn 110 credits for PG course out of total 128 credits.
2. In theory, 15hrs of teaching is equal to 1 credit.
3. In practical, 45hrs of laboratory works is equal to 2 credits.
4. Students can choose Elective Course Compulsory (minimum one and maximum two paper), Skill Enhancement Course compulsory (one) and Value added Course compulsory (one) in semester to earn credits as per choice.
5. In fourth semester students must involve in research dissertation to develop unique ideas for innovation and technology.
6. Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination /assignment/seminar/viva voce etc.
7. Students can exit his/her course after completion of one-year (first and second semester) secure minimum 54 credits with Post-Graduate (PG) diploma in Advanced Zoology.
8. There is also choice for the students to choose National Programme on Technology Enhanced Learning (NPTL), Study Webs of Active-Learning for Young Aspiring Minds (SWYAM), and Massive Open Online Course (MOOC) like online educational portals as an additional credit earning resources
9. Each theory paper shall carry 100 marks. It will be of 3hrs duration.
   Part A of question paper shall contain 10 (Ten) very short answer type questions covering the entire syllabus. Each question will carry 01 (one) marks i.e. part A will be of total 10 marks.
   Part B of question paper shall contain 04 questions with internal choice two per unit. Each question will carry 15 marks i.e. total of 60 marks.
10. Each paper practical examination will be of 2hrs duration and will involve laboratory experiments /exercises and Viva —voce examination shall carry maximum 50 marks with weightage in ratio of 75:25 respectively.

SCHEME OF PRACTICAL EXAMINATION

NOTE: For first, second, third and fourth Semesters, the scheme of practical examination is given after the practical.

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COURSE STRUCTURE

First Semester (With Laboratory Work)

S.No.	Subject Code	Course Title	Course Category	Credit
		Core Course Compulsory		
1	ZOL C101	Biosystematics & Taxonomy	CCC	4
2	ZOL C102	Biology of Invertebrates	CCC	4
3	ZOL C103	Biochemistry	CCC	4
4	ZOL 111	Practical Core Paper (Based on ZOL C101, ZOL C102 and ZOL C103)	CCC	6
		Elective Course Compulsory		
1	ZOL E101	Fundamentals of Computers and Bioinformatics	ECC	4
2	ZOL E102	Genetics	ECC	4
3	ZOL E103	Applied Zoology	ECC	4
4	ZOL E104	Toxicology	ECC	4
5	ZOL E105	Parasitology	ECC	4
6	ZOL 112	Practical Elective Paper (Based on ZOL E101/ ZOL E102/ ZOL E103/ZOL E104 and ZOL E105)	ECC	4
7	ZOL VAC1	Select any value added course from syllabus	VAC	2

Second Semester (With Laboratory Work)

S.No.	Subject Code	Course Title	Course Category	Credit
		Core Course Compulsory		
1	ZOL C201	Physiology	CCC	4
2	ZOL C202	Biology of Chordates	CCC	4
3	ZOL C203	Biostatistics	CCC	4
4	ZOL 211	Practical Core Paper (Based on ZOL C201, ZOL C202 and ZOL C203)	CCC	6
		Elective Course Compulsory		
1	ZOL E201	Immunology	ECC	4
2	ZOL E202	Wildlife: Its Management & Conservation	ECC	4
3	ZOL E203	Applied Biology	ECC	4
4	ZOL E204	Histology and Histopathology	ECC	4
5	ZOL E205	Population Genetics	ECC	4
6	ZOL 212	Practical Elective Paper (Based on ZOL E201/ZOL F202 ZOL E203/ZOL E204/ ZOL E205)	ECC	4
8	ZOL VAC2	Select any value added course from syllabus	VAC	2

Note: Student can exist his/her course after completion of one-year (Semester first and second) with PG Diploma in Advanced Zoology

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Third Semester (With Laboratory Work)

S.No.	Subject Code	Course Title	Course Category	Credit
		Core Course Compulsory (Group–A) Cancer And Radiation Biology (Specialization)		
1	ZOL CA301	Basics of Radiation Biology	CCC	4
2	ZOL CA302	Radiation Effects	CCC	4
3	ZOL CA303	Molecular Radiology and Its Application	CCC	4
4	ZOL A311	Practical Core Paper (Based on ZOL CA301, ZOL CA302 and ZOL CA303)		6
		Core Course Compulsory (Group–B) Cell And Molecular Biology (Specialization)		
1	ZOL CB301	Cellular Structure and Function	CCC	4
2	ZOL CB302	Cellular Physiology and Regulatory Mechanism	CCC	4
3	ZOL CB303	Gene Expression	CCC	4
4	ZOL B311	Practical Core Paper (Based on: ZOL CB301, ZOL CB302 and ZOL CB303)	CCC	6
		Core Course Compulsory (Group–C) Entomology (Specialization)		
1	ZOL CC301	Phylogeny, Taxonomy and Evolution of Insects	CCC	4
2	ZOL CC302	Morphology and Physiology of Insects	CCC	4
3	ZOL CC303	Development and Ecology of Insects	CCC	4
4	ZOL C311	Practical Core Paper (Based on: ZOL CC301, ZOL CC302 and ZOL CC303)	CCC	6
		Core Course Compulsory (Group–D) Environmental Biology (Specialization)		
1	ZOL CD301	Environmental Biology: Concept and Approaches	CCC	4
2	ZOL CD302	Population Ecology, Environmental Adaptations and Environmental Disasters	CCC	4
3	ZOL CD303	Natural Resources, Biodiversity, Wildlife and Conservation Biology	CCC	4
4	ZOL D311	Practical Core Paper (Based on: ZOL CD301, ZOL CD302 and ZOL CD303)	CCC	6
		Core Course Compulsory (Group–E) Reproductive Biology (Specialization)		
1	ZOL CE301	Endocrine Glands and Hormones	CCC	4
2	ZOL CE302	Male and Female Reproductive Systems	CCC	4
3	ZOL CE303	Biology of Gametes, Reproductive cycles and Behaviours	CCC	4
4	ZOL E311	Practical Core Paper (Based on: ZOL CE301, ZOL CE302 and ZOL CE303)	CCC	6
		Elective Course Compulsory (Opt one or two)		
1	ZOL E301	Molecular Biology	ECC	4
2	ZOL E302	Gene and Differentiation	ECC	4
3	ZOL E303	Evolution	ECC	4
4	ZOL E304	Ecology	ECC	4
5	ZOL E305	Ethology	ECC	4
6	ZOL E306	Tools & Techniques	ECC	4
7	ZOL 312	Practical Elective Paper (Based on ZOL E301, ZOL E302, ZOL E303, ZOL E304, ZOL E305 and ZOL E306)	ECC	4

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Skill Enhancement Course Compulsory				
1	ZOL SEC1	Select any one skill enhancement course from syllabus	SEC	4

Fourth Semester (With Laboratory Work)

S.No.	Subject Code	Course Title	Course Category	Credit
		Core Course Compulsory (Group–A) Cancer And Radiation Biology (Specialization)		
1	ZOL A401	Nature & Types of Cancer	CCC	4
2	ZOL A402	Molecular Mechanism of Cancer	CCC	4
3	ZOL A403	Tumour Immunology and Treatment	CCC	4
4	ZOL A411	Lab based on: ZOL 4A01, ZOL 4A02 and ZOL 4A03	CCC	6
5	ZOL RD-A404	Dissertation	CCC	8
		Core Course Compulsory (Group–B) Cell And Molecular Biology (Specialization)		
1	ZOL B401	Basic Immunology	CCC	4
2	ZOL B402	Immunology: Molecular Expression and Function	CCC	4
3	ZOL B403	Immunology: Application and Cellular	CCC	4
4	ZOL B411	Malfunction	CCC	6
5	ZOL RD-B404	Lab based on: ZOL 4B01, ZOL 4B02 and ZOL 4B03 Dissertation	CCC	8
		Core Course Compulsory (Group–C) Entomology (Specialization)		
1	ZOL C401	Insect Pests	CCC	4
2	ZOL C402	Insect Pest Management	CCC	4
3	ZOL C403	Applied Entomology	CCC	4
4	ZOL C411	Lab based on: ZOL 4C01, ZOL 4C02 and ZOL 4C03	CCC	6
5	ZOL RD-C404	Dissertation	CCC	8
		Core Course Compulsory (Group–D) Environmental Biology (Specialization)		
1	ZOL D401	Environmental Toxicology and Environmental	CCC	4
2	ZOL D402	Health	CCC	4
3	ZOL D403	Environmental Microbiology and Biotechnology	CCC	4
4	ZOL D411	Environmental Education, Management and Regulation Lab based on: ZOL 4D01, ZOL 4D02 and ZOL 4D03	CCC CCC	6
5	ZOL RD-D404	Dissertation	CCC	8
		Core Course Compulsory (Group–E) Reproductive Biology (Specialization)		
1	ZOL E401	Physiology of Reproduction	CCC	4
2	ZOL E402	Contraception and Reproductive Health	CCC	4
3	ZOL E403	Reproductive Technologies	CCC	4
4	ZOL E411	Lab based on: ZOL 4E01, ZOL 4E02 and ZOL 4E03	CCC	6
5	ZOL RD-E404	Dissertation	CCC	8

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Skill Enhancement Course Compulsory				
1	ZOL SEC2	Select any one skill enhancement course from syllabus	SEC	4

Note- Elective practical/s will be based on the elective theory paper/s opt

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M.Sc. ZOOLOGY I SEMESTER

CORE PAPER

ZOL C101: BIOSYSTEMATICS AND TAXONOMY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Taxonomy: Definition and basic concept of biosystematics and taxonomy.
2. History, scope and application of biosystematics.
3. Taxonomic diversity: Definition and types of various taxonomic categories, micro- and macro- taxonomy.
4. Dimensions of speciation: Species category, sub-species and other intra-species categories.
5. Kingdom of life: General outline of kingdom including Monera and Protista; Broad outline and diversity in kingdom Animalia.

