MAHARAJA SURAJMAL BRIJ UNIVERSITY, BHARATPUR

(A State Govt. University)

Chak Sakeetra, Kumher – 321201 (Rajasthan)

SYLLABUS

M.Sc. ZOOLOGY

(Semester Scheme)

Batch 2024-26
(III & IV Semester)

Post Graduate Curriculum Framework based on
Choice Based Credit System
&
National Education Policy - 2020

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MAX.MARKS: 100
THEORY PAPER DURATION: 3HRS

PASS MARKS: 40
PRACTICAL: 6HRS

SCHEME OF EXAMINATION AND CREDITS

1. The syllabus adopts from University of Rajasthan with appropriate changes.
2. The student will require to earn minimum 106 credits for PG course out of total 124 credits.
3. In theory, 15hrs of teaching is equal to 1 credit.
4. In practical, 45hrs of laboratory works is equal to 2 credits.
5. In each semester contain Core Course Compulsory (CCC), Elective Core Compulsory (ECC) and Value Added Course (VAC) and Skill Enhancement Course (SEC) with choice.
6. Students shall select any one specialization with compulsory research dissertation.
7. Each Semester will have continuous assessment which will include internal assessment in theory and practical by internal examination (15 marks) / Assignment presentation with Viva-Voce (10 marks) class attendance (5 marks). The maximum marks will be 30.
8. Each theory paper shall carry 100 marks. It will be of 3hrs duration. End semester examination and internal assessment weightage in ratio of 70:30 respectively.

   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.
9. Each paper practical examination will be of 2hrs duration and will involve laboratory experiments /exercises and Viva —voce 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

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	ZOLCA301	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)	CCC	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 CC30l, ZOL CC302 and ZOL CC303)	CCC	6
CORE COURSE COMPULSORY (GROUP–D) REPRODUCTIVE BIOLOGY (SPECIALIZATION)				
1	ZOL CD301	Endocrine Glands and Hormones	CCC	4
2	ZOL CD302	Male and Female Reproductive Systems	CCC	4
3	ZOL CD303	Biology of Gametes, Reproductive cycles and Behaviours	CCC	4
4	ZOL D311	Practical Core Paper (Based on: ZOL CD301, ZOL CD302 and ZOL CD303)	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	Tools & Techniques	ECC	4
4	ZOL E304	Evolution	ECC	4
5	ZOL E305	Ecology	ECC	4
6	ZOL E306	Ethology	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
SKILL ENHANCEMENT COURSE COMPULSORY				

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1	ZOL SEC	Select any skill Enhancement Course from Syllabus	SEC	2

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 CA401	Nature & Types of Cancer	CCC	4
2	ZOL CA402	Molecular Mechanism of Cancer Tumour Immunology	CCC	4
3	ZOL CA403	and Treatment	CCC	4
4	ZOL A411	Lab based on: ZOL CA401, ZOL CA402 and ZOL CA403	CCC	6
5	ZOL RD412	Research Dissertation		8
		CORE COURSE COMPULSORY (GROUP–B) CELL AND MOLECULAR BIOLOGY (SPECIALIZATION)		
1	ZOL CB401	Basic Immunology	CCC	4
2	ZOL CB402	Immunology: Molecular Expression and Function	CCC	4
3	ZOL CB403	Immunology: Application and Cellular Malfunction	CCC	4
4	ZOL B411	Lab based on: ZOL CB401, ZOL 4B02 and ZOL 4B03	CCC	6
5	ZOL RD412	Research Dissertation		8
		CORE COURSE COMPULSORY (GROUP–C) ENTOMOLOGY (SPECIALIZATION)		
1	ZOL CC401	Insect Pests	CCC	4
2	ZOL CC402	Insect Pest Management	CCC	4
3	ZOL CC403	Applied Entomology	CCC	4
4	ZOL C411	Lab based on: ZOL CC401, ZOL CC402 and ZOL CC403	CCC	6
5	ZOL RD412	Research Dissertation		8
		CORE COURSE COMPULSORY (GROUP–D) REPRODUCTIVE BIOLOGY (SPECIALIZATION)		
1	ZOL CD401	Physiology of Reproduction	CCC	4
2	ZOL CD402	Contraception and Reproductive Health Reproductive	CCC	4
3	ZOL CD403	Technologies	CCC	4
4	ZOL D411	Lab based on: ZOE CD401, ZOL CD402 and ZOL CD403	CCC	6
5	ZOL RD412	Research Dissertation		8
		SKILL ENHANCEMENT COURSE COMPULSORY		
1	ZOL SEC	Select any skill Enhancement Course from Syllabus	SEC	2

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

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M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA301: BASICS OF RADIATION BIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Fundamentals of radiation:

1. Natural and artificial radioactivity.
2. X-rays production, characteristics and applications, hard and soft X-rays.
3. Ionizing and non-ionizing radiation (electromagnetic radiation).
4. Units of radiation and half-life of radioisotopes.

UNIT-II

Cellular radiobiology:

1. Effects of radiation on macromolecules.
2. Cell survival curves.
3. Concept of ID50/30 and Dose reduction factor (DRF).
4. Radio-sensitivity of cell cycle phases, cell division delay and cell cycle check points.

UNIT-III

Detection monitoring and measurement of radiation:

1. Film badge.
2. Pocket dosimeter.
3. Thermo luminescence dosimeter.
4. G. M. counter.
5. Scintillation counter.
6. Proportional counter.
7. Gamma ray spectrophotometer.

UNIT-IV

Radiation safety and regulatory aspects:

1. Radiation contamination and Decontamination
2. Maximum permissible dose, ALARA
3. Personal management and safe work practice
4. National and International statutory bodies.
5. Radiation accidents and their management

M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA302: RADIATION EFFECTS

Max. Marks: 100 Total Hours: 60

UNIT-I

Radiation induced DNA damage and repair:

1. Repair of DNA breaks. 2. Repair of base damage.
3. Photo-reactivation, excision repair.

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4. Post-replication recovery.
5. Base excision repair, nucleotide excision repair (NER).
6. Transcription coupled repair (TCR) and bulk DNA repair.

UNIT-II

Radiation Chemistry:
1. Interaction of radiation with matter:
2. Photoelectric and Compton effects.
3. Ion pair production and Scattering.
4. Radiolysis of water.
5. Formation of oxygen reactive species, Oxygen effect.
6. Linear energy transfers and relative biological effectiveness.

UNIT-III

Cytogenetic effects of radiation:
1. Chromosomal aberrations.
2. Micronuclei induction.
3. Radiation induced Mutations
4. Radiation syndromes

UNIT-IV

Delayed radiation effects:
1. Stochastic and deterministic effects.
2. Direct and indirect effects.
3. Life shortening.
4. Radiation hormesis.
5. Radiologic aging.
6. Radiation carcinogenesis.

M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA303: MOLECULAR RADIOLOGY AND ITS APPLICATION

Max. Marks: 100

Total Hours: 60

UNI-I

Medical Applications
1. Radiation Imaging
2. Radiation therapy (External beam radiotherapy, Brachytherapy)
3. Radioactive tracers
4. Radioimmunoassay
5. Therapeutic nuclear medicine.
6. Autoradiography.

UNIT-II

Applications of Radiation in communication

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l. Radio Frequency (RF) Communication
2. Satellite communication
3. Infrared and Visible Light Communication (Wi-Fi)
4. Cellular Communication (IG to 5G)
5. Bluetooth and Near Field Communication

UNIT-III

Nuclear Energy

l. Introduction to Nuclear Energy
2. Nuclear fusion as a potential energy source
3. Nuclear Reactors
4. Nuclear Weapons
5. Safety considerations and containment in nuclear facilities

UNIT - IV

Application of Radiation in Research and Industry

1. Radiation in Biological Research: X-ray Crystallography, NMR, Circular Dichroism, DLS, XRD.
2. Material Science Applications: Industrial radiography, Ion Beam Analysis (IBA): Ion beams, such as Rutherford Backscattering Spectrometry (RBS) and Particle-Induced X-ray Emission (PIXE).
3. Radiocarbon dating

Practicals

l. Symbol of Radiation: Trefoil.
2. Knowledge and use of the various instruments. Geiger-Muller counter.
3. Scintillation counters, Survey meter, Single-channel gamma spectrometer.
4. Cobalt camera. Linear Accelerator.
5. Finding out the operating voltage of the G-M tube.
6. Calculation of Inverse Square Law.
7. Determination of the resolving time of the G-M tube.
8. Absorption of beta and gamma rays.
9. Determination of Back scattering factors.
10. Histopathological, histochemical and biochemical studies of various tissues after external irradiation.
11. Personnel monitoring: use of survey meter, film badge, and room contamination monitor.
12. Decontamination of contaminated material.
13. Visits to the Radiotherapy Department, S.M.S. Medical College, Jaipur; Rajasthan Atomic Power Project, Kota and Bhabha Atomic Research Centre, Mumbai.

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

Recommended Books

1. Radiation Biophysics. Prentice-Hall Engel-Wood Cliffs. Andrews, H. New Jersey. 1974 or Later Edition.
2. Ionizing Radiation and Life. Mosby, Avena, V: S l . Lonis. 1971 or Later Edition.
3. Low Dose Radiation Biological Bases of Risk Assessment. Baverstock, K. of Staltar,

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4. J. Taylor of Francis, 1989.
5. Low level Radiation Effects. Broil. AB. A fact Book: Society of Nuclear Medicine, USA, 1982.
6. Radiobiological Consequences of Nuclear Accidents -Contamination Radioecology, Bulokav EB., V Naiitel and J. B. Reitan: Radiobiology and Health.
7. Radioisotope Methodology. Chase, GD. and Robinowitz, J. L. Burgess Publishing Co. Minneapolis, Minn, USA. 3rd Edition, 1967 or Later.
8. Biological Effects of Radiation. Coggle. J.E.: Taylor and francis Ltd., London, 1988 or Later Edition.
9. Medical Radiation Biology, Dalrymple, G. V, Ganldev, M.E., Kollmorgen, G. M. and Vogel, H, J. Saunders. Philadelphia, 1973 or Later Edition.
10. Introductory Biostatistics for the Health Sciences. Duncan R. C. , Knapp. , R. G., and Miller Ill, NI.C., :John Wiley and Sons. Inc., New York, 1977 or Later Edition.
11. Radiobiology. Fobrikant. J. L: Year book med., Chicago, 1972 or Later Edition.
12. Biological Assessment of occupational Exposure to Actinides. G. B. Gendes, H. Metives and J. Stathes: Nuclear Tech. Pub. Kent, 1989.
13. Environment and Human Risks of Tritium, Gesben, G. , C. M. Menaene and H. Smilts: Nuclear Tech. Pub. Kent, 1986.
14. Applied Radiobiology of Radiation Protection. Granien, R., Prentice Hall, 1990.
15. Biological Effects of Radiations. Grosel, D. S. and Hop Zvood, L.E. Academic Press, New York, 2nd Edition, 1979 or Later Edition.
16. Radiobiology for the Radiologist. 3rd Edition, Hall. E. L.: Harper and Row, 1990 or Later Edition.
17. Radiation and Life. Hall. E. 1.: Pergamon Press, Oxford, U. K. 2nd Edition, 1987.
18. Health Effects of Low Level Radiation, Hendec. w. R.: Prentice Hall. 1984.
19. Low level Radiation and Living State. Huilgol. N. G. et al.: Naraza Publishing House, Community Center Panchsheel Park, New Delhi, 1993.
20. Biological Radiation effects. Kiefer, J. Springer-Venlag, Berlin, 1989.
21. Developmental Effects of Prenatal Irradiation. Kriegel, H..VCH,. 1982.
22. Cellular Radiobiology. Lawrence c.w. Arnold, London, 1971 or Later Edition.
23. Biological Aspects of Human Irradiation Eds. Pant, G. S. and Basu, AK. Himalaya Publishing House, Delhi, 1992.
24. Basic Radiation Biology. Pizzarello D.J., Witcofsli Lea R. L. and Febiger: Philadelphia, 1970 or Later.
25. Human Radiation Biology. Prasad, K. N., CRC Press, inc. Cleveland, Ohio, USA, 1984.
26. Advanced Medical Radiation Dosimetery. Rajan O. Prentice-Hall of India Pyt. Ltd. New Delhi, 1992.
27. Frontiers of Radiation Biology. Riklin, E. ed. VCH, 1990.
28. Radiation Exposure and Occupational Risks. Scheres, E., c. Streffer, K. R. Trott.. Eds. Berlin, 1990.
29. Elements of Radiobiology, Seiwan J. Thomas, C. C. 1983.
30. Essential of Radiation Biology and Protection, Steve Forshie: Publisher: Delmar Cengage Learning.
31. Radiation Carcinogenesis. Upton, A. C. Ehseviees, 1986.

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ZOL A311: PRACTICAL
Scheme for Practical Examination
(Based on ZOL CA301, ZOL CA302 and ZOL CA303)

Max Marks: 150 Time 6 hrs.

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

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M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB301: CELLULAR STRUCTURE AND FUNCTION

Max. Marks: 100 Total Hours: 60

UNIT-I

Bio-membranes:

l. Molecular constituents of membranes: Lipids (glycerophospholipids, sphingophospholipids, glycolipids, sterols); proteins (extrinsic, intrinsic —glycophorin, porin & fusion proteins)
2. Fluid Mosaic model.
3. Fluidity and mobility of lipids and proteins.
4. Diseases: Tay Sachs disease & Nieman —Picks disease.
5. Chemistry of fixatives: Common properties of fixatives, formalin, acetic acid, alcohol acetone, picric acid, gluteraldehyde, metallic ions and complexes.
6. Choice of fixatives: Glycogen, lipids, nucleic acid, enzymes (alkaline phosphatase, acid phosphatase, esterase & sulphatase).

UNIT-II

Transport across cell membrane:

l. Mechanism of diffusion; Facilitated diffusion.
2. Osmosis, permeability constant, factors influencing permeability & Gibb's — Donnan effect.
3. Uniporter-catalyzed transport, difference between uniport-catalyzed transport and passive diffusion, GLUT- 1-5 transport & its kinetics.
4. Ion channels and membrane electric potential (Nernst equation).
5. Active transport - P-class ion pumps, F-class and V-class ion pumps, ABC superfamily. Plasma membrane Ca++AT Pase pump, Muscle Ca ATPase pump & Na+/K+ ATPase pump, Ionophores.
6. Cotransport by symportors and antiporters.
7. Transport across epithelia; Endocytosis: pinocytosis, phagocytosis & receptor mediated; Transcytosis.
8. Diseases: Cystic fibrosis & Type I Diabetes mellitus.

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UNIT-III

Cytoskeleton:

1. Intermediate filament: Proteins, assembly, organization (desmosomes, hemidesmosomes, desmin & neuro filaments).
2. Microfilaments:
   (i) Actin: G-actin, F-actin, structural and functional polarity.
   (ii) Assembly, disassembly and organisation of actin filaments: Polymerization, actin _binding proteins (Formin, Arp2/3 complex, ADF/ Coffin, Proflin, CapZ etc.), actin bundling proteins, toxins affecting polymerization.
3. Actin filaments and plasma membrane: RBC cytoskeleton, platelet cytoskeleton projecting fingers of membrane.
4. Myosin: Structure, mechanism of movements with actin & conformational changes in myosin during movement.
5. Microtubules: Structure, assembly of microtubules from organizing centre, dynamic organization, microtubule associated proteins (MAPs),. microtubules associated structures (Centrosome duplication, kinetochore and force for poleward chromosome movement, Organization of spindle pole and orientation of assembly, astral microtubule and cytokinesis & microtubules and plant cell formation) and drugs disrupting microtubules.
6. Microtubules motor proteins:
   (i) Intracellular transport: Role of kinesin and dynein, microtubule tracks and intracellular membrane vesicles.
   (ii) Amoeboid movements.

Cilia and flagella:

1. Structure and movements
2. Syndrome /disease —Kartagener's syndrome & Charcot-Marie-Tooth disease.

UNIT-IV

Cell-cell adhesion and communication:

1. Cadherin mediated Ca^{2}+ dependent homophilic cell-cell adhesion.
2. N-CAM's mediate Ca^{2}+ independent homophilic cell-cell adhesion.
3. Cell junctions: Occluding junctions, anchoring junctions (adhesion belts, focal contacts, desmosomes & hemidesmosomes) & communicating junctions (gap junctions, chemical synapses & plasmodesmata).
4. Cell adhesion molecules as diagnostic tools in cancer. Cell matrix adhesion molecules:

1. Integrin-in cell matrix and cell-cell interaction.
2. Collagen-Basic structure and assembly.
3. Non-collagen components of extracellular matrix (elastin, glycosaminoglycan, cell
4. Surface proteoglycans, fibronectin & laminin).
5. Role of selectin, integrin & Ig in extravasation.

Cell wall:

1. Bacterial cell wall.
2. Plant cell wall.

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M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB302: CELLULAR PHYSIOLOGY AND REGULATORY MECHANISM

Max. Marks: 100 Total Hours: 60

UNIT-I

Cell-Cell signalling:

l. Endocrine, paracrine and autocrine signalling.
2. Receptor Proteins: Cell surface receptors and intracellular receptors, toll receptors.
3. Second messenger System: cAMP & signal to transcription (CREB); IP3 DAG and PIP3 (PI3 kinase, AKT & mTOR pathway).
4. Cell Surface receptors: G-protein coupled receptors (hormones etc.), ion channel receptors (voltage gated channel, ligand gated channel & signal gated channel), tyrosine kinase-linked receptors (general idea, EGF, erythropoietin & interferon) and receptors with intrinsic enzymatic activity.
5. MAP kinase, JAK/STAT and TGF -ß / Smad signaling and signalling.

Signal-mediated transport through nuclear pore:

l. Nuclear pore complex.
2. Nuclear exports signal and transport of cargo proteins from nucleus to cytosol.
3. Nuclear localization signal and transport of cargo proteins from cytoplasm to nucleus.

UNIT-II

Cell cycle:

1. Bacterial cell cycle (Helmstetter —Cooper or 1+ C+ D model).
2. Eukaryotic cell cycle
3. Cell cycle check points
4. Cell cycle regulation

UNIT-III

Cell death (Apoptosis):

l. Apoptosis and necrosis
2. Caspases: Initiator, executioner & inflammatory
3. Bch family proteins: anti-apoptic, apoptotic & depressors.
4. Extrinsic death receptor pathway (TNF-I & Fas); intrinsic mitochondrial pathway & mitophagy
5. Inhibitors of apoptotic proteins
6. Caspase independent cell death

UNIT-IV

Aging: The biology of senescence

l. Cellular basis of aging
2. Free radicals, oxidative damage and antioxidants.
3. Telomerases and aging.
4. Diseases: Alzheimer's, Parkinson's, Type II diabetes & Progeria.

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M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB303: GENE EXPRESSION

Total Marks:100 Total Hours: 60

UNIT-I

Molecular structure of genes and chromosomes:

1. Molecular definition of gene (recon, muton & cistron —complementation test).
2. Chromosomal organization of genes and non-coding DNA.
3. Functional re-arrangements in chromosomal DNA.
4. Morphological and functional elements of eukaryotic chromosomes.
5. Transposons: Retrotransposons viral & non-viral (LTR, reverse transcription of retroviral genomic RNA to DNA); Transposons; Miniature inverted Repeats transposable elements & transposons in bacteria.

Genes:

l. Mutable units: Seymour Benzer experiment-complementation test.
2. Mutation:Types and causes (radiation, chemical & environment).
3. Mutation rates;Reversion & suppression.
4. Isolation (Positive & negative selection) and analysis of mutants.

UNIT-II

Regulation of gene expression:

l. Operon concept.
2. Inducers and corepressors.
3. Positive and Negative regulation — lac operon.
4. Regulation by attenuation: trp operon.

Lytic and lysogeny:

l. Lambda lytic cascade
2. Lysogenic repression

UNIT-III

DNA binding proteins and gene regulation:

l. Homeodomain proteins.
2. Zinc finger proteins.
3. Winged-helix (Forked head) proteins.
4. Leucine-Zipper proteins.
5. Basic Helix - Loop - helix proteins.
6. Helix- turn —Helix.

UNIT-IV

Cancer:

l. Tumor types: Benign & malignant; sarcoma & carcinoma and leukaemia &lymphoma.
2. Onset of cancer; Metastasis. 3. Properties of cancer cells.

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4. Knudson two hit hypothesis
5. Proto-oncogene; retroviral oncogenes; oncogenes; tumor suppressor genes (RB, p53) and caretaker genes (BRCAI & BRCA2).

Practicals

1. Paraffin blocks preparation of mammalian tissue for microtomy.
2. Sectioning and processing by Haematoxylin and Eosin staining,
3. Study of cells/ tissues using fluorescence microscope.
4. Standardization of ocular micrometer.
5. Use of stage and ocular micrometer for measuring cell dimensions.
6. Histochemistry: Carbohydrate PAS method
7. Histochemistry: Proteins -Ninhydrin method.
8. Detection of enzymes (a) Alkaline phosphatase (b) Acid phosphatase.
9. Tissue homogenization and fractionation.
10. Comet assay.
11. Agarose gel electrophoresis of mammalian DNA
12. Electroelution of DNA from electrophoretic gels.
13. Separation of proteins using SDS-PAGE.
14. Isoenzymes study using PAGE
15. Study of permanent slides:Mitosis, Meiosis, types of cancer cells

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

Recommended Books

l. The Biochemistry of the Nucleic Acids. Adams RLP, Knowler JT and Leader DP.Chapman and Hall,,London. 1986.
2. Essential Cell Biology 4th edition. Alberts B, Brav D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K and Walters P. Garland Science Publishing New York UISA ,2013.
3. Molecular Biology of the Cell. 5th edition. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. Garland Science.2007.
4. Molecular Biology of the Cell. 4th edition Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. Garland Science .2002.
5. From Genes to Cells. Bolrover SR, Hyams JS, Jones S, Shephard EA and White HA. Wiley -Liss, New York. 997.
6. A Means to an End: The Biologicat Basis of Aging and Death. Clark WR. Oxford University Press, New York, Oxford.2002.
7. The Celi. A Molecular Approach.4 th edition. Cooper GM and Hausman RE. ASM Press Washington, DC -2007.
8. Cell Adhesion and Cytoskeletal Molecules in Metastasis. Cross AE and Nagle RD. Vol XII. Springer Publications 2006.
9. Molecular Cell Biology. 5 th edition W Darnell J. H Freeman and Company, New York, 2004.
10. cell and Molecular Biology. 8th edition. De Robertis EDP and De RoberGs Jr EMF Lippincot Williams & Wilkins 2006.
11. Cell Adhesion Molecules in Cancer and Inflammation, Epenetos A and Pignatelli M, Harwood Academic Publishers. CIRC Press 1995.
12. Cancer Stem Cells. Farrar WL. Cambridge University Press. 2009.

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13. DNA Repair and Mutagenesis. Friedberg EC, Walker GC and Siede W. ASM Press, Washington DC 1995.
14. BRS Cell Biology and Histology. 6th edition (South Asian Edition), Gartener LP, Hiatt JL, Strum JM. Lippincott Williams & Wilkins, 2010.
15. Molecular biotechnology. Principles and Applications of Recombinant DNA. Glick BR and Pasternak JJ. ASM Press Washington DC, 1998.
16. Cell and Molecular Biology. Concepts and Experiments. 7 th edition. Karp G. John Wiley &Sons Inc., New York.2013.
17. cell Biology.6th edition. Karp G. Hoboken, NJ: Wiley 2013.
18. Essential Genes. Levin B Pearson Higher Education. International edition.2006.
19. Genes IV. Lewin B. Oxford University Press Bombay, 1990.
20. Genes V. International Students Edition. Lewin B. Oxford University Press Oxford, 1994.
21. Genes V ll. Lewin B. Oxford University Press, Oxford, 2000.
22. Genes V lll. Lewin B. Pearson Education International. London, Sydney.2004.
23. Molecular Cell Biology 6th edition. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P. W.H Freeman and Company, New York, 2008.
24. Molecular cell Biology.5 th edition. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL, Darnell J W.H Freeman and Company, New York 2004.
25. Molecular Cell Biology. 4th Edition Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, Darnell J. W.H Freeman and Company, New York, 2000.
26. Molecular Cell Biology. 7th edition. Lodish H, Berk A, Kaiser CA, Krieger M, Bertscher A, Ploegh H, Amon A, Scott M P. Mac Millian High Education (International edition) England 2013.
27. Lewin's Cell. 2 nd edition. Lynne C, Lingappa VR and P lopper G (Editors). Jones & Barlett Publishers, USA 201 1.
28. Essentials of Molecular Biology. Malacinski GM and Friefelder D. Jones and Bartlett Publishers, Boston 1999.
29. Molecular Biology and Biotechnology. Meyers R.A. A Comprehensive Desk Reference.VCH Publishers. 1995.
30. Advancements in Cancer Stem Cell Biology. Scantena R, Mordente A, Giardina B. Springer Publication 2012.
31. Genetics and Molecular Biology.2nd edition. The John Hopkins university Press. Schleif R. Baltimore & London. 1993.
32. Stem Cell Therapeutics for Cancer. Shah Khalid. John Wiley & Sons Inc. Hoboken, New Jersey.2013.
33. Cell and Molecular Biology. Shelve P and Blanch DEW. John Wiley &Sons Inc., New York. 1994.
34. Genes to Proteins 3 rd edition. Molecular Biology. Tropp B E. Jones &Bartlett Publishers, Sadbury Massachusetts. 2008.
35 Advanced Molecular Biology. A Concise Reference. Twyman RM and Wisden W. Viva Books Pvt Ltd.New Delhi 1999.
36. Molecular Biology of the Gene. 7th edition. Watson J, Baker T, Bell S, Gann A, Levine M and Losick R Pearson Higher Education 2013.
37. Molecular Biology of the Gene. 5 th edition Watson J, Baker T, Bell S, Gann A, Levine M and Losick R. Pearson Higher Education 2008.
38. Recombinant DNA 2nd edition. Watson JD, Gilman M, Witkowski J and Zoller M. W.H Freeman and Company, New York 1992
39. Molecular Biology. 2nd edition. Weaver R.F. McGraw Hill Company, New York, NY 2002.