UNIT-II

Modern trends in taxonomy

1. Behavioural taxonomy
2. Chemotaxonomy
3. Cytotaxonomy
4. Molecular taxonomy
5. Neo-taxonomy
6. Numerical taxonomy

UNIT-III

1. Taxonomic procedures: Collection, preservation, curetting and process of identification.
2. Taxonomic character of different kinds-quantitative and qualitative analysis of variation.
3. Theories of biological classification: Hierarchy of categories.
4. Interpretation and application of important rules and formation of scientific names of different taxa.

UNIT-IV

1. Interpretation and application of important rules of zoological nomenclature, formation of scientific names of the various taxa.
2. Taxonomic keys: Their merits and demerits.
3. International code of zoological nomenclature (ICZN).
4. Systematic publications and different kinds of publications.

PRACTICALS

1. Identification, classification and study of the animals from major invertebrate groups (Protozoa to Hemichordata including minor phyla) using museum specimens, microscopic slides, models or charts or photographs.
2. Preservation techniques of selected invertebrates.
3. Museum specimens and slides:

- PROTOZOA.' Gregarina, Monocystis, Ceratium, Euplotes, Noctiluca,
- Radiolarian, Stentor, Opalina
- PORIFERA: Museum specimen of Hyalonema and Euspongea, Sectional view of Sycon (T. S. & L. S.), Grantia (T. S.)

Dr. Farbat Singh
Asstt. Registrar
Acad.I

- COELENTERATA (CNIDARIA): Slides of Obelia polyp and medusa, Pennaria, Aurelia-tentaculocytes. Museum specimens of Virgularia, Spongodes, Zoanthus, Favia.
- HELMINTHES: Slides of Temnocephala.
- Museum Specimens of Ascaris lumbricoides, Taenia solium, Planaria.
- ANNELIDA: Slides of Ozobranchus, Glossiphonia.
- Museum specimens of Eunice, Polynoe, Terebella, Eužythoe.
- ARTHROPODA: Slides of Cyclops, Daphnia, Chelicerata, Section of Peripatus. Museum specimen of Balanus, Lepas, Palinurus, Uca princeps, Pycna, Emerita, Gongylus, Belostoma, Limulus, Squilla, Eupagurus.
- MOLLUSCA: Museum specimens of Dolobella, Pteria, Nerita, Sanguinolaria, Chicoreus, Ficus, Lambis, Tridacna, Onchidium, Oliva, Murex, Turritella, Bulla, Cardium.
- ECHINODERMATA: Museum Specimens of Linckia, Echinodiscus, Holothuuria, Antedon.
- MINOR PHYLA: Slides of Bugula, Plumatalla, Cristatella, Pectinella.
- Museum Specimen of Phoronis, Dendrostoma.
- LARVAE: Planula, Redia, Cercaria, Metacercaria, Trochophore, Nauplius, Zoea, Mysis, Phyllosoma, Trilobite larvae of Limulus, Antilon, Veliger, Bipinnaria, Ophiopluteus and Echninopluteus, Auricularia, Tornaria.

Note: Photographs may be supplemented if unavailable.

Visit to a river/pond/sea: Collection, preservation, curetting and identification of animals.

SUGGESTED BOOKS

1. Biodiversity, E. O. Wilson, Academic Press: Washington.
2. Principles of Animal Taxonomy: G. G. Simpson. Oxford IBH Publishing Company.
3. Elements of Taxonomy, E. Mayer.
4. The diversity of life (The College Edition), E. O. Wilson. W. W. Northen & Co.
5. Theory and Practice of Animal Taxonomy, V. C. Kapoor. Oxford IBH Publishing Co. Pvt. LTD.
6. Advancement in Invertebrates Taxonomy and Biodiversity. Rajeev Gupta. Agrobios International.
7. The Invertebrates, Hyman, L. H. Vol. I to 9. McGraw Hill Co., New York.
8. A Biology of Higher Invertebrates, W. D Russel-Hunter, The Macmillan co. Ltd., London.
9. Collection, preservation and identification of animals. J. R. B. Alfred and Ramakrishna (2004). Zoological survey of India Publications.
10. The Biology of Biodiversity, M. Kato, Springer.

Dr. Farbat Singh
Asstt. Registrar
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M.Sc. ZOOLOGY I SEMESTER

CORE PAPER

ZOL C102: BIOLOGY OF INVERTEBRATES

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Origin of Protozoa, parazoa and metazoa.
2. Origin of radiata and bilateria.
3. Origin, characters and types of metamerism.
4. Origin and evolution of coelom.
5. Evolution of reproductive and non-reproductive units (evolution of sex), division of labour and social evolution.

UNIT-II

1. Locomotory organs and mechanisms of locomotion in invertebrates, flight mechanism of Insects, modification of foot organelles in Mollusca.
2. Feeding and digestion in invertebrates.
3. Excretory and osmo-regulatory organs and their mechanisms in invertebrates

UNIT-111

1. Respiration in invertebrates.
2. Nervous system in invertebrates: (i) Primitive nervous system- Coelenterata and Echinodermata and (ii) Advanced nervous system- Annelida, Crustacea, Insecta and Mollusca.
3. Reproduction in invertebrates.

UNIT-IV

1. Introduction to minor phyla, their salient features and characters
2. Origin and significance of mesozoa, ctenophora and rhynchocoela.
3. Larval forms and their significance, free living, marine & freshwater protostome and deuterostome larval forms (including trochophore), crustacean, mollusc and insect larval forms, their strategies and significance, parasitic larva, larvae of parasitic forms.

PRACTICALS

I. Anatomy

1. Leech: Alimentary canal, nephridial and reproductive system
2. Crab: Nervous system.
3. Cockroach: Nervous system and reproductive system.
4. Aplyisa, Scpia and Unio- Nervous system.
5. Sea Urchin — Aristotle's lantern.
6. Holothuria — General anatomy, alimentary canal.

II. Collection, culture, live study & permanent mounting

1. Amoeba, Paramecium.
2. Trematodes, Cestodes and Nematodes.
3. Permanent Mounting - Obelia, Sertulria, Companularia, Cercaria, Daphnia, Cyclops, Zoea, Megalopa, Mysis, Lucifer
4. Mouth parts and salivary glands of cockroach, nephridia of leech.

Note:

- Anatomy: Study of systems of the prescribed types with the help of dissection.

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Acad.I

- With reference to microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.
- It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently

SUGGESTED BOOKS

1. Invertebrate Zoology: A Functional Evolutionary Approach, Edward E. Ruppert, Richard S. Fox
2. Invertebrate Zoology, R. S. K. Barnes.
3. The Invertebrates. Vol. I . Protozoa through Ctenophora, Hyman, L.H. McGraw Hill Co., New York.
4. The Invertebrates. Vol.2. Hyman, L.H. McGraw Hill Co., New York.
5. The Invertebrates. Smaller Coelomate Groups, Vol. 5. Hyman, L.H. McGraw Hill Co., New York.
6. The Invertebrates. Vol.8. Hyman, L.H. McGraw Hill Co., New York.and London
7. Invertebrate Structure and Function. Barrington, E.J.W. Thomas Nelson and Sons Ltd., London.
8. Invertebrates. Richard C. Brusca , Gary J. Brusca and Nancy J. Haver.
9. A Biology of Higher Invertebrates. Russel-Hunter, WD. McMillan Co. Ltd., London.
10. Student Text Book of Zoology. Vol. I, II and III. Sedgwick A. Central Book Depot, Allahabad.
11. Text book of Zoology. Parker, T.J., Haswell. W.A. Macmillan Co., London.
12. Biology of the Invertebrates by Jan A. Pechenik.
13. Invertebrate Zoology Laboratory Manual, Robert L. Wallace, Walter K. Taylor
14. The Invertebrates: A Synthesis - R. S. K. Barnes Peter P. Calow P. J. W. Olive D. W. Golding J. I. Spicer.
15. Reproductive Behavior and Evolution (Evolution, Development and Organization of Behavior) Rosenblatt, J. Springer, 1997.
16. Invertebrate Zoology: A Functional Evolutionary Approach, 7th Edition, Ruppe Fox & Barness, Cengage India, 2015.

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M.Sc. ZOOLOGY I SEMESTER
CORE PAPER
ZOL C103: BIOCHEMISTRY

Max. Marks: 100 Total Hours: 60

UNIT-I

Scope of biochemistry: Biomolecules, Chemical bonds, pH, Acid, base, buffer, Concept of free energy.