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40. Molecular Biology, 3rd edition, Weaver, R.F., McGraw-Hill Company, New York, NY 2005.

ZOL B311: PRACTICAL
Scheme for Practical Examination
(Based on ZOL CB301, ZOL CB302 and ZOL CB303)

Max Marks: 150 Time 6 hrs.

l. Exercise Core I	18
2 Exercise Core 2	18
3. Exercise Core 3	18
4. Spotting (12 X 4)	48
5. Viva Voce	30
6. 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 III SEMESTER
CORE PAPER (GROUP – C)
(SPECILISATION: ENTOMOLOGY)
ZOL CC301: PHYLOGENY, TAXONOMY AND EVOLUTION OF INSECTS

Max. Marks: 100 Total Hours: 60

UNIT-I

l. Collection, preservation and methods of study of insects.
2. Historical development of classification of insect, basis of insect classification.
3. Use of taxonomic keys in insect identification.
4. Elementary idea of DNA base reading and its application in insect identification.

UNIT-II

l. Origin and evolution of insects, theories of evolution of insects, fossil history.
2. Causes of success of insects, evolution of flight and socialism.
3. Phylogeny of Arthropoda and Hexapoda.
4. Introduction to primitive insects:
   a) Protura,
   b) Collembola
   c) Dipleura.
   d) Microcoryphia
   e) Thysanura.

UNIT-III

Detailed classification of orders up to families (economically important):

l. Orthoptera
2. Isoptera
3. Hemiptera
4. Phasmida

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5. Dictyoptera
6. Dermaptera

UNIT-IV

Detailed classification of orders up to families (economically important):

1. Odonata
2. Thysanoptera
3. Coleoptera
4. Lepidoptera
5. Diptera
6. Hymenoptera

M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – C)
(SPECILISATION: ENTOMOLOGY)
ZOL CC302: MORPHOLOGY AND PHYSIOLOGY OF INSECTS

Max.Marks:100 Total Hours: 60

UNIT-I

1. Integument: structure and function, moulting and mechanism of cuticular sclerotization.
2. Head: Sutures and area of cranium, Dyar's law, tentorium, gnathalappendages, antennae.
3. Thorax: legs and their modifications, wings and wing coupling, - wing bearing segment.
4. Abdomen: male and female external genitalia and their modifications, abdominal appendages.

UNIT-II

1. Digestive system: Alimentary canal and its modifications (including filter chamber) physiology of digestion.
2. Physiology of circulatory system.
3. Excretory system and its modification (cryptonephridial system)
4. Respiratory system and its modifications, adaptations for aquatic respiration.

UNIT-III

1. Nervous system and its modifications.
2. Sense organs: mechanoreceptors, Chemoreceptors.
3. Auditory organs (tympanum), light producing organs, sound producing organs, visual organs (Compound eye and ocelli).

UNIT-IV

1. Muscular system and distribution of muscles.
2. Reproductive system. Morphology and physiology of male and female reproductive system, its associated ducts and glands and pheromones.
3. Insect behaviour: mating, feeding and defensive strategies (defensive organs and their products: allomones, kairomones and pheromones, blood as defensive secretion, adaptations to autointoxication).

M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – C)

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(SPECILISATION: ENTOMOLOGY)
ZOL CC303: DEVELOPMENT AND ECOLOGY OF INSECTS

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Embryology: Structure of eggs, types, embryonic and postembryonic development, parthenogenesis.
2. Morphology and physiology of neuroendocrine system.
3. Metamorphosis and endocrine control of development and metamorphosis.
4. Types of larvae and pupae.

UNIT-II

1. Social life in Isoptera
2. Social life in Hymenoptera.
3. Life cycle of locusts (phase theory)
4. Life cycle of aphids (polymorphism).

UNIT-III

1. Effect of physical Factors, viz., temperature, light, relative humidity, wind, etc. on insects.
2. Intraspecific interactions of biotic factors.
3. Interspecific interactions of biotic factors.
4. Insect plant interaction: theory of co-evolution, role of allelochemicals in host plant mediation, tritrophic interaction, host plant selection by phytophagous insects, establishment of insect population on a plant surface.

UNIT-IV

1. Population ecology: population dynamics, size, fluctuation, biogeography, factors affecting population density, methods of determination of population density of insects.
2. Community ecology, community structure and diversity.
3. Biochemical adaptations to environmental stress: diapauses, polymorphism, swarms, out breaks and migration.
4. Biodiversity: Definition, types and methods of study, species diversity indices species richness, simpson's index, Shannon-Weiner Index, and Pileou's Evenness Index.

Practicals

1. Anatomy:
   a. Cockroach: Alimentary canal, Nervous system, Neuroendocrine complex.
   b. Grass hopper/ Chrotogonous: Alimentary canal, Reproductive system, Nervous system. c. Gryllus: Nervous system.
2. Permanent Mounting
   a. Types of mouth parts
   b. Types of antennae
   c. Types of legs
   d. Types of wings
   e. Tympanum, spiracle and trachea
3. Study of prepared slides
   a. Whole mounts of insects

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b. Legs
c. Mouth parts
d. Wings
e. Antennae
f. Histology of insects

4. Study of selected insects
   a. Collection and preservation of Orthopteran, Dictyopteran, Dermapteran, Hemipteran, Phasmida etc.
   b. Study of selected insects and their identification with the help of taxonomic keys.
5. Exercise in Physiology and Biochemistry
   a. Analysis of honey and its quality control.
   b. Analysis of chitin presence in the insect integument.
   c. Study of pH of the gut in larvae of insects
   d. Action of amylase enzyme in the cockroach.
   e. Application of Dyar's law.
   f. Study of polytene chromosome.
   g. Detection of Allantoin in cockroach excreta by paper chromatography.
   h. Haemocyte count.
   i. Biochemical estimation of haemolymph.
6. Microtomy
7. Field trips for biodiversity study and insect collection.

Recommended Books

1. Agricultural Pests of India & South east Asia, Atwal: Kalyani Publishers. 1986
2. The Insects: Structure & function 4th ed. Chapman: ELBS, 1998
3. Physiological System in insects, Klowden: 2002 4. Essential Entomology, Oxbord Uni. McGavin: 2001
5. Principles of Insect Morphology Snodgrass:
6. The Principles of Insect Physiology Wigglesworth-
7. Borror and Delong's introduction of the study of insects —Charles A, Triplehorn and Norman F., Johson, Thomson Books/Cole
8. Insect Physiology and Biochemistry, Third Edition, James L Nation Sr, T&F, 2016
9. Insect Ecology, Nitish Shekhar, Sonali Publications, 2012
10. Practicals in Basic Entomology, Sathe, TV Bhoje, PM Kolekar, Vaishali S., Daya Publishing House, 2014.

ZOL C311: PRACTICAL

Scheme for Practical Examination

(Based on ZOL CC301, ZOL CC302 and ZOL CC303)

Max Marks: 150 Time 6 hrs.

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

Note:

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1. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.
2. 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 III SEMESTER
CORE PAPER (GROUP – D)
(SPECILISATION: REPRODUCTIVE BIOLOGY)
ZOL CD301: ENDOCRINE GLANDS AND HORMONES

Max. Marks: 100

Total Hours: 60

UNIT-I

1. Endocrine glands: An overview, basic concepts of endocrinology.
2. Vertebrate endocrine glands: Study of the major endocrine glands of vertebrate.
3. Structure, secretions and physiology (With the special emphasis on the role in reproduction):
   - i The pituitary gland
   - ii Thyroid
   - iii Parathyroid
   - iv Adrenal
   - v Pineal
   - vi Pancreas
   - vii Gastrointestinal tract

UNIT-II

Hormones:

1. Classification and characteristics of hormones
2. Chemical nature of hormones
3. Hormonal regulation
4. Feedback mechanism. Steroid hormones:
   - i Structure and nomenclature
   - ii Steroidogenesis.

UNIT-III

Hormone actions:

1. Transportation of hormones
2. Receptors and target cells
3. Mechanism of action of hormones.
4. Prostaglandins: Chemistry, mechanism of action and their role in reproduction.

Pheromones:

1. Mammalian and insect pheromones
2. Applications of pheromones
3. Fertility control in insects
4. Induced spawning in fishes and amphibians.

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UNIT-IV

Invertebrate endocrine glands: Anatomy and physiology of the endocrine and neuroendocrine structures of

1. Annelids
2. Arthropods
3. Mollusca (with special reference to their role in reproduction.

M.Sc. ZOOLOGY III SEMESTER
CORE PAPER (GROUP – D)
(SPECILISATION: REPRODUCTIVE BIOLOGY)
ZOL CD302: MALE AND FEMALE REPRODUCTIVE SYSTEMS

Max. Marks: 100

Total Hours: 60

UNIT-I

The female reproductive system:

1. Comparative anatomy and physiology of the mammalian and sub mammalian ovary and ductal system.
2. Follicular growth, kinetics and atresia.
3. Mechanism of ovulation, ovarian hormones, two cell theory of estrogen biosynthesis.
4. Autocrine, paracrine and endocrine regulation of ovarian functions.

UNIT-II

The male reproductive system:

1. Comparative anatomy and physiology of the mammalian and sub mammalian testis.
2. Functional organization of testis, spermatogenic cycle.
3. Testicular androgens, autocrine, paracrine, and endocrine regulation of testicular functions.
4. Epididymis and the sex accessory glands, semen and its biochemistry.

UNIT-III

Regulation of reproduction:

1. Hypothalamus and its neurosecretory centres: Structure of neurosecretory cells, the hypothalamic principles: synthesis, storage, release and chemistry.
2. The phenomenon of neuroendocrine integration and the hypothalamo-hypophyseal gonadal axis.

UNIT-IV

Biology of Sex-determination and Sex differentiation:

1. Development of gonads
1. Development of genital ducts and accessory organs
2. Development of external genitalia.
3. Sex determination in mammals.

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CORE PAPER (GROUP – D)

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(SPECILISATION: REPRODUCTIVE BIOLOGY)
ZOL CD303: BIOLOGY OF GAMETES, REPRODUCTIVE CYCLES AND BEHAVIOUR

Max. Marks: 100

Total Hours: 60

UNIT-I

Biology of spermatozoa and ovum:

1. Structure, development and function of spermatozoa and ovum.
2. Hormonal regulation of reproductive behaviour.

UNIT-II

Breeding seasons and reproductive cycles and their hormonal regulation (Brief account):

1. Breeding seasons in vertebrates
2. Types of reproductive cycles
3. Estrous cycle
4. Menustrual cycle

UNIT-III

Puberty, adolescence and menopause:

1. Onset of puberty
2. Hormonal control of onset of puberty
3. Precocious and delayed puberty
4. Menopause and climacteric

UNIT-IV

Impact of aging on male and female reproduction:

1. Andropause
2. Menopause
3. Hormone replacement therapy

Practicals

1. Location and identification of various endocrine glands in rodents
2. Anatomy of male reproductive systems.
3. Anatomy of female reproductive systems.
4. Microtomy: Histology of male and female genital organs and endocrine glands in normal and pathological conditions
5. Staining of permanent slides of endocrine glands
6. Morphometry of spermatozoa
7. Study of the permanent histological slides-mammalian and sub mammalian
8. Monitoring of vaginal smear.
9. Permanent slide preparation of vaginal smear
10. Sperm density & sperm motility
11. Eosin - Nigrosin stain for live & dead spermatozoa.