Proteins

1. Covalent properties of proteins: Structure and chemistry of amino acid, isolation and purification of protein, protein sequencing, covalent modifications, protein splicing.
2. Secondary and tertiary structures of proteins, peptides and peptide bonds, Ramchandaran plots and amino acid propensities, common secondary structures, protein tertiary structure and folding patterns, common tertiary structural motifs, role of packing constraints in tertiary structure patterns.
3. Globular and fibrous protein, water and hydrophobic effect, tertiary and quaternary effect, motifs in globular proteins, fibrous proteins (keratin, fibrin, collagen and elastin).
4. Protein folding and thermodynamics, Levinthal paradox, condensation and molten globules, chaperone assisted protein folding.
5. Amino acid sequences variation and protein misfolding diseases, allostery (Hemoglobin), myoglobin structure and oxygen binding.
6. Haemoglobin subunits cooperatively, Hill coefficient, Quaternary structural change sickle cell and other molecular diseases

UNIT-II

Carbohydrates: Structure and biological importance

1. Monosaccharides
2. Oligosaccharides
3. Polysacharides (Storage and structural polysaccharides, glycosaminoglycans)
4. Glycoconjugates (glycoprotein and proteoglycans).
5. Fatty acids: Structure, nomenclature, acyl glycerols, wax, phospholipids, sphinogolipids, glycolipids, lipoproteins.
6. Terpenoids and sterols: Structure, properties and functions.
7. Functions of lipids.

UNIT-III

Vitamins

1. Classification, structure, occurrence and functions and fat soluble vitamins
2. Classification, structure, occurrence and biological function deficiency symptoms of water soluble vitamins.

Enzymes

1. Enzyme as biocatalyst, the kinetics of enzyme catalysis, principles of enzyme catalysis, proteases, polymerases and other examples.
2. Co-enzymes and Co-factors, Isozymes.
3. Enzyme inhibition, allosteric enzyme.
4. RNA catalysis, chemistry and structure of ribozymes, evolutionary implications, enzymes as biosensor.

UNIT-IV

Metabolism

1. Catabolism, anabolism, metabolic pathway, regulation, concept of free energy

Dr. Farbat Singh
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Acad.I

2. Carbohydrate metabolism: Enzymatic reactions, regulation importance of Glycolysis, Citric acid cycle, Pentose phosphate pathway, glycogenolysis, glycogenesis
3. Lipid metabolism: Fatty acid oxidation and biosynthesis, Beta-oxidation.
4. Amino acid metabolism: Catabolism of amino acid, transamination, deamination, biosynthesis of non-essential amino acids, fate of carbon skeleton
5. Nucleotide metabolism: Degradation of purine and pyrimidine nucleotides, biosynthesis (de novo, salvage pathways) of purine and pyrimidine nucleotides.
6. Oxidative phosphorylation and mechanism of ATP biosynthesis.

Metabolic disorders

1. Carbohydrate — Galactosemia, Glycogen storage disease (Von Gierke disease), Hereditary fructose intolerance and Diabetes mellitus.
2. Protein — Phenyl ketonurea, Maple syrup urine disease, Carbamoyl phosphate synthetase I deficiency, alkaptonurea.
3. Lipid- Lipid storage disorder (Gaucher's disease, gangliosidoses), Diabetic ketoacidosis, Coenzyme A dehydrogenase deficiencies, Carnitine related deficiencies.
4. Nucleotide- Lesh-nyhan syndrome, Gout immunodeficiency diseases associated with defects in purine degradation.

PRACTICALS

1. Verification of Beer Lambert's Law using any colour solution
2. Determination of absorption maxima of a coloured solution
3. Standard curve —cholesterol, protein
4. Determination of pH of different solutions.
5. Quantities estimation of the following in various tissues.

- Carbohydrates: Glycogen, & Glucose
- Proteins: Total protein.
- Lipids: Total Lipid & Cholesterol
- Nucleic Acid: DNA and RNA
- Enzymes; Acid and Alkaline Phosphatase

6. Paper chromatography: Unidimensional chromatography using amino acids from purified samples and biological materials. (Ascending & Descending)
7. Determination of serum protein through paper / PAGE electrophoresis.

Note:

1. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

SUGGESTED BOOKS

1. Biochemistry, Albert's R.H. Frey, P.A. and Jencks, W.P. Jones, and Bartlett Publisher, Boston/London 1992.
2. Lehninger Principles of Biochemistry, Nelson D.L. And Cox, M.M. acmillan/Worth Publishers 2000.
3. Biochemistry, Stryker L. W.H. Freeman and Co. New York 2001
4. Fundamentals of Biochemistry, Voet D, Voet J.G. and Prhtt C.W. Johan Wiley and Sons Inc. New York, 1999.
5. Principles and Techniques of Practical Biochemistry, Wilson K. and Walker J. Cambridge University Press Cambridge, 1994.

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Acad.I

6. Principles of Biochemistry, Zubay G.L. Parson W. W. and Vence. DE. Wm. C Brown Publishers, Oxford, England 1995.
7. Harper's Biochemistry, Murray, Granner, May Rodwell, McGraw Hill Publication.
8. 2000.
9. Biochemistry, Donald Voet, Judith G. Voet.
10. Biochemistry, Mathew, C.K. Van Holde, K.E. Ahren, K.G. Peason Education Pvt. Ltd.
11. Delhi, India 2003
12. Principles of Biochemistry, Horton, H.R. Morsanl. A Scringeour, K.G., Perry, M.D. Rawn, J.D. Peasons Educations, International, 2006.
13. Biochemistry (The Molecular Basis of Life, Mckee, T. Mc Kee, J.R. Mc Grew Hill Companying.
14. Biochemistry and Molecular Biology, Elliort, W.H. Elliott, D.C. Oxford University Press, Oxford, 2003.
15. Lippincott'S Illustrated Review by Champe, P.C. Harvey, R.A. Lippincott Williams & Wilkins, Philadelphia.

ZOL 111: PRACTICAL
CORE GROUP
(BASED ON ZOL C101, ZOL C102 and ZOL C103)
Scheme for Practical Examination

Max. Marks: 150 Time: 6 hrs

1. Exercise (Core l)	18
2. Exercise (Core 2)	18
3. Exercise (Core 3)	18
4. Spotting (12 x 4)	48
5. Viva Voce	30
6. Record	18

M.Sc. ZOOLOGY I SEMESTER
ELECTIVE
ZOL E101: FUNDAMENTAL OF COMPUTERS AND BIOINFORMATICS

Max. Marks: 100 Total Hours: 60

UNIT-I

Fundamentals of computers

1. Types of computers
2. Basic components of a computer
3. Generations of computer
4. Number system: Interconversion between binary, octal, decimal and hexadecimal
5. Softwares: System & application softwares
6. Operating systems: MS DOS, MS Windows, Unix/Linux
7. MS Office: MS Word, MS Excel, Power Point
8. Elementary idea of Adobe Photoshop

Dr. Farbat Singh
Asstt. Registrar
Acad.I

9. Internet: Physical and logical topologies, types of networking (LAN, MAN and WAN)
10. Web search engines: Yahoo, Google, MSN and Entrez (including PubMed).

UNIT-II

Introduction of bioinformatics

1. History, definitions & scope of bioinformatics
2. Related fields and areas of bioinformatics
3. Applications of bioinformatics
4. Bioinformatics in India.

Biological database

1. Classification: Primary, secondary and composite databases
2. Nucleotide sequence databases: GenBank, EMBL and DDBJ
3. Protein sequence databases: SWISS-PROT, TrEMBL, UniPROT and PROSITE
4. Structural databases: Protein Data Bank (PDB), Molecular Modeling Database (MMDB), Nucleic Acid Database (NDB), Structural Classification of Proteins (SCOP) and Class Architecture Topology Homology (CATH).

UNIT-111

Sequence analysis

1. Types of sequence alignment: According to sequence number and sequence length, homologous sequences
2. Methods of sequence alignment: DOT PLOT or DOT MATRIX, Dynamic programming, Heuristic methods (FASTA and BLAST)
3. Scoring scheme: Point accepted mutations (PAM) matrices, Blocks amino acid substitution matrices (BLOSUM)
4. Gaps and gap penalties

UNIT-IV

Genomics and proteomics

1. Genomics: Definition, history and classification (structural, functional and comparative)
2. Proteomics: Definition, metabolomics, classification (protein expression profiling, functional and structural), data mining
3. Significance of genomics and proteomics

Phylogenetic analysis

1. Graphical representation, molecular clock theory
2. Monophylatic, paraphylatic and polyphyletic
3. Gene/Protein Versus species trees
4. Methods for inferring molecular phylogenies 5. Software packages for phylogenetic analysis.

PRACTICALS

1. Exercises related to operating systems.
2. Exercises related to word processing (file formatting, page layout, mailing, printing etc.) using MS Word.
3. Use of MS Excel sheet for data processing.

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Asstt. Registrar
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4. Use of MS Power point for slide preparation.
5. Use of search engines.
6. Retrieve the sequence for the database.
7. Genome sequencing techniques.
8. Exercise based on various methods of sequence alignment.
9. Nucleotide and protein sequence databases.
10. Gene bank flat file format. 11. Data mining in proteomics.
11. Web based tools for sequence searchers and homology screening.