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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Recommended Books

1. Biology of Gestation. Assali, N. S. (ed.) Vol. I and Il Academic Press, New York.
2. An Introduction to General and Comparative Endocrinology by Barrington: E. J. W. Clarenden Press, Oxford, 1963
3. Delayed Implantation Enders, N.C. University of Chicago Press, Chicago, 1963.
4. A Text Book of comparative Endocrinology. Gorbman, A and Bern, H. A. John Wiley and Sons Inc., New York, 1962. (Indian reprint, Wiley Eastern Pvt. Ltd., New Delhi, 1974).
5. Biology of ovarian follicles in Mammals- Gyraya, S. S., Springer Verlag, Berlin.
6. Encyclopedia of Reproduction. Vol. I to IV. Knobii E. and Neill J.D. Academic Press, New York, 1998.
7. Reproductive Physiology. Nalbandov. A. S, W H. Freeman and Co., New York, 1 964_ (Indian Reprint), D. B. Taraporevala, Sons and Co. Ltd., Bombay, 1970.
8. Andrology Male Reproductive Health and Dysfunction. Nieschlag F. and Behre H.M Springer-Verlag, Berlin-2001
9. Hormones. Norman A W. and Litwack G. Academic Press, New-York, 1997.
10. Marshall's Physiology of Reproduction Parkes. A. S. Vols. l; Part I (1956) and 2 (1960) 3 (1952) and 4 (1966) Longmans, Green and Co., London.
11. Biology of Human Reproduction. Pinon, Jr. R. University Science Books, California, 2002.
12. The Mammary gland and its Secretion Vol. I and Il by S. K. Kon and A. T. Cowie. Academic Press, New York.
13. General Endocrinology. Turner, C.D., W B. Saunders and Co., Philadelphia (Tappan International. Edition, Tappan Co. (Singapore) Pvt. Ltd., New Delhi, 1974).
14. Williams Textbook of Endocrinology. Shlomo Melmed, Kenneth Polonsky and P. Reed Larsen ed., SAUNDERS,2007
15. Vertebrate Endocrinology, Norris D.O.
16. Comparative Vertebrate Endocrinology, Benttey P.
17. Human Physiology (Vol. Il), C.C. Chatterjee.
18. Sex and Internal Secretions Vols. I and ll., Young, W. C.: Baltimore, Williams & Wilkins, 1961.
19. Knobil and Neill's physiology of reproduction, Vol. I and Il, Ernst Knobil, Jimmy D. Neill Academic Press, 2006.
20. Yen & Jaffe's Reproductive Endocrinology Jerome Strauss and Robert Barbieri Elsevier 2009.
21. Comparative Reproductive Biology Reviewed. Ali Honaramooz, Blackwell Publishing House, Ames, Iowa, USA, 2007.
22. Molecular Mechanisms in spermatogenesis, Volume 636. C. Yan Cheng, Springer, USA 2008.
23. Essential Reproduction. M. H. Johnson, Barry J. Everitt Blackwell publishing, USA 2007.
24.

ZOL D311 PRACTICAL
Scheme for Practical Examination
(Based on ZOL CD301, ZOL CD302 and ZOL CD303)

Max. Marks: 150

Time: 6 hrs

l. Exercise Core I

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

Note: 18

I. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of dissection, charts/models/CD-ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.

II. 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 III SEMESTER
ELECTIVE PAPER
ZOL E301: MOLECULAR BIOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

DNA:

1. Equivalence rule.
2. Primary & secondary structure.
3. Unusual secondary structure (slipped & cruciform structure; triple helix DNA; tetraplex) and G-quadruplex.
4. Types (A-, B- & Z-DNA) and flexibility.
5. Forces stabilizing the structure: Denaturation & renaturation; base pairing, hydrophobic interactions & ionic interactions.
6. Tertiary structure (super coiled DNA, twisting number with linking number & topoisomerases).
7. Packaging of DNA: Nucleosome, solenoid & scaffold.

DNA replication:

1. Prokaryotic and Eukaryotic replication.
2. Mechanics of DNA replication including end replication.
3. Enzymes and accessory proteins involved in DNA replication.
4. Drugs that effect replication.

UNIT-II

RNA and transcription:

1. Types & structural features (mRNA, tRNA & rRNA).
2. Prokaryotic transcription.
3. Eukaryotic transcription.
4. Regulatory elements and mechanisms of transcription regulation.
5. Transcription termination-attenuation and anti-termination.
6. Drugs inhibiting transcription.
7. Gene silencing.

Post- transcriptional modifications in RNA:

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1. 5'- Cap formation.
2. End processing and polyadenylation.
3. Splicing and editing.
4. Nuclear export of mRNA.
5. RNA stability.
6. Inhibitors of RNA synthesis.

UNIT-III

Translation:

1. Genetic code.
2. Prokaryotic and eukaryotic translation.
3. Regulation of translation
4. Co- and post-translation modifications of proteins.
5. Inhibitors of protein synthesis. Organelles and protein sorting:

1. Endoplasmic reticulum
   (i) Targeting proteins to and across ER membrane.
   (ii) Insertion of membrane proteins into ER.
   (iii) Protein modification, folding and processing in ER.
2. Mitochondria & Chloroplast
   (i) Targeting of proteins.
3. Golgi apparatus
   (i) Glycosylation.
   (ii) Protein sorting & export.
   (iii) Mechanism of vesicular transport.
4. Lysosomes
   (i) Endocytosis and lysosome formation, phagocytosis & autophagy.
5. Peroxisomes
   (i) Assembly.
   (ii) Sorting of peroxisomal proteins.

UNIT-IV

Recombination and repair:

1. Homologous Recombination-Holliday model & ds break repair model
2. Homologous recombination protein machinery —Rec BCD pathway, RecA, Ruv AB complex &Ruv C.
3. Homologous recombination in eukaryotes- Meiosis.
4. FLP/FRT and Cre-Lox recombination.
5. DNA repair mechanisms- Radiation damage, Direct reversal, Oxidative damage, Alkylation, Base excision repair, Nucleotide excision repair, Mismatch repair, ds break repair, SOS response and Translesion DNA synthesis.

Eukaryotic genomes:

1. C-value paradox.
2. Re-association kinetics.
3. Non repetitive DNA complexity.
4. Repetitive sequences.
5. Structural genes (as present in mRNA)- Existing gene number by kinetics of RNA driven reactions.

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6. Structural genes- Internal organizations.

Practicals

1. Study of polytene chromosome in salivary gland of chironomus larva / Drosophila III rd instar larva using acetocarmine.
2. Identification of mitochondria using vital stains (Neutral Red & Janus Green B).
3. Electrophoresis:
   (i) DNA molecular size determination.
   (ii) Extraction & purification of DNA from gel.
   (iii) Extraction & isolation of genomic DNA from bacteria / Yeast / human cheek cells.
   (iv) Experiments using restriction enzymes & DNA ligase. (v) Isolation of RNA from bacteria.
4. Isolation of genomic DNA.
5. Extraction and quantitative estimation of DNA.
6. Study of permanent slides-Squamous cells, columnar epithelial cells, nerve fibre, striated and unstriated muscle cells, connective tissue

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. Essential Cell Biology, Alberts B, Bray D, Hopkin K, Johnson A, Lewis J, Raff M, Roberts K and Walters P. 4th edition. Garland Science Publishing New York UISA, 2013.
2. Molecular Biology of the Cell. Alberts B, Johnson A, Lewis J, Raff M, Roberts K and Walter P. 5th edition. Garland Science, 2007.
3. Molecular Biology of the Cell. Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P. 4th edition. Garland Science, 2002.
4. Genomes, Brown TA. 2nd edition. Oxford: Wiley-Liss, 2002.
5. Genomes 3, Brown TA. Garland Science, 2006.
6. Molecular Cell Biology. Darnefi J. 5th edition. W.H Freeman and Company, New York, 2004.
7. Cell and Molecular Biology. De Robertis EDP and De Robertis Jr EMF. 8th edition, Lippincott Williams &Wilkins. 2006.
8. Molecular biotechnology. Glick BR and Pasternak JJ. Principles and Applications of Recombinant DNA. ASM Press Washington DC, 1998.
9. Cell Biology. Karp G. 6th edition, Hoboken, NJ: Wiley 2013.
10. Essential Genes. Levin B. Pearson Higher Education. International edition. 2006. 1 1 . Genes IV. Lewin B. Oxford University Press Bombay, 1990.
12. Genes V. Lewin B. International Students Edition. Oxford University Press Oxford, 1994.
13. Genes V Il. Lewin B. Oxford University Press, Oxford, 2000.
14. Genes V Ill. Lewin B. Pearson Education International. London, Sydney, 2004.
15. Molecular Cell Biology. Lodish H, Berk A, Kaiser CA, Krieger M, Scott MP, Bretscher A, Ploegh H, Matsudaira P. 6th edition W.H Freeman and Company, New York, 2008.
16. Molecular cell Biology. Lodish H, Berk A, Matsudaira P, Kaiser CA, Krieger M, Scott MP, Zipursky SL, Darnell J. 5 th edition. W.H Freeman and Company, New York, 2004.
17. Molecular Cell Biology. Lodish H, Berk A, Zipursky SL, Matsudaira P, Baltimore D, Darnell J.4th Edition, W.H Freeman and Company, New York, 2000.

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18. Molecular Cell Biology. Lodish H, Berk A, Kaiser CA, Krieger M, Bertscher A, Ploegh H, Amon A, Scott M P. 7th edition. Mac Millian High Education (International edition), England, 2013.
19. Molecular Biology and Biotechnology. Meyers R.A. A Comprehensive Desk Reference. VCH Publishers, 1995.
20. Principles of gene manipulation and Genomics. Primrose SB and Twyman RM. 7th edition. Blackwell Publishing, USA, 2006.
21. Human Molecular Genetics. Strachan T and Read AP. 2nd edition. New York: WileyLiss•, 1999.
22. Molecular Biology. Tropp BE. Genes to Proteins, 3 rd edition. Jones & Bartlett Publishers, Sadbury Massachusetts, 2008.
23. Watson ID, Hoopins NH, Roberts J W, Steiz JA and Weiner AM. Molecular Biologv of Gene. 4th edition. The Benjamin/Cummings Publishing Company, Inc, USA, 1998.
24. Recombinant DNA. Watson JD, Gilman M, Witkowski J and Zoller M. 2nd edition. W.H Freeman and Company, New York, 1992.
25. Molecular Biology. Weaver R.F. 2nd edition. McGraw Hill Company, New York, NY, 2002.
26. Molecular Biology, Weaver, R.F. 3rd edition, McGraw-Hill Company, New York, NY 2005.

M.Sc. ZOOLOGY III SEMESTER
ELELCTIVE PAPER
ZOL E302: GENES AND DIFFERENTIATION

Max. Marks: 100

Total Hours: 60

UNIT-I

Principles of developmental biology:

1. Potency, commitment, specification, induction and competence.
2. Determination and differentiation; morphogenetic gradients; cell fate and cell lineages.
3. Development in unicellular eukaryotes and metazoans.

Early vertebrate development:

1. Cleavage types
2. Gastrulation, Cell movement and formation of germ layer (fruit fly, frog, chick and mouse)

Cell- cell interaction and cell signalling.

1. Cell-cell interaction and cell signalling during morphogenesis in early embryo gastrulation, neurulation and primordial organ rudiments
2. Origin and fate of neural crest cells.

UNIT-II

Body Axes:

1. Genetics of axis specifications in Drosophila
2. Establishment of body axes in mammals and birds
3. Tetrapod limb development
4. Homeobox concept in different phylogenetic groups.

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Hormones as mediators of development:

1. Insect metamorphosis
2. Amphibian metamorphosis

UNIT-III

Environmental regulation and animal development:

1. Environmental cues and effects
2. Malformations and disruptions.
3. Changing evolution through development modularity
4. Developmental constraints
5. Creating new cell types-basic evolutionary mystery.

Biology of sex determination:

1. Chromosomal sex determination in Drosophila and Mammals
2. Testis determination genes
3. Ovarian development
4. Secondary sex determination in mammals.
5. Environmental sex determination

UNIT-IV

Embryonic stem cells:

1. Totipotency and Pleuripotency
2. Embryonic stem cells, stem cells niches.
3. Genomic equivalence and the cytoplasmic determinants
4. Renewal by stem cells-epidermis, connective tissue & skeletal muscle

Hemopoietic Stem cells:

1. Blood cell formation
2. Bone marrow transplants
3. Stem cell disorders
4. Gene therapy
5. Genetic errors of human development:

Practicals

1. To Study life cycle of Drosophila
2. Identification of male and female Drosophila
3. Identification of wild and mutant forms of Drosophila
4. To prepare permanent slide of Sex comb of Drosophila
5. To prepare permanent slide of W.M. of Drosophila
6. To make a squash preparation of salivary gland chromosome from 3rd Instar larva of Drosophila
7. Monohybrid and dihybrid inheritance in Drosophila
8. Simple problems based on Mendelism
9. Demonstration of sex chromatin
10. Embryology of Frog (slides & preserved materials).
11. Embryology of Chick.
12. Blastoderm mounting of chick embryo
13. To study development of chick embryo through window preparation.

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Recommended Books
1. Development Biology S.F.Gilbert, Sinauer Associates Inc., Massachusetts
2. Morphogenesis of vertabrate. Torrey,T. W. John Wiley and Sons Inc., New York and London.
3. An Introduction to embryology, Balinsky, B.I.: W.B. Saunders Comp.
4. Davidson, E.H.: Gene activity in early development. Academic Press, New York. ,
5. Modern embryology, Bodemer, C.W.: Holt Chart and Winston, Inc. New York;
6. Chicago
7. Principle of Animal Developmental Biology. Geol, S.C. Himalaya Publishers 1984.
9. Metamorphosis, Etkin, W L.I. Gilbert.: North-Holland Co., Amsterdam.
10. Developmental Biology. R.M Twyman. Viva Books Private Limited. New Delhi.
11. From egg to Embryo. Slack J.M. W. Cambride University Press, Cambridge UK.
12.Principles of Development. Wolpert, L. Oxford University Press, Oxford, UK.

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE PAPER
ZOL E303: TOOLS AND TECHNIQUES

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Principle, construction and applications of Microscopy
2. Light Microscopy.
3. Bright field and Dark Field Microscopy.
4. Phase contrast Microscopy.
5. Fluorescence Microscopy.
6. Electron Microscopy (TEM & SEM).
7. Confocal and Atomic Force Microscopy.
8. Micrometry.

UNIT-II

Separation Techniques Centrifugation:

1. Basic principles of sedimentation
2. Types of centrifuges
3. Analytical and preparative centrifugation
4. Differential and density gradient centrifugation

Chromatography:

1. Paper chromatography
2. Thin layer chromatography
3. Ion exchange chromatography
4. Gel permeation chromatography
5. Affinity chromatography
6. Gas chromatography
7. High pressure liquid chromatography (HPLC)

Electrophoresis:

1. Paper electrophoresis
2. Polyacrylamide gel electrophoresis (PAGE) and SDS-PAGE

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3. Agarose gel electrophoresis
4. Two Dimensional electrophoresis and Isoelectric focusing
5. Pulse field electrophoresis, Capillary electrophoresis
6. Immuno-electrophoresis
7. Blotting techniques (Southern and Western)
8. DNA sequencing
9. Polymerase Chain Reaction (PCR)

UNIT-III

1. Principle and applications of colorimetry and spectrophotometry; UV-VIS Spectrophotometer.
2. Spectroscopy: Flame emission spectroscopy, Atomic absorption spectroscopy, Nuclear Magnetic Resonance spectroscopy (NMR).
3. Dosimetry, Ionization chamber, GM counter, Solid and liquid scintillation counters 4. Radioisotopes- types, characteristics and uses, Autoradiography.

UNIT-IV

Histological techniques:

1. Principles of tissue fixation, factors affecting tissue fixation.
2. Chemical basis of fixation by Formaldehyde, Glutaraldehyde, Chromium salts, 3. Mercury salts, Osmium salts, Alcohol and Acetone.
4. Theory and practice of Microtomy.
5. Staining of carbohydrates, proteins, lipids and nucleic acids.

Animal tissue culture techniques:

1. Design of animal tissue culture laboratory and essential instruments required in tissue culture.
2. Sterilization of materials to be used for tissue culture.
3. Culture media, preparation and essential components.
4. Types of tissue culture, organ and organotypic cultures.
5. Primary culture and the establishment of cell lines.
6. Characterization of cell lines.
7. Cell proliferation measurements and cell viability tests. 8. Cryopreservation and retrieval of cells from frozen storage.

Practicals

1. Experiments using Fluorescence microscope and Phase Contrast Microscope.
2. Measurement of cell size using micrometry.
3. Preparation of samples using different centrifuges.
4. Use of Spectrophotometer for measuring the optical density of different biological samples.
5. Separation of free sugars/amino acids from different samples by paper chromatography.
6. Separation of neutral lipids/ amino acids by Thin Layer Chromatography.
7. Separation of molecules by Ion exchange/ Gel permeation/ Affinity Chromatography (Demonstration).
8. Study the working of (a) Gas Liquid Chromatography (b) HPLC (Demonstration).
9. Separation of protein samples by PAGE/SDS-PAGE (Demonstration).
10. Isolation of Genomic DNA from blood or any other sample.
11. Study the working of PCR (Demonstration).
12. Agarose gel electrophoresis of DNA.

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M.Sc. ZOOLOGY III SEMESTER
ELECTIVE
ZOL E304: EVOLUTION

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Concept of evolution (Lamarkism, Darwanism & Neo Darwinism).
2. Evidences of evolution (macro and micro) — From comparative anatomy, embryology and physiology.
3. Rate of evolution (Horotely, Bradytely and Tachytely).
4. Time line for major events in the history of life on earth.

UNIT-II

1. Variations including transgressive variation.
2. Mutations.
3. Genetic drift.
4. Meiotic drive.
5. Migration 6. Natural selection.

UNIT-III

1. Isolation and isolating mechanisms.
2. Species and Speciation — Phylogenetic and biological and other concepts of species, modes of speciation (Allopatric, sympatric, parapatric and peripatric)
3. Adaptation — With special reference to deep sea, desert & aerial.
4. Phenotypic plasticity.
5. Polymorphism

UNIT-IV

1. Punctuated equilibrium and phyletic gradualism.
2. Human evolution.
3. Altruism, selfish gene, coevolution and kin selection.
4. Extinctions and mass extinctions.

Practicals

1. Exercises based on natural selection
   (a) Darwinian fitness
   (b) Selection coefficient
   (c) Effects of natural selection on gene frequencies
   (d) Genetic drift
   (e) Migration
   (f) Meiotic drive
2. Construction of phylogenetic trees
3. Study of examples of different types of speciation.
4. Study of examples of adaptations in various habitats.
5. Study of selected stages in human evolution.
6. Study of altruism, co-evolution and kin selection with the help of examples.

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Recommended Books

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

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE
ZOL E305. ECOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I Ecosystem:

Structure and function:

1. Types of ecosystem
2. Basic structure of ecosystem
3. Physical, chemical & genetic structure of ecosystem
4. Function of ecosystem
5. Energy flow within the ecosystem & Y -shaped mode of energy flow.
6. Productivity.
7. Food chain and trophic levels.
8. Ecological efficiencies.
9. Ecological pyramids.
10. Ecological niche
11. Homeostasis and stability of ecosystem

UNIT-II Fragile

Ecosystems

1. Coral reef ecosystem
2. Mangroves
3. Wetlands
4. Antarctic ecosystem
5. Arctic ecosystem
6. Mountain environment

Population Ecology:

1. Population density, natality, mortality and age distribution 2. Biotic potential of population.
3. Growth forms and concept of carrying capacity of population
4. Population dispersal
5. Regulation of population

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UNIT-III

Environmental factors

1. Law of minimum (Leibig's Law)
2. Law of tolerance (Shelford's Law)
3. Combined concept of limiting factors
4. Physiological environment as limiting factor
5. Light, humidity, temperature, fire, atmosphere gases, current and pressure

Species interactions

1. Biotic environmental factors
2. Competitive Exclusion principle
3. Interspecific and intraspecific interactions.

UNIT-IV

Concept of community:

1. Characters and classification of community
2. Community periodism
3. Community stratification, succession & climax
4. Community boundary: Ecotone and edge effects.

Biogeochemical and nutrient cycles:

1. Nitrogen cycle
2. Carbon cycle
3. Phosphorus cycle
4. Sulfur cycle

Practicals

1. Estimation of alkalinity, acidity, dissolved oxygen, chloride in water samples.
2. Estimation of nitrogen and phosphorous estimation in soil.
3. Listing of animals around your home/department & comments upon them.
4. Microbial analysis in soil/air/water.
5. Limnological study of a local water body submission of written report.
6. Estimation of population density belt and Quadrates method, Line transect method.

Recommended Books

1. Ecology, Individuaks. Populations and Communities. Begon. M., J.l., Harper and
2. C.R. Townsend, Blackwell Science. Oxford U.
3. Ecological concepts. Cherrett, J.M. Blackwell Sci. Publi. Oxford U.K.
4. Population Biology. Elseth. B.D. and K.M.Baumgartner. Van Nostrand Co., New York
5. Fundamentals of ecological modeling. Jorgension. SE. Elsevier. New,,
6. A New Ecology - Systems Perspective Sven Erik Jørgensen, Brian Fath, Simone Bastianoni, Joao Marques, Felix Muller,S. Nors Nielsen, Bernard Patten, Enzo Tiezzi and Robert Ulanowicz Elsevier May 2007
7. Ecological Census Techniques - A Handbook Edited by William J. Sutherland CUP August 2006
8. The Life of Mammals (Life of Mammals) by David Attenborough
9. Fundamentals of Ecology by Eugene Odum, Gary W, Barrett, Hardcover: 624 pages, Brooks Cole

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10. The Science of Ecology by Richard Brewer, Hardcover: 816 pages, Publisher: Brooks Cole
11. Applied Ecology and Environmental Management (2ND 00) Edward f. Newman (Paperback f [SBN 10: 0632042656; ISBN 13:9780632042654)
12. Applied Ecology arrd Natural Resource Management (03) Guy R k McPherson and Stephen DeStefano I ISBN 10: 051 10581 1 x; ISBN 13:978051 10581 10)
13. Essentials of Ecology C Townsend, M Begon, J L Harper
14. Essential Environmental Studies. Misra, S P and Pandey S. N. 2009. Ane Books Pvt. Ltd.
15. Field Biology and Ecology. Benton, A.H. and Werner, W.E. 1976. Tata McGraw Hill, New Delhi.
16. Fundamentals of Ecology. Odum, E P. 1996. W.B Saunders College Publishing, Philadelphia.
17. Essentials of Ecology and Environmental Science (4thedn.). Rana,S.V.S. 2009. PHI learning Pvt. Ltd., New Delhi.
18. Ecology and Environmental Biology. P.D. Sharma. Rastogi publication, Meerut.

M.Sc. ZOOLOGY III SEMESTER
ELECTIVE
ZOL E306: ETHOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Scientists and their works: Konrad Lorenz, Niko Tinbergen, Karl Von Frisch, Skinner BF and Harlow Harry, Richard Dawkins, EO Wilson, Desmond Morris.
2. Concepts of Ethology (SS, FAP, ASE, IRM), Flush Toilet model; Genes and behaviour; Evolution of behaviour.

UNIT-II Neuroethology:

1. Methods of studying brain and behaviour: Neuroanatomical, neurophysiological and neurochemical.
2. Mammalian brain and behaviour, Limbic system and hypothålamus.
3. Behavioural studies in invertebrates.

UNIT-III

Social behaviour:

1. Properties and advantages of social grouping, social group of monkeys.
2. Sociobiology-Darwinian fitness, individual fitness, kin selection, group selection. Cooperation, reciprocation, altruism, reciprocal altruism, proximate and ultimate causations
3. Territorial behaviours: home range, territory, core area
4. Aggressive behaviour: Types & causes of aggression, neural and hormonal control.

UNIT-IV

1. Feeding and sexual strategies in animals.
2. Courtship and mating behaviour in animals
3. Parental care in animals.
4. Communication in animals: auditory, tactile, visual and chemical.
5. Learning introduction and definition, types of learning, Habituation, trial and error,

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6. conditioning, cognition and imprinting.
7. Short and long term memory, neural mechanism of learning.

Practicals

1. Learning by trial and error in animals using maze and jumping box.
2. Study of movement of fish in aquarium.
3. Food preference in Tribolium.
4. Pheromones in Earthworms.
5. Study of exploratory behaviour of rats/mice.
6. Study of grooming, rearing and locomotory behaviour of rats/mice.
7. Nest building behaviour in anyone species of animal (Insects, spiders, fishs, birds and mammals)
8. Reproductive behaviour in anyone species of animal

Recommended Books

1. Animal behaviour: A synthesis of ethology and comparative psychology. Hinde. R.A. McGraw-Hill. New York.
2. The Life of Mammals, Life of Mammals, by David Attenborough
3. Animal Behaviour — An evolutionary approach, Alcock, John. Sinauer Associates. Animal Behaviour, Barnard, C.J. Croom Helm, London.
4. Modern Ethology, Barnett, S.A.
5. Ethology: The biological study of Animal Behavior Chauvin, Remy, International Univ. Press).
6. Quantitative Ethology. John. Wiley & Sons. Colgan, Patric W.
7. Introduction to Ethology, Immelman, C.
8. An Introduction to animal behaviour.Manning, Aubrey. Edward Arnold Publ., London.
9. An introduction to animal behaviour. Manning, Aubrey. Addison-Wesley Publ,Co.
10. Essentials of animal behaviour. Slater, P.J.B. Cambridge Univ. Press.
11. The ecology and evolution of animal behavior. Wallace, Robert A. (Goodyear Publ. Co. Inc.). 284 pages.
12. The Science of Ecology by Richard Brewer, Publisher: Brooks Cole
13. Applied Ecology and Environmental Management, Edward I. Newman
14. Applied Ecology and Natural Resource Management Guly R. McPherson and Stephen De Stefano, Cambridge University.
15. Animal Behaviour, Reena Mathur Rastogi Publication

ZOL 312: PRACTICAL
(Based on ZOL 301, ZOL E302, ZOL E304, ZOL E305 and 306)
Scheme for Practical Examination

Max. Marks: 100 Time: 4 hrs

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

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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 IV SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA401: NATURE & TYPES OF CANCER

Max. Marks: 100 Total Hours: 60

UNIT-I

Cancer epidemiology:

1. Global aspects of cancer.
2. Cancer problem in India.
3. Geographic and environmental risk factors (tobacco, alcohol, physical factors, occupational exposure, and environmental carcinogens).
4. Cancer of different age groups and sex.
5. Nutrition and food.