SUGGESTED BOOKS

1. Introduction to Bioinformatics, Attwood, T. K. and Parry Smith D. J., Pearson Education, Singapore 2006.
2. Structural Bioinformatics, Bourne P. E. and Weissig, H. Wiley—Liss New Jersey, USA.
3. 2003
4. Introduction to Bioinformatics, Lesk A. M. 2nd ed., Oxford Press, 2005.
5. Fundamental Concepts of Bioinformatics, Krane Dan E. Pearson education (Singapore) Pte. Ltd, 2005.
6. Beginning Perl for Bioinformatics, Tisdall J. D. O'rclly, California, USA 2001.
7. Bioinformatics: Scquenee and Genome Analysis, Second edition Cold Spring, David W. Mount, Harbor Laboratory Press, New York 2004.
8. Statistical Bioinformatics: A Guide for Life and Biomedical Science Resarchers. Jae. K. Lee John Wiley & Sons, New York 2010.
9. Francis Ouellette Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins. Andreas D. Baxevanis and B. F. John Wiley & Sons, New York 2004.
10. Structural Bioinformatics, Jenny Gu and Philip E. Bourne Wiley Blackwell. 2009.
11. International I. Bioinformatics: Concepts, Methodologies, Tools, and Applications edited by information Resources Management Association, IGI Global publishers 2013.
12. 11. Handbook of Statistical Bioinformatics Henry Horng-Shing Lu, Bernhad Scholkopf and Hongyu Zhao, Springer publishers, 201 1.
13. Computer Fundamentals, Architecture & Organisation. Ram B. and Kumar S. 5 th edition. New Age International (P) Ltd., New Delhi, 2014
14. Bioinformatics Methods and Protocols, Krawetz Stephen Misener and Stephen A. Humana press Inc 1999.

M.Sc. ZOOLOGY I SEMESTER
ELECTIVE
ZOL E102: GENETICS

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Brief life history of Gregor John Mendel.
2. Laws of Inheritance, modified Mendelian ratios, Lethal genes, Co-dominance, Incomplete dominance.
3. Pedigree analysis
4. Multiple allelism
5. Pleiotropism.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

6. Chromosome theory of inheritance.

UNIT-II

Sex-determination and *ex-linked inheritance

1. Sex -determination in Humans, Drosophila.
2. Sex linked Inheritance: Haemophilia, colour blindness, baldness in man.
3. Sex chromatin and drum sticks

Linkage and crossing over

4. Crossing over: Concept and significance, Linkage disequilibrium and recombination.
5. Linkage: Concept & history, complete & incomplete linkage, Bridge's experiment, coupling & repulsion, recombination frequency, Basic concept of dosage compensation, linkage maps based on two factor crosses.

UNIT-III

1. Genetic code: repetitive and unique DNA sequences, split genes, overlapping genes and pseudo genes.
2. Gene interactions: Lethal alleles, penetrance and expressivity, pleiotropism, modifiers, atavism, phenocpoies.
3. Genetic control of cell division; Proto-oncogenes, Oncogenes and Tumor suppresser genes.
4. Transposable genetic elements.
5. Molecular mechanism of mutation, forward and reverse genetic mutations at DNA and protein level, frame shift mutation, extra-genic suppression, physiological suppression
6. Extra-nuclear inheritance, maternal effect, organelle heredity, infection heredity.

UNIT-IV

1. Cytogenetics of human chromosomes.
2. Inbreeding and related disorders; Other genetic diseases.
3. Molecular diagnosis-of genetic diseases (Cystic fibrosis, Huntington's disease and sickle
4. cell anaemia), Screening of risk factor for genetic diseases.
5. Elementary idea of gene therapy.
6. Behavioural genetics, circadian rhythm in Drosophila.
7. Human genome project.

PRACTICALS

1. Gene interactions with the help of Drosophila culture for the following dihybrid F2 segregation ratios: 9: 7; 9:4:3; 13:3;12:3:1.
2. Construction of linkage map based on recombination frequency data obtained from a two-point cross from real life data.
3. Chi-square analysis of a dihybrid F2 population data.
4. Study of meiosis in testes of grasshopper.
5. Pedigree analysis of haemophilia in Royal family of Great Britain.
6. Colour blindness: Ishihara's chart.
7. Study of the following with the help of photographs: Sex chromosome in Melandrium/ Coccinia, multivalent, inversion • Bridge, laggards, translocation ring (Rhoeo), human genetic syndromes (Down 's, Turner's, Klinefelter's), Barr bodies.

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8. Preparation of Chromosome plate from bone marrow of laboratory mice.

SUGGESTED BOOKS

1. Principles of Genetics, Grdner E.J., V Ill edition, Simmons M.J. and Snustad D.P. Willey India, 2008.
2. Concepts of Genetics. XI edition. Klug WS, Cummings M.R,, Spencer C.A. Benjamin Cummings, 2009.
3. Genetics- A Conceptual Approach. Pierce B.A. W.H. Freeman & Co., NY, 2008.
4. A Conceptual Approach. Russell P. J. Ill edition. Benjamin Cummings, 2009.
5. Genetics of populations. Hedrick. R. W. Jones and Bartelt publisher. Sudbury. Massacluseltts.
6. Human Genetics: problems and approaches. Vogel F and Motulsky A. Springer Verlof.
7. Human Molecular Genetics. Strachan T and Read A. Ill ed. Garland Science. 2003.

M.Sc. ZOOLOGY I SEMESTER
ELECTIVE
ZOL E103: APPLIED ZOOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Economic importance of beneficial and harmful Protozoa, helminthes, mites and ticks, crustaceans and spiders.
2. Insects as pollinators, ornamental insects; insects as food.
3. Industries related to Lac insect, Honey bees and Silk worm.
4. Disease causing insects (in man and animals) and their control.

UNIT-II

1. Fresh and Brackish water fish culture.
2. Products of fishing industry.
3. Common freshwater and marine food fishes of India.
4. Freshwater aquarium, common freshwater aquarium fishes.
5. Fishing methods in India.
6. Larvicidal fishes of India.
7. Prawn culture
8. Pearl culture.

UNIT-III

1. Poultry keeping and Duck poultry.
2. Dairy farming and Piggery.
3. Leather industry, wool industry, fur and fur industry.

UNIT-IV

1. Pharmaceuticals from animals.
2. Economic importance of snakes
3. Economic importance of mammals.
4. Stored grain pests, polyphagous pests

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Asstt. Registrar
Acad.I

PRACTICALS

1. General introduction to stains, preservatives and fixatives.
2. Museum specimens:
   I. Protozoa- Selected species of economic importance
   II. Platyhelminthes: Selected species of economic importance
   III. Arthopoda: Mites, Ticks, Spiders, Insects
   IV. Molluscs, Echinoderms, fishes, snakes and mammals
3. Visit to Poultry farm /dairy (Report to be submitted).
4. Collection and preservation of pest of economic importance (Detailed life history)
5. Visit to leather / wool / fur industries (Report to be submitted).
6. Study of protozoan, Helminth parasites and arthropod vectors associated with human disease.

SUGGESTED BOOKS

1. Economic Zoology. G.S Shukla & V.B. Upadhyay. Rastogi Publications, Meerut, India 1991-92.
2. Fish & Fisheries. Kamaleshwar Pandey & J.P Shukla. Rastogi Publications, Meerut, India 2007.
3. Fish & Fisheries, of India, V.G. Jhingran, Hindustan Pub, Corp. India 1982.
4. A Hand Book on Economic Zoology, Jawid Ahsan and Subhas Prasad Sinha, S. Chand & Company Ltd. Ramnagar.

M.Sc. ZOOLOGY I SEMESTER
ELECTIVE
ZOL E104: TOXICOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

Fundamentals of toxicology

1. Definition, scope and basic divisions of toxicology.
2. Basic concept of Toxicology: Toxicants and toxicity; Factors affecting environmental concentrations of toxicants; Factors influencing toxicity.
3. Dose; Effect and response; Dose-response relationships; Statistical concepts of toxicity; Margin of safety (Slope); Toxicity curves; Cumulative toxicity.
4. Toxicological testing methods: General test design; Single species tests; Multispecies tests; Acute, Subacute and Chronic toxicity tests.
5. Concept of QSAR, Toxicogeomics, Metabonomic technology, Molecular toxicology and Chronotoxicology.

UNIT-II

Toxicants of public health

1. Toxic chemicals and their effects: Pesticides; Heavy metals; Fertilizers; Food additives; 2. Radioactive substances; Automobile emissions.

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Asstt. Registrar
Acad.I

2. Membrane permeability and mechanisms of chemical transfer: Absorption and translocation of xenobiotics; Membrane barriers, binding of xenobiotics and storage depots; Excretion of xenobiotics.
3. Toxic chemicals in the environment; Bio-concentration and Bio-magnification.
4. Occupational diseases: Pneumoconiosis (Silicosis, Anthracosis, Byssinosis, Bagassosis, Asbestosis, Farmers lung), Plumbism and Occupational dermatitis.

UNIT-111

Biotransformation of toxicants

1. Definition and Biotransformation sites.
2. Phase reactions: Oxidation, Reduction and Hydrolysis.
3. Phase II Reactions: Glucuronide formation, Methylation, Sulphate conjugation, Acetylation, Amino acid conjugation and Glutathione conjugation.
4. Complex nature of biotransformation, Factors affecting biotransformation and Bioactivation.