UNIT-II

Classification of tumors:

1. Benign and malignant.
2. Carcinoma and sarcoma.
3. Leukemia and lymphoma.
4. Epithelial and non-epithelial tumors.
5. Specialized tumors-Mixed salivary gland tumors, uterine carcinosarcoma, teratocarcinoma.

UNIT-III

Characteristics of tumors:

1. General properties of cancer cells.
2. Staging and grading.
3. Clinical gross and microscopic features.
4. Rate of tumor growth.
5. Local invasion and metastasis
6. Angiogenesis

UNIT-IV

Common types of cancer (signs, symptoms, prevention and treatment):

1. Oral cancer.
2. Stomach cancer.
3. Liver cancer.
4. Lung cancer.
5. Prostate cancer.
6. Skin cancer.
7. Breast cancer.

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8. Gynecological cancers.
9. Blood cancer.

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA402: MOLECULAR MECHANISM OF CANCER

Max. Marks: 100 Total Hours: 60

UNIT-I Cancer

genetics:

1. Proto-oncogenes and oncogenes
2. Tumor suppressor genes
3. Hereditary cancer
4. Cancer epigenetics (DNA methylation, Histone modification)
5. Telomeres and immortalization

UNIT-II

Signalling Pathways in Cancer

1. Ras-RAF-MEK-ERK pathway: Role in cancer cell proliferation and survival.
2. P13K-AKT-mTOR pathway: Impact on cell growth and metabolism.
3. Wnt/ß-catenin, and Notch pathways: Influence on cell fate, differentiation and self-renewal

UNIT-III

Tumor Microenvironment

1. Tumor microenvironment and its impact on cancer progression
2. Introduction to the components of the tumor microenvironment: Stromal Cells, Immune cells, Cancer Cells, Extracellular Matrix (ECM), Blood Vessels, Cytokines and Chemokines
3. Tumor microenvironment and cancer therapy resistance

Unit-IV

Cancer Bioinformatics

1. Introduction to bioinformatics tools (e.g., BLAST, UCSC Genome Browser)
2. Data formats used in cancer bioinformatics (FASTA, SAM/BAM, VCF, etc.)
3. Biological databases relevant to cancer research: TCGA, CCLE, ICGC, GDC, GDSC, COSMIC, TARGET
4. Introduction to cancer genomics and transcriptomics

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – A)
(SPECILISATION: CANCER & RADIATION BIOLOGY)
ZOL CA403: TUMOR IMMUNOLOGY AND TREATMENT

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Max. Marks: 100 Total Hours: 60

UNIT-I

Apoptosis and cancer:

1. Cell death, Apoptosis and Necrosis.
2. Caspases.
3. BCL2 family proteins.
4. Extrinsic and Intrinsic mitochondrial pathway.
5. Inhibitors of apoptotic protein.
6. Role of apoptosis in cancer.

UNIT-II Diagnosis

and prevention of cancer:

1. Tumor markers.
2. Histological and cytological methods.
3. Histochemistry and cytochemistry methods.
4. Immunohistochemistry and biochemical assays.
5. PET, CAT, MRI Scans'
6. Modern aids in tumor diagnosis.

UNIT-III

Tumor immunology:

1. Immune suppression and role of immune surveillance in growth of tumors.
2. Tumor specific antigens and immune response.
3. Modulation of immune response
4. Cancer vaccines
5. Managing immune-related adverse events

UNIT-IV Treatment

of cancer:

1. Surgery.
2. Radiation therapy.
3. Chemotherapy.
4. Hormone therapy.
5. Targeted therapy (Immunotherapy, CAR-T cell therapy, Small molecule based therapy, Nanomedicine and drug delivery systems)
6. Gene Therapy

Practicals

1. Sarcomas, Carcinomas, Leukemias, teratocarcinomas.
2. Tumor induction,
3. Skin carcinogenesis in mice.
4. Cervical carcinogenesis in mice.
5. Short term carcinogenicity tests.
6. Chromosomal aberrations.
7. Micronucleus test.
8. Image analysis of tumor markers expression
9. Breast cancer: Staging and Grading

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10. Chemoprevention of chemical carcinogenesis.
11. Morphological, histopathological and biochemical studies of various cancerous tissues.
12. Study of Pre-cancerous and cancerous lesions of oral cancer, breast cancer, cervix cancer, prostate cancer etc.
13. Visit to Radiotherapy Department, S. M. S. Medical College, Jaipur; Sri Bhagwan Mahaveer Cancer Hospital, Jaipur and Tata Memorial Cancer Hospital, Mumbai.

Note: It should be ensured that animals used in the practical exercises are not covered under the Wildlife Act 1 972 and amendments made subsequently.

Recommended Books

1. Who runs the risk of cancer? A. Ramesha Rao. Shipra publication.
2. Targeted Therapies in Cancer, Craig A. Almeida, Publisher: Springer.
3. Cancer, Publisher: Craig A. Almeida, Oxford University Press, USA.
4. Cancer Prevention, Devita VT, Heilmos, Rosensey, S. A. J. B. Lippincott.
5. P Pathology of Diseases, S. Lotran, V. Kumar, T. Collins. Robbins.
6. The Basic science of oncology. Tannode, I F and Richand P. Th. Il MacGraw, Hill.
7. Basic pathology. Vinay Kumar, Ramzi, S. Contran and Stranley L. Robbins. Thomson press Ltd. NOIDA, 1999.
8. Principals of metastases. Weiss, L. Academic press.
9. Principles of Cancer Biology. Lewis J. Kleinsmith, Publisher: Benjamin Cummings.
10. The biology of Cancer, Robert A. Weinberg, Publisher: Garland Science.
11. Lauren Pecorino, Cellular and Molecular Biology of Cancer, Publisher: Oxford University Press, USA.
12. Lauren Pecorino, Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Published May 1st 2005 by Oxford University Press, USA (first published 2005).
13. Biology of Cancer, Randall W. Phillis, Publisher: Benjamin Cummings.
14. Cancer of System Biology, Randall W. Phillis, Publisher: CRC Press
15. The Biology and Treatment of Cancer, Arthur B. Pardee, Publisher: Wiley-Blackwell.
16. Cancer Systems Biology, Edwin Wang, May 4, 2010 by CRC Press.
17. Introduction to Cancer Biology, Robin Hesketh, University of Cambridge, January 2013.
18. The Biology of Cancer Paperback — Robert A. Weinberg, Garland Science; I Pck Pap/ edition

ZOL A411: PRACTICAL
Scheme for Practical Examination
(Based on ZOL CA401, ZOL CA402 and ZOL CA403)

Max Marks: 150 Time 6 hrs.

l. Exercise Core I	18
2 Exercise Core 2	18
3. Exercise Core 3	18
7. Spotting (12 X 4)	48
8. Viva Voce	30
9. Record	18

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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 IV SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB401: BASIC IMMUNOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

Molecular immunology:

1. Innate (non-specific) immunity
   - i. Anatomic barriers.
   - ii. Physiological barriers
   - iii. Chemical mediators
   - iv. Phagocytic / endocytic barriers
   - v. Inflammatory barriers
2. Adaptive (specific) immunity

Cells and organs of immune system:

- i. Cells of immune system.
- ii. Organs of immune system
  - a) Primary lymphoid organs (Thymus and bone marrow) & Thymic education.
  - b) Secondary lymphoid organs (Lymph nodes, spleen, mucosal associated lymphoid tissue and cutaneous associated lymphoid tissue, tonsils and Peyer'spatches).
  - c) Lymphatic system.

UNIT-II

Haematopoiesis

1. Haematopoiesis growth factors, Genes involved in haematopoiesis
2. T-cell lineage
3. B-cell lineage

Immune response:

1. Phases of Immune response
   - (i) Cognitive.
   - (ii) Activation.
   - (iii) Effector.
   - (iv) Clonal selection hypothesis.
2. Humoral and cell-mediated immune responses (CMI)
   - (i) Recognition of antigen by B-and T-lymphocytes and antigen presenting cell
   - (ii) Clonal selection of lymphocytes
3. Cellular interactions required for generation of immune responses
   - (i) Activation and proliferation of B and T cells
   - (ii) Generation of humoral immune responses
   - (iii) Generation of CMI and cell mediated cytotoxicity

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UNIT-III

Antigens:

1. Immunogenicity versus antigenicity
2. Factors that influence immunogenicity
   (i) Contribution of immunogens (foreignness, molecular size, chemical composition and heterogenesity, susceptibility to antigen processing and presentation).
   (ii) Haptens and epitopes
   (iii) Immunogen dosage and route of administration and adjuvants
3. Structural aspects of antigens

Immunoglobulins Structure and Function:

1. Molecular structure of Ig
2. Immunoglobulin classes (IgG, IgM, IgE, IgA and IgD) and their biological activities
3. Immunoglobulin mediated effector functions (Opsonization, activation of complement, antibody dependent cell-mediated cytotoxicity, neutralization)
4. Antigenic determinants on immunoglobulin (isotype, allotype and idiotype).

UNIT-IV

Organization and Expression of Ig Genes:

1. Genetic model compatible with Ig structure.
2. Multigene organization of lg Genes
3. Mechanism of variable region DNA rearrangement
4. Generation and antibody diversity
5. Class switching among constant region genes, Expression of Ig genes

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB402: IMMUNOLOGY: MOLECULAR EXPRESSION AND FUNCTION

Max. Marks: 100 Total Hours: 60

UNIT-I Monoclonal

Antibodies:

1. Formation and selection of hybrid cells
2. Production of monoclonal antibodies
3. Clinical uses of monoclonal antibodies
4. Catalytic monoclonal antibodies (abzymes).

Antigen-antibody Interaction:

1. Antibody affinity and avidity.
2. Cross reactivity.
3. Agglutination reactions.
4. Precipitation reactions.
5. Complement & its regulation; complement fixation test.

UNIT-II

Major Histocompatibility Complex:

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1. General organization and inheritance of MHC.
   (i) Location and function of MHC.
   (ii) MHC haplotypes.
2. MHC molecules and genes
   (i) Structure of class I molecules.
   (ii) Structure of class Il molecules
   (iii) Organization of class I and Il genes.
   (iv) Peptide binding by MHC molecules.
   (v) Class Ill molecules
3. Regulation of MHC expression. Antigen Processing and Presentation
   1. Role of antigen presenting cell
   2. Evidence for two processing and presentation pathways.
      (i) Endogenous antigens. The cytosolic pathways, Peptide generation by proteasomes, Peptide transport from the cytosol to ER, Assembly of peptide with class I MHC molecules.
      (ii) Exogenous antigens. The endocytic pathway, Peptide generation in endocytic vesicles, Transport of class II MHC molecules to endocytic vesicles, Assembly of peptide with class II MHC molecules.

UNIT-III

Cytokines:

1. Properties of cytokines.
2. General structure of cytokines.
3. Types of cytokines.
4. Function of cytokines.
5. Cytokines related diseases
   (i) Bacterial septic shock.
   (ii) Bacterial toxic shock and similar diseases.
   (iii) Lymphoid and myeloid cancers.
   (iv) Chagas disease.

UNIT-IV Immune

System in Health and Disease:

1. Immune response to infectious diseases: Viral infections, Viral neutralization by humoral antibody, Cell - mediated antiviral mechanism, Viral evasion of host defense mechanisms.
2. Immune response to Bacterial infections, Immune responses to extracellular and Intracellular bacteria, bacterial evasion of host defense mechanism.
3. Immune response to Protozoa and diseases-Trypanosoma
4. Immune response to Diseases caused by helminthes.

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – B)
(SPECILISATION: CELL AND MOLECULAR BIOLOGY)
ZOL CB403: IMMUNOLOGY: APPLICATION AND CELLULAR MALFUNCTION

Max. Marks: 100

Total Hours: 60

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UNIT-I Vaccines:

1. Characteristics of vaccine.
2. Active and passive immunization.
3. Immunization schedule (Recommended by Indian Academy of Pediatrics)
4. Designing vaccines for active immunization.
5. Types of vaccines: Whole organism vaccine: Attenuated vaccines, inactivated vaccines; polysaccharide vaccines, synthetic peptide vaccines, vaccines, Recombinant vector vaccines, DNA vaccines.