UNIT-IV

Natural Toxins and their health effects

1. Microbial toxins: Anthrax, Botulism, Staphylococcal Enterotoxin, Mycotoxicosis, Mushrooms.
2. Venoms of invertebrates: Sponges, Coelenterates, Annelids, Arthropods, Molluscs and Echinoderms.
3. Venoms of Vertebrates: Fishes, Amphibians and Reptiles (lizards and snakes).
4. Neurotoxic plants: Hemlock (Conium maculatum), Water hemlock (Cicuta virosa), Curare (Chondrodendron tomentosum).
5. Cyanogenic plants: Hydrangea (Hydrangea paniculata), Apricot, Cassava (Manihot esculenta).
6. Poisonous plants: Castor (Ricinus communis), Rosary pea (A brusprecatorius), Oleander (Nerium oleander), Azalea (Rhododendron)

PRACTICALS

1. Determination of LCso/LD50 of any toxicant using organisms.
2. Study the effects of toxicants on blood cells and blood biochemistry.
3. Study the effects or toxicants on liver function enzymes such as, Alkaline phosphatase, SGPT and SGOT.
4. Study the effects of toxicants on kidney function.
5. Study the effects of toxicants on enzyme Acetylcholinesterase.
6. Study the detects of toxicants on chromosome of various organisms.
7. Study the protein profile of various tissues of toxicant exposed animals.
8. Histopathological/histochemical study of liver, kidney, brain and GIT after exposing suitable experimental organisms exposed to various toxicants.
9. Study of various natural toxins producing organisms (microbes, plants and animals) based on syllabus.
10. Writing report on any one type of occupational hazardous event in the past.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

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SUGGESTED BOOKS

1. Fundamentals of Toxicology. Casseret and Doulls: Cur-this Klassen 1997.
2. Environmental Pollution, Health and Toxicology. S. V. S Rana, Narosa Publishing House, New Delhi.
3. Fundamentals of Toxicology. Kamleshwar Pandey, J. P. Shukla, S. P. Trevedi. New Central Book Agency (p) Ltd.
4. Environmental Biology and Toxicology. P. D. Sharma. Rasthogi Publications.

M.Sc. ZOOLOGY I SEMESTER
ELECTIVE
ZOL E105: PARASITOLOGY

Max. Marks: 100

Total Hours: 60

UNIT-I

Introduction to parasitology

1. History of parasitology.
2. General idea of life cycle of parasites.
3. Types of development of parasitic forms and alternation of generation.
4. Development of parasite in tissue system.
5. Mechanism of pathogenicity.
6. International Zoological Nomenclature as applicable to parasites.
7. Economic importance of taxonomic study of parasites.

UNIT-II

Parasitic Protozoa

1. Classification of parasitic protozoa.
2. Structure, life history, pathogenicity, treatment and management of: Trypanosoma brucei gambiense, T. b. rhodensiense, T. cruzi, T. lewisi, Leishmania donovani, Giardia lamblia. Trichomonas tenax and Trichomonas vaginalis.
3. Structure, life history, pathogenicity, treatment and management of: Entamoeba coli, E. gingivalis, E histolytica and E. muris.
4. Structure, life history, pathogenicity, treatment and management of: Eimera tenella, Gregarinia, Monocystis lumbrici, Plasmodium vivax, P. ovale, P. malaria and P. falciparum.

UNIT-III

Parasitic Helminthes

1. Classification of the parasitic helminthes.
2. Structure, life history, pathogenicity, treatment and management of: Fasciola hepatica, Fasciola buski, Schistosoma haematobium, Schistosoma mansoni and Schistosoma japonicum.
3. Structure, life history, pathogenicity, treatment and management of: Taenia solium and T. saginata.
4. Structure, life history, pathogenicity, treatment and management of: Ascaris lumbricoides, Trichinella spiralis, Trichuris trichiura, Dracunculus medinensis and Wuchereria bancrofti.

Dr. Farbat Singh
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Acad.I

UNIT-IV

Parasitic Annelids and Arthropods

1. Classification of parasitic Annelids and Arthropods.
2. Structure, life history, pathogenicity, treatment and management of: Glossiphonia, Pontobdella and Hirudo medicinalis.
3. Structure, life history, pathogenicity, treatment and management of: Pediculus humanus capitis, Pediculus humanus corporis, Phthirus pubis, Cimax lectularius, Mites, Ticks, Cattle louse and Xenopsylla cheopis.

PRACTICALS

1. Examination of blood for parasites.
2. Detection of exflagellation (microgamete formation in Plasmodium).
3. Examination of blood for microfilarial infection (Papanicaulou-hematoxylin and eosin).
4. Permanent slides: Trypanosoma brucei gambiense, T.b. rhodensiense, T. cruzi, T. levisi, Leishmania denovani, Giardia lamblia. Trichomonas tenax, Trichomonas vaginalis, Entamoeba coli, E. gingivalis, E. histolytica, E. muris, Eimera tenella, Gregarinia, Monocystis lumbrici, Plasmodium vivax, P. ovale, P. malaria, P. falciparum, Fasciola hepatica, Fasciola buski, Schistosoma haematobium, Schistosoma mansoni, Schistosomajaponicum, Taenia solium, T. saginata, Ascaris lumbricoides, Trichinella spiralis, Trichuris trichiura, Dracunculus medinensis, Wuchereria bancroßi, Glossiphonia, Pontobdella, Hirudo medicinalis, Pediculus humanus capitis, Pediculus humanus corporis, Phthirus pubis, Cimax lectularius, Mites, Ticks, Cattle louse and Xenopsylla cheopis

SUGGESTED BOOKS

1. Textbook of Medical Parasitology. Chakraborty P. New Central Book Agency (P) Ltd., Kolkata.
2. Parasitology. Chatterjee K.D.
3. Parasitology. Dasgupa, B., Books and Allied Pvt. Ltd., Calcutta.
4. Essential of Parasitology. Schmidt G.D. Universal Book Stall, New Delhi.

ZOL 112: PRACTICAL
(BASED ON ZOL E101/ ZOL E102/ ZOL E03/ ZOL El04/ ZOL El 05)
Scheme for Practical Examination

Max. Marks: 100 — Time 4 hrs

1. Exercise (Core 1)	18
2. Exercise (Core 2)	18
3. Spotting (8 x 4)	32
4. Viva Voce	20
5. Record	12

Notes:

1. Anatomy: Study of systems of the prescribed types with the help of dissection.
2. With reference to Museum specimens and microscopic slides, in case of non-availability, the exercise should be substituted with diagrams / photographs.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

3. It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

Dr. Farbat Singh
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M.Sc. ZOOLOGY II SEMESTER
CORE PAPER
ZOL C201: PHYSIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Digestive system:

1. Nature of food-stuff
2. Various types of digestive enzymes and their action in alimentary canal
3. Absorption and assimilation of food
4. Nervous and hormonal control of digestion
5. Energy balance

Circulatory system:

1. Composition and function of blood
2. Haemopoiesis, blood clotting
3. Blood volume, blood volume regulation
4. Comparative anatomy of heart structure
5. Myogenic heart, ECG — its principle and significance, cardiac cycle
6. Heartbeat, blood pressure and blood groups.

Respiratory system:

1. Respiratory organs (gills, trachea and lungs), respiratory pigments
2. Mechanism of breathing
3. Physiology of respiration, control of breathing
4. Aerodynamics and BMR

UNIT-II

Excretory system:

1. Comparative physiology of excretion
2. Functional architecture of kidney and nephron
3. Nitrogenous end products, formation of urine and its hormonal control
4. Role of kidney in osmoregulation, urine concentration .
5. Waste elimination, micturition
6. Electrolyte balance, acid-base balance

Muscular system:

1. Types and properties of muscles
2. Functional architecture of skeletal muscles
3. Biophysical and biochemical events during muscular activity

Nervous system:

1. Functional architecture of neurons
2. Origin and propagation of nerve impulse through axon
3. Action potential, synaptic transmission
4. Reflex arc and reflex action
5. Gross neuro-anatomy of the brain and spinal cord
6. Central and peripheral nervous system
7. Neural control of muscle tone and posture.

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Acad.I

UNIT-III

Sense organs:

1. Structural architecture and functioning of eyes and ears
2. Tactile response

Thermoregulation and cold tolerance:

1. Heat balance and exchange, endotherms Vs ectotherms
2. Counter-current heat exchanger
3. Torpor, hibernation and aestivation
4. Adaptations to extreme climate
5. Comfort zone, body temperature- physical, chemical and neural regulation

Stress:

1. Basic concepts of environmental stress and strain
2. Homeostasis, physiological response to body exercise
3. Meditation, yoga and their effects

UNIT-IV

Endocrinology:

1. Endocrine glands in vertebrates, hormones and related diseases

Reproduction:

1. Reproductive cycle.
2. Reproductive processes (implantation, parturition and lactation), neuroendocrine regulators in insects and mammals, pheromones.

Practicals

1. Photometric determination of haemoglobin in blood sample.
2. Determination of MCV, MCH, MCHC and colour index of the given sample of blood.
3. Demonstration of the blood clotting time and erythrocyte sedimentation rate.
4. Determination of the urea in blood.
5. Determination of the glucose in blood.
6. Liver function test: SGOT & SGPT.
7. Study of digestive enzymes in different parts of the alimentary canal.
8. Study of histological slides of endocrine glands.
9. Study of estrus smear.
10. Demonstration of location of endocrine glands in rat.
11. Measurement of human blood pressure.
12. Demonstration of haemolysis and crenation.
13. Demonstration of Kymographic recording of the frog heart beat and the study of the effect of electrical stimulation, hot and cold, drugs, etc*
14. Kymographic recording of muscle twitch, summation of twitches, chronic contractions, tetanus, fatigue and stair-case phenomenon from the sciatic nerve gastronemius muscle preparation of frog. *
15. Study of spinal and convulsive reflexes in frog*

Following CAL exercise may be included (please see E-pharm programme).

- The effect of K+, Ca++, ACh and Epinephrine on the isolated heart of frog and conclude your data with the graphic representation.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

- The effect of various doses of ACh and Nor-epinephrine on Blood pressure, Heart Rate and Respiratory Rate of the dog with the help of softwares.
- The effects of Atropine, Epinephrine, Ephedrine and Eserine on Rabbit's eyes and other such exercise can be framed from the E-Pharm software.

Note: * indicates use of Computer softwares.

- It should be ensured that animals used in the practical exercises are not covered under the wild life act 1972 and amendments made subsequently.

SUGGESTED BOOKS

1. Animal Physiology Mechanisms and Adaptation. R. Eckert (ed), 5th edition, W.H. Freeman and Company, New York.
2. Biochemical Adaptation. P. W. Hochachka and G.N. Somero (eds). Priceton Univ. Press. Princeton, New Jersey.
3. General and Comparative Animal Physiology. W.S. Hoar (ed). Prentice Hall of India.
4. Animal Physiology: Adaptation and Environment. K.S. SchiemdtNeilsen (ed). University Press, Cambridge, UK.
5. A regulatory Systems Approach. Strand, FL. Physiology: Macmillan Publishing Co., New York.
6. Practical Biochemistry, L. Lummer (ed), Tata McGraw Hill
7. Environmental and Metabolic Animal Physiology, CL. Prosser (ed), Wiley-Liss Inc., New York.
8. Environmental Physiology, P. Willmer, G. Stone, and I. Johnson (eds), Blackwell Publishing, Oxford, UK.
9. Adaptation to Environment: Essays on the Physiology of Marine Animals. R.C. Newell (ed), 1976. Butterworths, London, UK.
10. Physiological Ecology: An evolutionary approach to resource use. Townsend, C.R. and P. Cawlow. Blackwell Sci. Inc. Pub., Oxford, UK.
11. Optima for Animals. R.M. Alexander (ed). Princeton Univ. Press. Princeton, New Jersey.
12. Comparative Physiology: Life in water or land. P. Dejours, L. Bolis, C.R. Taylor and E.R. Weibel (eds). Liviana Press, Padova, Italy.
13. Animals and Temperature: Phenotypic and Evolutionary Adaptation. I.A. Johnson & A.F. Bennett (eds), Cambridge Univ. Press, Cambridge, UK.
14. Physiological Animal Ecology. G.N. Louw, Longman Publishing Group, Harloss, UK.
15. An Introduction to General and Comparative Endocrinology, E.J.W. Barrington (ed), Clarendon Press, Oxford.
16. Comparative Vertebrate Endocrinology. P.J. Bentley (ed), Cambridge University Press.
17. Text Book of Endocrinology, R.H. Williams (ed), W.B. Saunders, Company, Philadelphia.
18. Endocrine Physiology. C.R. Martin (ed), Oxford Univ. Press, New York.
19. Comparative Endocrinology, A. Gorbman, New York: John Wiley and Sons.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

M.Sc. ZOOLOGY II SEMESTER
CORE PAPER
ZOL C202: BIOLOGY OF CHORDATES

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Outline classification of the chordates and characters
2. Evolutionary time scale; evolutionary significance of notochord and endostyle in protochordates
3. Origin, evolution and adaptive radiation of chordates.
4. Origin, evolution and general characters of Agnatha: Ostracoderms and Cyclostomes.
5. The early Gnathostomes (Placoderms).

UNIT-II

1. A general account of the Elasmobranchii, Holocephali, Dipnoi and Crosspterygii.
2. Adaptive radiation in bony fishes.
3. Origin, evolution and adaptive radiation of Amphibia.
4. Origin and evolution of Reptiles: Seymouria and Cotylosauria; Dinosaurs
5. Skull types in Reptiles.
6. Sense organs in reptiles including vomeronasal organs.

UNIT-III

1. Origin and evolution of birds.
2. Origin of flight: Flight adaptations.
3. Flightless Birds.
4. Modifications of beak, feet and palate in birds.

UNIT-IV

1. Origin of mammals: Primitive mammals (Prototheria and Metatheria); Evolution of viviparity
2. Evolution and significance of exothermy & endothermy.
3. General account on adaptive radiations in Eutherian mammals.
4. Stomach in ruminents; evolution of primates

Practicals

1. Anatomy:

   Cranial Nerves of Wallago attu or any other locally edible fish.
   Display Weberian ossicle in fish.
   Tubular air sac of Heteropneustusfossilis, arboracenta organ of Clarius, labyrinthine organs of Anabas, suprabranchial cavity in Channa .
2. Museum specimens: Lower Chordates: Salpa-Asexual and Sexual stage, Doliolum- oozoid, Botryllus, flerdmania and Amphioxus, Petromyzon, Myxine.

Pisces: Rhinobatus,'Pristis, Trygon, Chimaera, Polyclon, Acipenser, Amia, Lepidosteus, Protopterus, Lepidosiren, Neoceratodus, Notopterus, Exocetus, Echeneis, Pleuronectes,

Dr. Farhat Singh
Asstt. Registrar
Acad.I

Clarias, Mestacembelus, Diodon, Tetradon, Ostracion, Lophis, Syngnathus, Hippocampus, Anguilla, Labeo, Ophiocephalus, Harpodon (Bombay Duck).

Amphibia: Icthyophis, Necturus, Proteus, Ambystoma, Axolotle larva, Salamander, Siren, Alytes, Pipa, Bufo, Hyla, Rhacophorus, Rana.

Reptilia: Testudo, Chelone, Sphenodon, Calotes, Hemidactylus, Phrynosoma, Draco, Varanus, Chameleon, Cobra, Hydrophis, Rattle Snake, Viper, Pit Viper, Krait, Eryx, Gavialis.

Aves: Archaeoptéryx, Taylor Bird, Indian Koel, Jungle fowl, Pavo, Columba, Psittacula, Wood Pecker, Bubo (Horned), Flamingo.

Mammals: Ornithorhynchus, Echidna, Macropus, Hedgehog, Manis, Loris, Bat, Mangoose, Hystrix, Otter.

3. Microscopic Slides: Lower Chordates: Herdmania -tadpole larva, Amphioxus -T. S. passing through oral hood, pharynx, testes, ovary, intestine and caudal regions, Ammocoete- larva whole mount.

Pisces: Placoid scale, Cycloid scale, Ctenoid scale.

Amphibia: V S skin of Frog, T S passing through stomach, duodenum, intestine, liver, pancreas, lung, kidney, testes, ovary, spinal cord, bone.

Reptelia: V S skin of lizard.

Aves: V S skin of bird, contour feather, down feather.

Mammalian tissues: Blood smear, Simple cuboidal epithelium, Simple columnar epithelium, Simple squamous epithelium, Adipose tissue, Reticular tissue.

Mammals: V S skin of mammals, T S passing through stomach, intestine, liver, pancreas, kidney, testes, ovary, thyroid gland, adrenal gland, pituitary gland, lung, bone, spinal cord.

4. Comparative Osteology:

- Comparative account of axial and appendicular skeletons of Frog, Varanus, Fowl and Rabbit (both articulated and disarticulated).
- Skull of Reptiles (Anapsida and Diapsida).
  Palate in Birds.
- Skull and lower jaw of carnivore mammal & herbivore mammal.

Collection of various types of feathers.

Note:

1. With reference of whole mounts and museum specimens the animal types may be substituted with diagrams/photographs/models etc.
2. It should be ensured that animals used in the practical exercise are not covered under the wild life act 1972 and amendments made subsequently.

Recommended Books

1. The Chordata, Alexander, R.M. Cambridge University Press, London.
2. Structure and Habit in vertebrate evolution carter, G.S.Sedgwick and Jackson, London.
3. Analysis of Vertebrate Structure. Milton Hilderhrand. John Wiley and Sons, Inc, New York.
4. Vertebrate Body. Romer A.S. W.B. Saunders Co., Philadelphia.
5. Life of Vertebrate, Young. J.Z. The Oxford University Press. London.
6. Life of Mammals, Young. J.Z. The Oxford University Press. London.
7. Evolution of the Vertebrates, Colbert. E.H. John, Wiley and Sons Inc., New York.
8. Vertebrate Paleontology. Romer. A.S.University of Chicago Press, Chicago.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

9. Chordata Structure and Function. Waterman. A.J.Macmillan Co. New York. 10. Vertebrate Evolution. Joysey.K.A. and T.S.Kemp. Oliver and Boyd. Edinbourgh. 11. The Phylogeny of Vertebrate. Lovtrup.S.JohnWiley and Sons. London
12. The Biology of the Amphibia. Kingsley Noble G.Dover Publications. New York
13. Avian Biology (in several volumes). Farner, D. S. and King, J. R., AcademicPress, New York, 1971.
14. Analysis of Vertebrate Structure, Hildebrand, M. 4th edition, John Wiley & Sons, Inc., New York, 1995.
15. Vertebrate Life, McFarland, W. N., Pough, F. Fl., cade, T. J. and Heiser, J. B., Macmillan Publishing Co., Inc., New York, 1979.
16. Text Book of Zoology, Parker, T. S. and Haswell, W. A., ELBS, 1978. Weichert CK and Presch. W. Elements of chordate Anatomy 4th Ed. Mc Growhall Co. New Delhi.
17. Mammalogy: Adaptation, Diversity, Ecology. 3 rd Edition, George A Feldhamer Et, Johns Hopkins, 2007.
18. Vertebrates: Comparative Anatomy, Function, Evolution, 7th Edition, Kardong, Mc Graw Hill, 2014