UNIT-II

Immunodeficiencies:

1. Primary immunodeficiency:
   (i) Lymphoid - Severe Combined Immunodeficiency, Defects in B-cell maturation, Defects in T-cell development
   (ii) Myeloid lineage Chronic Granulomatous Disease, Leukocyte Adhesion
   (iii) Deficiency, Chediak —Higashi syndrome & Neutropenia or Granulocytopenia.
2. Secondary immunodeficiency: AIDS- genome organization, replication, opportunistic agents, immunologic abnormalities associated with HIV infection and therapeutic agents.

UNIT-III Hypersensitivity:

1. Type 1, 11, 111 and IV Tolerance and autoimmunity: General features of immunologic tolerance.
2. T - and B - cell tolerance; Induction of tolerance.
3. Organ specific autoimmune disease.
4. Systemic autoimmune disease.

UNIT-IV

Tumor immunology:

1. Tumor antigen.
2. Immune response to tumors (T-cell mediated; NK cell and macrophage mediated)
3. Tumor evasion.
4. Therapies.

Transplantation immunology:

1. Acute, hyper acute and chronic rejection
2. Tissue matching (HLA typing)
3. Graft Vs host (GVH) reaction
4. Xenotransplantation
5. Immunosuppressive drugs; role of monoclonal antibodies in transplantation

Practicals

1. Immunization routes: Intradermal, subcutaneous, intramuscular, intra peritoneal, intravenous, foot pad.
2. Bleeding schedules and collection of blood from ear.
3. Preparation of antigen to raise antibodies; raising antibodies in animal model.
4. Serum preparation, Storage and preservation of serum.
5. Isolation of macrophages from peritoneal cavity of mice.

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6. Purification of antibodies and antigens: Immuno-adsorption or Affinity chromatography (antibody purification).
7. Differential staining of leucocytes.
8. Isolation and fractionation of mononuclear cell population (T and B cells).
9. Rosette formation of T-cells from red blood cells.
10. Agglutination test Widal test or C-reactive protein (CRP).
11. Immunodiffusion Methods-Radial (RID).
12. Ouchterlony Double Diffusion (ODD).
13. Immunoelectrophoresis -RIE.
14. Immunoassay: ELISA.
15. Permanent slides: Thymus, bone marrow, spleen, Lymph node, and slides related to experiments.

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

Recommended Books

l. Immunology. Brostoff D and Roitt 1M. 7th e dition Mosby &Elsevier Publishing, Canada, USA. 2006.
2. Understanding the Immune System. Elgert KD.Immunology. Wiley —Blackwell USA.2009.
3. Immunobiology. Goldsby RA, Kindt TJ, Osborne BA and Kuby J. 5 th edition. W.H. Freeman & co. Ltd. 2002.
4. Immunobiology —The immune system in Health and Disease. Janeway CA Jr ,Travers P, Walport M & Shlomchik MJ. 5 th edition. Garland Science Publishing NY, USA 2001.
5. Immunobiology —The immune system in Health and Disease. Janeway CA Jr, Travers P, Walport M & Shlomchik MJ. 6th edition. Garland Science Publishing NY, USA 2005.
6. Elements of Immunology. Pearson Higher Education, Khan FH. New Delhi 2009.
7. lmmunology. Kuby J, Goldsby RA, Kindt TJ, Osborne BA. 4th edition. W.H. Freeman & co. Ltd. 2000.
8. Janeway's Immunobiology. Murphy K. 8th edition. Garland Science 201 1.
9. Immunology. Owen J, Punt J & Stranford S.Kuby. 7th edition. W.H.Freeman & Co. Ltd. 2013.
10. Fundamental Immunology. Paul WE. 7th edition. Lippincott Williams & Wilkins. 2012.
11. Tizard IR. Immunology. An Introduction 4th edition Thompson Asia Pvt. Ltd. Singapore. 1984.
12. Roitt's Essential Immunology, Delves PJ, Martin SJ, Burton DR and Roitt 1M. I lth edition, Blackwell Publishing [Oxford University Press. 2006.
13. Kuby Immunology, Kindt TJ; Goldsby RA, Osborne BA and Kuby J. 6th edition, WH Freeman, New York 2006.

ZOL B411: PRACTICAL
Scheme for Practical Examination
(Based on ZOL CB401, ZOL CB402 and CB403)

Max Marks: 150	Time 6 hrs.
l. Exercise Core I	18
2 Exercise Core 2	18
3. Exercise Core 3	18
4. Spotting (12 X 4)	48

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5. Viva Voce	30
6. 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 IV SEMESTER
CORE PAPER (GROUP – C)
(SPECILISATION: ENTOMOLOGY)
ZOL CC401: INSECT PESTS

Max. Marks: 100 Total Hours: 60

UNIT-I

1. Pest-definition and ecology, pest status, Economic injury level, Economic threshold level, action threshold, pest spectrum, carrying capacity, secondary outbreak, pest surveillance and sampling. Agro-ecosystem and phases of pest population fluctuations.
2. Bionomics, distribution, mode of damage caused and management of major polyphagous pests —
   a. Locust
   b. Termites
   c. white grubs
   d. Army worm.
   e. Aphids
   f. Gram pod borer

UNIT-II

Bionomics, distribution, mode of damage caused and management of—

l. Pests of cash crops 2.
Pests of sugar cane
3. Pests of tobacco
4. Pests of cotton

UNIT-III

Bionomics, distribution, mode of damage caused and management of—

l. Pests of cereal crops: maize, millet wheat, paddy, sorghum, pulses.
2. Pests of vegetables
3. Pests of fruits
4. Pests of oil seed crops

UNIT-IV

Bionomics, distribution, mode of damage caused and management of—

1. Pests of stored grains and milled products
2. Methods of safe storage.
3. Insect vectors transmitting bacteria, protozoans and viruses of medically and veterinary importance: fleas, lice, bugs, mosquitoes and flies.

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4. House hold pests: Cockroaches, crickets, ants, wasps, clothes moth, silver fish, carpet beetles, furniture beetles and book lice.

M. SC ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – C)
(SPECILISATION: ENTOMOLOGY)
ZOL CC402: INSECT PEST MANAGEMENT

Max. Marks: 100 Total Hours: 60

UNIT-I

Definition and history of various methods of insect pest control-

1. Physical
2. Mechanical
3. Cultural
4. Behavioural: semio-chemicals, pheromones and allele chemicals
5. Quarantine regulations

UNIT-II

1 Chemical control

a. Nomenclature and classification of insecticides (I, II and III generation pesticides), Pesticide acts of India and pesticide registration.
b. Inorganic and synthetic organic insecticides
c. Botanical pesticides.
d. Insect Growth Regulators, attractants, repellents and anti-feed ants

2 Mode of action, metabolism and degradation of insecticides.

3 Mechanism of insecticide resistance in insects and resurgence.

UNIT-III

1 Biological control: Definition, Biological control agents: pathogens, predators, parasites and parasitoids, Mass production, inoculation and augmentation, advantages and disadvantages.

2 Genetic and Biotechnological control: methods of genetic manipulation and sterilisation, transgenic plants, transgenic biocontrol agents, environmental impact of biotechnological control.

3 Integrated pest management (IPM): concepts, principles, components, constraints and strategies of IPM implementation for the management of major pests in crop fields.

UNIT-IV

1. Plant resistance to insects: types of resistance, mechanism of resistance: antibiosis, antixenosis, tolerance, factors mediating resistance, JH. mimics and MH agonist (paper factor).
2. Application of insecticides
   a. Selection and formulation of insecticides, synergists, antagonists, adjuvants.
   b. Appliances used for application.
3. Impact of climate change on insect pests.

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M. SC ZOOLOGY IV SEMESTER
CORE PAPER (GROUP – C)
(SPECILISATION: ENTOMOLOGY)
ZOL CC403: APPLIED ENTOMOLOGY

Max. Marks: 100 Total Hours: 60

UNIT-I

1 Forensic entomology: Insects of forensic Importance-Order Diptera- Calliphoridae, Sarcophagidae and Muscidae; Order Coleoptera -Staphylinidae, Histeridae, Silphidae, Dermestidae and Cleridae. Collection of entomological evidence during a death investigationfrom cadaver site. Temperature and climatic records, collection, preservation and handling of insects/maggots from the crime scene. Analysis of entomological evidence and estimating PMI (Post Mortem Index) using Maggot age and Insect succession on corpse. Forensic entomology in wildlife investigation.

2 Entomophagy: nutritional value of insects and future prospects for food and food security. insects as food (Entomophagy), Insect as medicine (Entomotherapy), Insect as weapons (Entomological warfare), Insect as pets

UNIT-II

1. Insect aided pollination: pollinator evolution and diversity, foraging economics and the importance of pollinators in agriculture and ecosystem sustainability, Native pollinators decline and conservation.
2. Apiculture: kinds of honey bees, beekeeping methods, apiary management. Apiculture in India and problems related to its industry.

UNIT-III

1. Sericulture: mulberry, non-mulberry sericulture, cultivation, bio-ecology and rearing of silkworms, structure and chemical composition of silk. Sericulture in India and problems related to its industry.
2. Lac culture: life history of lac insects, host plant management, strains of lac insects, propagation of lac insects, lac crop management. Lac culture in India and problems related to its industry.

UNIT-IV

1. Impact of pesticides on wildlife and human health. Carcinogenic, mutagenic and teratogenic effects.
2. Bio-concentration, bio-accumulation, bio-magnifications.
3. Biological half-life and biodegradation of pesticides (microbial and environmental degradation).
4. Dynamics of environmental pollution due to pesticides.

Practicals

l. Anatomy:

a. Honey bee: Alimentary canal, Nervous system.
b. House fly: Nervous system.
c. Flesh fly: Cephalopharyngeal skeleton and spiracles of larval stage

3. Permanent Mounting

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a. Sting apparatus and pollen basket of honey bee.
b. Salivary glands of mosquito, Drosophilla and honey bee.
c. Whole mounts of thrips and aphids.

4. Toxicology
   a. Bioassay and LD50)
   b. Pheromone trap functioning
   c. Pesticide residue analysis of contaminated soil, vegetables and water.
5. Appliances
   a. Dusters (manually and powered operated)
   b. Sprayers (manuallv and powered operated)
   c. Fumigators
5. Study of selected insects
   a. Collection and preservation of Odonata, Coleopteran, Lepidopteran, Hymenopteran, Dipteran etc. Insects
   b. Study of selected insects and their identification with the help of taxonomic keys.
6. Insect rearing
   a. Stored grain pests
   b. Polyphagous pests
   c. Flesh flies
   d. Mosquitoes
   e. Drosophila
7. Field trips for pest surveillance.

Recommended Books

1. A. D. Imms (1 997): A General textbook of entomology, Asia Publication.
2. V -B. Awasthi (202 1): Agricultural insect pests and their control (2nd revised edition), Scientific Publication.
3. M. M. Trigunayat (201 6): A manual of practical entomology (3rd revised edition), Scientific Publication.
4. A. Prakash and P.G. Fennemore (2014): Applied Entomology, International (P) Ltd., New Age Publishers.
5. V.B. Awasthi (2009): Introduction to entomology and Applied Entomology, Scientific Publication.
6. D.B. Tembhare (1984): A Text book of insect morphology, physiology and endocrinology, Chand Publication.
7. CL. Metcalf and W.P. Flint (1951): Destructive and Useful Insects, McGraw Hill Publication.
8. G.S. Shukla and V.B. Upaddhaya (2022): Economic Zoology (5th edition), Rastogi Publication.
9. A. V. Huis, J. V. Itterbeeck, H. Klunder, E. Mertens, A. Halloran, G. Muir and P. Vantomme (201 3): Edible insects: Future prospects for food and feed security- FAO of the United Nations, Rome (Available online).
10. E. Paul and M.D. Cherniack (2010): Bugs as Drugs, Part l: Insects. The "New" Alternative Medicine for the 21st Century. Alternative Medicine review.
11. L. P. Pedigo (2014): Entomology and Pest Management (6th Edition), Pearson Education.
12. J. H. Byrd and J. L. Castner (2009): Forensic Entomology-The utility of Arthropods in legal investigation (2nd Edition), CRC Press.