M.Sc. ZOOLOGY II SEMESTER
CORE PAPER
ZOL C203: BIOSTATISTICS

Max. Marks: 100

Total Hours: 60

UNIT-I

Introduction to Biostatistics:

1. Definition of biostatistics
2. Scope and applications of biostatistics
3. Collection, organization and representation of data (graphical- Bar, Histogram, Frequency polygon, line diagram & diagrammatic)

Measures of Central Tendency & Variability (Direct, Shortcut and Step-deviation)

1. Mean, median & mode
2. Mean deviation
3. Standard deviation & standard error
4. Variance & coefficient of variation
5. Confidence interval and level of confidence

UNIT-II

Correlation and Regression:

1. Types of correlation
2. Methods of studying correlation
3. Regression analysis

Probability:

1. Basic concepts related to probability theory.
2. Classical, Posteriori, Personalitic & Axiomatic probability.
3. Theorems of probability & Probability distributions.
4. Properties of Binomial, Poisson, Normal and skewed distribution & their application in biology.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

UNIT-III

Tests of significance:

1. Hypothesis testing & level of significance
2. Type I & II errors
3. Significance of difference in means
4. Z-test
5. Student's t-test (Unpaired & Paired)
6. F-test (variance ratio)

Analysis of variance:

1. One-way classification
2. Two-way classification

UNIT-IV

Chi square test:

1. Testing Goodness of fit
2. Chi Square distribution and characteristics
3. Applications of Chi-square test
4. Yate's correction

Computational statistics using MS Excel

Practicals

1. Preparation of frequency tables, bar diagrams, histograms, frequency, ogives and pidiagrams.
2. Calculation of mean, median, mode, standard deviation and coefficient of variation.
3. Estimation of probability.
4. Estimation of significance between samples using Student's t-test, F-test and Chisquare test.
5. Plotting of scatter diagrams & regression lines, calculation of correlation and regression analysis.
6. Use of MS Excel spread sheet for data processing.
7. Preparation of graphs using computers

SUGGESTED BOOKS

1. Introduction to Bioinformatics, Attwood, T. K. and Parry Smith D. J. (2006) Pearson Education, Singapore.
2. Fundamentals of Biostatistics, 7th edition, Bernard Rosner (201 1) Cengage learning Inc.
3. Structural Bioinformatics, Bourne P. E. and Weissig, H. (2003) Wiley —Liss New Jersey, USA.
4. Elementary Statistics: A Breif Version (5thed.) Bulman A. (2012) McGraw-Hill Higher Education.
5. Biostatistics: The Bare Essential 3 rd edition, Geoffrey R. Norman and David L. Streiner (2008) BC Decker Inc.
6. Biostatistics: A Methodology for the Health Sciences, Gerald van Belle, Lloyd D. Fisher, Patrick J. Heagerty and Thomas Lumley (2004) John Wiley & Sons, New Jersey.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

7. Sampling Design and Statistical Methods for Environmental Biologist,Green R. H. (1979) John Wiley & Sons, Newyork.
8. Biostatistical Analysis 5 th edition, Jerrold H. Zar (2010) Pearson Education, Singpore.
9. Biostatistical Methods: The Assessment of Relative Risks 2nd edition, John M. Lachin (2010) John Wiley & Sons, Newyork.
10. Basic Epidemiological Methods and Biostatistics Randy M. Page, Galen E. Cole and Thomas C. Timmreck (1995): A Practical Guidebook, Jones and Bartlett publishers.
11. Biometry: The Principles and Practices of Statistics in Biological Research, Sokal R. R. and Rolff. J. (2003) W. H. Freeman publishers.

ZOL 211: PRACTICAL
(BASED ON ZOL C201, ZOL 202 and ZOL C203)
Scheme for Practical Examination

Max. Marks: 150 Time: 6 hrs

I. Exercise Core I	18
2 Exercise Core 2	18
3. Exercise Core 3	18
3. Spotting (12 X 4)	48
4. Viva Voce	30
5. Record	18

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

M.Sc. ZOOLOGY II SEMESTER
ELECTIVE
ZOL E201: IMMUNOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Historical perspective of Immunology, Early theories of Immunology, Innate, Adaptive (cell mediated and humoral)- Passive: Artificial and Natural Immunity, Active: Artificial and Natural Immunity.
2. Haematopoiesis, Cells of the immune system, Organs of the immune system: Primary and secondary lymphoid organs, Lymphatic system.

UNIT-II

1. Properties of antigens, Haptens, Determinants, Adjuvants.
2. Antibodies: Basic structure, classes and function.
3. Antigen- Antibody Interactions: Precipitation, Agglutination, immune-electrophoresis, Neutralizing reactions, Complentation (Classical, Alternative & Lectin pathway).

UNIT-III

Dr. Farbat Singh
Asstt. Registrar
Acad.I

1. Mechanism of cell mediated and humoral immunity.
2. MHC Structure and types, Endogenous pathway and exogenous pathway of antigen presentation.
3. Vaccine: Immunization schedule, types: attenuated and inactivated, DNA vaccine, Recombinant vaccine.

UNIT-IV

1. Immunodeficiency:
   A. Phagocytic deficiencies
      (i) Neutrophil deficiencies.
      (ii) Defective phagocytic functions.
   B. Humoral Deficiencies
      (i) Hyper IgM syndrome.
      (ii) X linked Agammaglobulenemia.
      (iii)Common variable hypogammaglobulenemia.
   C. Cell Mediated Diseases- (i) DiGeorge Syndrome. (ii) Nude mice.
2. Hypersensitivity: Type I, II, III & IV.
3. Tolerance: General features of immunologic tolerance, T- and B-cell tolerance, induction of tolerance.

Practicals

1. Dissection, localization and study of lymphoid organs in rats.
2. ABO blood group determination.
3. Widal's test.
4. Ouchterlony's double immunodiffusion method.
5. Immunoelectrophoresis (Rocket electrophoresis).
6. Viability and cell counting of peritoneal macrophages using Trypan blue.
7. Study of various types of immune reactions in vitro.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

Suggested Books

1. Principles of Biochemistry. Nelson D.L., Cox, M.M. and Lehninger, A.L. IV Edition. W.H Freeman and co., 2009.
2. Harper's Illustrated Biochemistry. Murray R.K., Granner D.K., Mayes, P.A. and Rodwell V.W. XXVIII Edition. Lange Medical Books/McGraw-Hil[., 2009.
3. Immunology. Kindt T.J, Golds R.A., Osborne B.A. and Kuby J. VI Edition. W.H. Freeman and Company, 2006.
4. Roitt's Essential Immunology. Delves P.J., Martin, S.J. Burton DR. and Roitt, I.M. XI edition. Blackwell Publishing, 2006.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

M.Sc. ZOOLOGY II SEMESTER

ELECTIVE

ZOL E202: WILD LIFE, ITS MANAGEMENT AND CONSERVATION

Max. Marks: 100 Total Hours: 60

UNIT-I

Wildlife:

1. Definition and significance.
2. National park and Sanctuaries, Reserves. Hot spots and Hope spots.
3. IUCN classification of species, red data book.

UNIT-II

1. Techniques of studying wild life, traditional and advanced both.
2. Endangered species of India and their present status.
3. Measures adopted by government to protect them.
4. Management of excess population and translocation, Bio-telemetry, care of injured animal and Quarantine

UNIT-III

1. Management of special habitats.
2. Problems in plantations and exploited forests.
3. Species conservation projects: Tiger, lion, rhino and crocodile management plan for protected areas
4. Threats to survival of slender Loris, Musk Deer, Great Indian Bustard and Olive Ridley turtle.

UNIT-IV

1. Wildlife and livelihood, wildlife and illegal trade, its control 2. Use of Biotechnology in Wild life conservation.
3. Captive breeding in-situ and ex-situ gene pool conservation.
4. Indian biodiversity act, economics of Indian biodiversity.
5. Wildlife protection Act 1972 its amendments and its applications.

Practicals

1. Study of wildlife habitat.
2. Visit to Zoological Park/ National park and sanctuaries/ reserves and hot spots.
3. Study of different type of animals in terrestrial and aquatic habitat
4. Quantitative estimation of any two species in nature by traditional method. (Insect, amphibian, reptiles or mammals).
5. Techniques of studying wildlife's and its census; traditional and advanced methods.
6. Project report -Tiger project / Ghariyal project in Rajasthan.
7. Evaluation of biodiversity: (a) Shannon-Weiner index (b) Dominance index.
8. Hair samples: (a) Species identification of selected mammals (minimum five, slides to be submitted).

(b) Morphometric studies.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

Suggested Books

1. Techniques for wildlife Census in India (A field manual): Rogers W.A. Wildlife Institute of India, Dehradun.
2. Wifdfife M/ealth of India, Majupuria T.C Tecpress Services, L.P., 487/42-SOI. Wattenslip, Pratunam Bangkok, 10400, Thailand
3. Handbook of Birds, of India, Ali, Ripley S.D. Pakistan 10-Vols. Oxford University Press, Bombay.
4. The Book of Indian Prater S.H. BNHS-Publication, Bombay.
5. Wildlife in India. Saharia V.B. Natraj Publishers, Dehradun.
6. The Wildlife of India E.P. Gee.
7. Techniques for wildlife census in India (A Field Manual) W.A. Rogers, Wildlife Institute of India.
8. Species identification from guard hair OF SELECTED Indian mammals: A reference guide. Bahuguna A, Sahajpal V , Goyal SP, Mukherjee SK & Thakur V. Wild Life Institute of India 2010.

M.Sc. ZOOLOGY II SEMESTER

ELECTIVE

ZOL E203: APPLIED BIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Introduction to the concept of Recombinant DNA Technology.
2. Cloning vectors.
3. Restriction and modifying enzymes,
4. Transfection techniques (microbial, plants and animals).
5. Isolation, Sequencing and synthesis of genes.
6. Construction and screening of cDNA libraries.

UNIT-II

1. Molecular analysis of DNA, RNA and proteins (i.e., Southern, Northern and Western blotting), DNA sequencing (Maxxam-Gilbert and Sanger methods).
2. Polymerase chain reaction and DNA microarrays.
3. Molecular map of animal genomes.

UNIT-III

1. Molecular diagnosis of genetic diseases (Cystic fibrosis, Huntington"s disease and Sickle cell anaemia).
2. Recombinant vaccines.
3. Recombinant DNA in Medicine (Recombinant insulin and Human growth hormone),
4. Gene therapy (ADA and Cystic fibrosis).
5. Stem Cells and their applications.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

UNIT-IV

1. Production and applications of transgenic plants (biotic, abiotic and improvement of nutritional quality) and transgenic animals (generation of medicines and hormones).
2. Different types of Bioreactors and their uses.
3. Use of Biotechnology in conservation of Biodiversity.

Practicals

1. Isolation of plasmid DNA from E. coli.
2. Transformation of E. coli (PUC 18 and 19) and calculation of transformation efficiency.
3. Restriction Endonuclease Digestion of plasmid DNA.
4. Ligation of Target DNA.
5. Gene amplification using PCR.
6. DNA sequencing: Interpretation of sequence from the data provided.
7. Analysis of DNA fingerprint.
8. Separation of proteins by SDS-PAGE.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

Suggested Books

1. Microbiology. 5th edition Pelezar M.J. Chan E.C.S and Krieg N.R. Tata McGraw-Hill Book co. New Delhi, 2001.
2. Preventive and Social Medicine. Park K. B.B. publishers, 2007.
3. Molecular Biotechnology- Principles and Applications of Recombinant DNA, Glick B.R. and Pasternak J. J. (2010) ASM press, Washington, 2010.
4. Recombinant DNA- Genes and Genomics- A short Course. 3rd edition. Watson J.D., Myers RM., caudy A., Witkowski J.K. (2007) Freeman and co. NY, 2007.

M.Sc. ZOOLOGY II SEMESTER

ELECTIVE

ZOL E204: HISTOLOGY AND HISTOPATHOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Definition and scope of histology and histopathology.
2. Tools in histology: Principles, design and functioning of microtomes, automated microtomes, ultra-microtome, problems and trouble shooting.
3. Techniques in histology: Sample preparation, obtaining tissue samples, handling reagents, fixatives, processing of fixed samples, dehydration, embedding, block making and slide preparation
4. Staining principles and demonstration techniques. Stains, dyes and dye binding reactive groups, mordants and mordanting.

Dr. Farbat Singh
Asstt. Registrar
Acad.I

UNIT-II

1. Cellular Pathology; necrosis, pycnosis, apoptosis, nuclear fragmentation, fatty degeneration etc.
2. Fundamentals of histology: Epithelial, connective, muscular, nervous and other specialized tissues.
3. Skin.
4. Histology and histopathology of blood, spleen and thymus.

UNIT-III

1. Histology and histopathology- thyroid, parathyroid, pituitary and adrenal gland.
2. Reproductive system — male and female.

UNIT-IV

1. Histology and histopathology-esophagus, stomach, intestine, colon and rectum, liver, pancreas.

Practicals

1. Fixation, dehydration, embedding, sectioning, staining, permanent mounting of tissues and histology
2. Microscopic measurements of histological samples using micrometers and planimete
3. PAS reaction, Alcian blue reaction, and detection in situ
4. Alkaline phosphatase detection in situ
5. Feulgen reaction
6. Sudan black B staining for lipids
7. Methyl green — Pyronin G method of detection of nucleic acids
8. Study of different types of pathology in the tissues with the help of permanent slides.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1972 and amendments made subsequently.

SUGGESTED BOOKS

1. Histological and Histochemical methods: Theory and Practice. 4th edition (2008), J. A. Kiernan Publisher — Scion Publishing Ltd. Oxford shire.
2. Colour Atlas of Histology. 3rd edition (2000) L. P. Gartner and J. L. Hiat Publisher — Lippincott- Williams & Wilkins, Baltimore.
3. Histology: A text book and Atlas. 2nd edition (1989). M. H. Ross, E. J. Reith and L. J. Romrell Publisher - Williams & Wilkins, Baltimore.
4. Bailey's text book of Histology. 15th edition (1964). W. M. Copenhaver. Publisher — The Williams & Wilkins Company. Baltimore.
5. A text book of Histology (1975), Bloom and Fawcett Publisher W. B. Saunders Company Philadelphia.
6. Histology and Cell Biology: An introduction to pathology (2002), A. L. Kierszenbaur Publisher - Mosb.y Inc. St. Louis USA.
7. Histopathology (2012) Guv Orchard and Brian Nation — Oxtòrd Univ. Press.

Dr. Farbat Singh
Asstt. Registrar
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M.Sc. ZOOLOGY II SEMESTER
ELECTIVE
ZOL E205: POPULATION GENETICS

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Introduction to population genetics.
2. Genetic variation, Ecological significance of molecular variations.
3. Hardy Weinbergs law of genetic equilibrium — Assumptions, predictions and derivation of Hardy Weinbergs law, testing & extensions of Hardy Weinbergs law and limitations.
4. Genetic structure of natural populations, Models explaining changes in genetic structure.

UNIT-II

1. Molecular phylogenetics.
2. Construction of phylogenetic tree.
3. Phylogenetic inference- Distance methods, Parsimony methods, Maximum likelihood method.
4. Immunological techniques.
5. Amino acid sequence and phylogeny.
6. Nucleic acid phylogeny, DNA — RNA hybridizations, restriction enzyme sites, nucleotide sequence comparisons and homologies.

UNIT-III

1. Molecular evolution
2. Gene evolution.
3. Gene duplication and divergence.
4. Evolution of gene families.
5. Molecular drive.
6. Molecular clocks.

UNIT-IV

1. Genetics and quantitative traits in population.
2. Estimation of heritability.
3. Molecular analysis of quantitative traits.
4. Genotype —Evolution interaction.
5. Inbreeding and Heterosis.
6. Neutral theory of molecular evolution. 7. Migration including One Way migration.

Practicals

1. Estimates of Heritability
   a) Broad sense
   b) Narrow sense
   c) Components in Phenotypic variations
   d) Genetic variance
   e) Genetic environmental interactions
2. Hardy Weinberg Principle
   a) Genotypic frequencies and Hardy Weinberg law

Dr. Farbat Singh
Asstt. Registrar
Acad.I

b) Allelic frequencies (from observed no of different genotypes at particular locus and from genotypic frequencies
c) Calculation of allelic frequencies with multiple alleles and at X linked locus

3. Genetic Structure of populations
   a) Phenotypic Frequency
   b) Allelic frequency
   c) Recessive and dominant characters
4. Exercises based on blood groups
5. Demonstration of microbes' increment (Population Growth) by inoculating culture medium with microorganisms from soil air and water

Suggested Books

1. Evolution, Strickberger, M. W. Jones and Barlantt Publishers. Boston London
2. Evolutionary and Genetics. J.M. Oxford University Press. New York
3. Evolution Genetics Merral, D.J. Holt, Rinchart and Winston, Inc.
4. Species Evolution — The role of chromosomal change. King, M. Cambridge University Press, Cambridge.
5. A primer of Population Genetics. Hart, D.L. Suinuaer Associate, Inc. Massachusetts. 6. Evolutionary Biology, Futuyamma, D.J. Suinuaer Associate, Inc. Publishers, Sunder land
7. Genetics and Origin of Species, Dohnzhansky, Th. F.J. Alaya G.L. Stebbines and J.M Valentine, Surjeet Publication Delhi
8. Genes and Evolution, Jha A.P. John, Publication New Delhi.

ZOL 212: PRACTICAL-IV

(BASED ON ZOL E201/ ZOL E202/ ZOL E203/ ZOL E204/ ZOL E205)

Scheme for Practical Examination

Max. Marks: 100	Time 6 hrs
1. Exercise I	18
2. Exercise 2	18
3. Spotting (12 X 4)	32
4. Viva Voce	20
5. Record	12

Note: It should be ensured that animals used in the practical exercises are not covered the Wildlife act 1972. and amendments made subsequently.

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