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13. K. K. Nayar, T. N. Ananthakrishnan, B. V David 0976): General and applied Entomology, Tata McGraw Hill
14. D.B. Tembhare (1984): Insect endocrinology and physiology, S Chand publication.
15. R. D. Akre, L. D. Hansen, and R. S. Zack (1991): Insect Jewcllery in Summer, Online available as research article.
16. Insect, The Year Book of Agriculture- American Agriculture Department Publication.
17. Irwin, M. E. and Kampmeier, G. E. (2002): Commercial products, from Insect. In V. H. Resh and R. Carde (eds.) Encyclopedia of insects. Academic press, San Diego.
18. A. L. Jeffrey (1 987): Entomological warfare: History of the use of insects as weapons of Wars: in Bulletin of the ESA in Summer (Online available as research article).
19. A. Prakash (2001): Laboratory manual of entomology, New Age Publishers.
20. J.S. Castner (2001): Photographic Atlas of Entomology and guide to insect identification, Seline press Florida, Marketed by Scientific Publication.
21. R.E. Snodgrass (1993): Principles of insect morphology, Tata McGraw Hill.
22. V.B. Wigglesworth (1982): Principles of insect physiology, ELBS Publication.
23. S. Turner (2008): Termites: Friends or Foe, AGRICOLA.
24. H. H. Ross, C. A. Ross, J. P. Ross (1982): A Text book of Entomology, John Wiley publication.
25. R. F. Chapman (1 998): The Insects - Structure and Function (4th Edition). Cambridge University Press.
26. T.A. Evans., T. Z. Dawes, P. R. Ward and N. Lo (201 1): Ants, and termite increases crop yield in dry climate, Nature communication. 262. doi: 10.1038/ncomms1257
27. Kachhwaha, N. and Kaushik, P (2019): freely online available gaming websiteinnovativezoology.com to study entomology classification.
28. Kachhwaha, N. (2019): Insect Morphology, Physiology and Systematics, Agrobios ISBN 978-81-7754-601-9 Ohttps:i/doi.org/10.6084/m9.figshare. 14230100.v I
29. Kachhwaha, N., Kumari, V., Meena, G., Meena, S., Kaushik, P., Gaur, A., Rajpurohit, A., Sharma, R., Nagar, G.: MOOC Contribution (Online teaching learning Pedagogy) under Project: Zoology, PG in Zoology (entomology), 12 modules (online lecture) each having four quadrants (l, Il, Ill, IV) in VIDYA MITRA under NME-ICT, MHRD, India https:flvidvamitra.inflibnet.ac.in/index.php/projects
30. Kumari, V., Choudhary, S. K., Meena, S., Kuri, B. R. and Bamboriya, S. D. (2022) Climate Resilient Agriculture System. Surahee Publications, Jaipur (Raj.)
31. Meena, S., Choudhary, S. K., Kumari, V., Kuri, B. R. and Bamboriya, S. D. (2022) Environment and Food Security. Surahee Publications, Jaipur (Raj.)
32. Choudharv, S. K., Kumari, V., Meena, S. and Singh, S. (2022) Recent Trends in Agricultural Sciences. AnaamayaPrakashan, Jaipur. (Raj.)
33. houdhary, S. K. , Kumari, V., Meena, S. and Singh, S. (2022) Advances in Sustainable Agriculture. AnaamayaPrakashan, Jaipur (Raj.)
34. Kumari, V. and Kachhwaha, N. (2020) Souvenir of National Workshop on skill-base entomologv. Ideal International Publication Pvt. Ltd., Indore (MP).
35. Omkar (2017) Industrial Entomology, Springer Nature Singapore Pte Ltd.
36. Omkar (2021) Polyphagous pests of crops, Springer Nature Singapore Pte Ltd.
37. T. D. Schowalter (201 1) Insectecology-an ecosystem approach, Elsevier Inc.
38. P W Price, R F Deno, M D Eubanks, D L Finke, I Kaplan (201 1) Insect Ecology Behaviour, Populations and Communities, Cambridge University Press. 39. D Gennard (2012) Forensic entomology, John Wilev & Sons, Ltd

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ZOL C411: PRACTICAL
Scheme for Practical Examination
(Based on ZOL CC401, ZOL CC402 and ZOL CC403)

Max. Marks: 150 Time: 6 hrs

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

Note:

l. With reference to anatomy and study of museum specimens, candidates must be well versed in the study of various systems with the help of dissections/' charts/models/CD- ROMs, multimedia computer based simulations including computer assisted learning (CAL) and other softwares.

2. 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 IV SEMESTER
CORE PAPER (GROUP-E)
(SPECILISATION: REPRODUCTIVE BIOLOGY)
ZOLCD401: PHYSIOLOGY OF REPRODUCTION

Max. Marks: 100 Total Hours: 60

UNIT-I

Fertilization:

1. Pre-fertilization events.
2. Biochemistry of fertilization
3. Post-fertilization events
4. Capacitation.

UNIT-II

Implantation:

1. Implantation, deciduai changes
2. Hormonal regulation.
3. Delayed implantation
4. Placenta as endocrine tissue: foeto-placental unit.

UNIT-III

Gestation:

1. Physiological change
2. Pregnancy tests
3. Hormonal regulation.

Parturition:

1. Onset of parturition

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2. Hormonal control of parturition.

Lactation:

1. The mammary gland
2. Hormonal control of lactation.

UNIT-IV

Miscellaneous factors affecting reproduction:

1. Nutrition and reproduction
2. Effect of light, temperature
3. Environmental disruptors
4. Change of lifestyle.

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP-E)
(SPECILSATION: REPRODUCTIVE BIOLOGY)
ZOL CD402: CONTRACEPTION AND REPRODUCTIVE HEALTH

Max. Marks: 100

Total Hours: 60

UNIT-I

Fundamental aspects of control of fertility in males:

1. Mechanical
2. Surgical
3. Chemical
4. Immunological methods.

UNIT-II

Fundamental aspects of control of fertility in females:

1. Natural.
2. Mechanical.
3. Surgical.
4. Chemical.
5. Immunological.
6. Emergency contraception.

UNIT-III

Sexually transmitted diseases: Pathophysiology, diagnosis, prevention, treatment of

1. Bacterial diseases (Syphilis. Gonorrhea)
2. Viral (AIDS)
3. Fungal (Candidiasis)
4. Protozoan (Trichomoniasis)

Hormones and cancer:

1. Definition cancer
2. Beningn and malignant tumor
3. Types of cancer: Prostate, cervical, breast, testicular and ovarian cancers
4. Cancer problem in India
5. Hormones and cancer

UNIT-IV

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1. Teratological effects of Xenobiotics.
2. Demography:
   a. Population growth rate
   a. National population policy
   b. Pearl Index
   c. Family welfare programmes

M.Sc. ZOOLOGY IV SEMESTER
CORE PAPER (GROUP-E)
(SPECILISATION: REPRODUCTIVE BIOLOGY)
ZOL CD403: HEALTH REPRODUCTIVE TECHNOLOGIES

Max. Marks: 100

Total Hours: 60

UNIT-I

Reproductive dysfunctions in males and females:

1. Endocrinological
2. Physiological
3. Anatomical
4. Congenital
5. Idiopathic factors

Diagnosis of male infertility:

1. Semen analysis: Physical examinations, microscopic examinations, biochemical analysis, Immunological tests.
2. Sperm functional tests: Zona binding assays, hamster-oocyte penetration test, Hypoosmotic swelling test, acrosome reaction, Acrosome intactness test, Nuclear chromatin decondensation test, Sperm mitochondrial activity index test.
3. Endocrinological diagnosis.

UNIT-II

Diagnosis of female infertility:

1. Monitoring of ovarian and reproductive cycles.
2. Endometrial biopsy.
3. Ductal blockage.
4. Endocrine diagnosis

Assisted reproductive technology (ART)

1. Artificial insemination
2. Super ovulation, oocyte collection
3. Collection and preparation of sperm for assisted fertilization
4. In vitro fertilization and related techniques (IVF, GIFT, ZIFT, TET, ICSI etc.).
5. Ethical issues and regulatory guidelines Cryopreservation:
   1. Semen
   2. Oocytes
   3. Embryos

UNIT-III

1. Animal cloning.
2. Sperm and embryo sexing.

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3. Animal husbandry:
   a. Improvement of breeds of farm animals
   b. Artificial insemination and embryo transfer technique
   c. Transgenic animals.
   d. Induction of early puberty in cattle

UNIT-IV

1. Pre-natal diagnosis of genetic diseases.
2. Hormonal bioassay: 'Principles, Procedure and applications
   a. ELISA
   b. Radio immunoassay (RIA)
   c. Radio receptor binding assay
   d. Immuno-cytochemistry.

Practicals

1. Surgical procedure in reproduction:
   (i) Castration
   (ii) Ovarectomy
   (iii) Adrenalectomy
   (iv) Vasectomy
2. Biochemical investigation of marker parameters.
3. Induction of superovulation and collection of oocytes.
4. Hormonal bioassays estrogens & androgen.
5. Pregnancy test.
6. Biochemical investigations of the reproductive glands with special reference to their markers. Fructose, glycogen, cholesterol, Acid & Alkaline phosphatase.
7. Electrophoresis: Study of protein profile in epididymic fluid.
8. Demonstration of in vitro fertilization (GIFT, ZIFT, TET, ICSI, etc.).
9. Immunoassays: RIA, ELISA. 10. Monitoring of sperm function tests.
10. Visit to State and National laboratories /institute.

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

Recommended Books

1. Reproduction in Domestic animals. Cole, H. H. and Cupps P. T. Academic Press, New York.
2. Male Fertility and Infertility, Clover TD. and Barratt C.L.R. Cambridge University Press, Cambridge, 1999.
3. Biology of Human Reproduction. Pinon, Jr. R. University Science Books California,2002.
4. The Reproductive Physiology of Mammals: From Farm To Field And Beyond, Keith K.Schillo Cengage Delmar Learning 2008.
5. Assisted Reproductive Technology: A Reference Book on A.R.T., Philippe Merveil Eska Publishing, 2010.
6. Reproductive Endocrinology & Infertility, Daftary & PatkiBl Publications Pvt Ltd,2009.
7. Reproductive Endocrinology and Infertility: Integrating Modern Clinical and Laboratory Practice, Douglas T. Carrell Springer, 2010.
8. Andrology: Male Reproductive Health and Dysfunction, Eberhard Nieschlag, Hermann M. Behre, Susan Nieschlag Springer, 2010.

प्रभारी अधिष्ठानक प्रथम

9. Reproductive Endocrinology: A Molecular Approach, Pedro J. Chedrese springer, USA, 2009.
10. Hormonal Contraception: Birth Control, Endocrine System, Steroid Hormone, Frederic P. Miller, Agnes F. Vandome, John McBrewster Alpha script Publishing, 2010.
11. Hormonal contraception, Ronald T. Burkman, Steven G. Gabbe Wolter Kluwer; Lippincott Williams & Wilkins, 2007.
12. Text Book on Sexually Transmitted Diseases and AIDS by IASSTD & AIDS, V inod K Sharma, Rishi Bhargava and N. Usman VIVA BOOKS PVT. LTD, Jaipur
13. Sexually transmitted diseases: epidemiology, pathology, diagnosis, and treatment By Kenneth A. Borchardt, Michael A. Noble CPC Press, 1997.
14. Sexually transmitted diseases, Louise I. Gerdes Greenhaven Press, 2002.
15. Reproductive Biotechnology of Farm Animals, Dugwekar V g Agrotech Publishing Academy, 2006.
16. Biotechnology of human reproduction, Alberto Revelli, Ilan Tur-Kaspa, Jan Gunnar Holte Parthenon Pub. Group, 2003.
17. Menopause: Biology and Pathobiology, Lobo, Rogerio A. Academic Press 2000.
18. Dynamics of human reproduction: biology, biometry, demography, James W. Wood Transaction publishers 1994.
19. Introduction to Endocrinology, Negi PHI Learning PvtLimited, New Delhi, 2009.
20. The Reproductive System, Kara Rogers (Ed.) Britannica Educational Publishing, 2010.
21. WHO. Laboratory manual for the examination of human semen and sperm cervical mucus interaction. Cambridge: Cambridge University Press; 1999 & 2010.

ZOL E411: PRACTICAL

Scheme for Practical Examination

(Based on ZOL CD401, ZOL CD402 and CD403)

Max Marks: 150 Time 6 hrs.

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

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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M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC1: BIOFERTILIZERS

Unit – I

Biofertilizers - Introduction, status and scope; Rhizobia: isolation, purification, morphology, identification, and mass cultivation. Actinorrhizal symbiosis.

Unit -II

Azospirillum: isolation and mass multiplication – carrier-based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication

Unit –III

Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation. FCO specifications and quality control of biofertilizers

Unit-IV

Mycorrhizal association, types of mycorrhizal association, taxonomy, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop Plants

Suggested Books and References –

1. Dubey, R.C. (2005). A Text Book of Biotechnology. S. Chand and Co, New Delhi.
2. John Jothi Prakash, E. (2004). Outlines of Plant Biotechnology. Emkay Publication, New Delhi.
3. Kumaresan, V. (2005). Biotechnology, Saras Publications, New Delhi.
4. Sathe, T.V. (2004). Vermiculture and Organic Farming. Daya Publishers.
5. Subha Rao, N.S. (2000). Soil Microbiology, Oxford and IBH Publishers, New Delhi.
6. Vayas, S.C, Vayas, S. and Modi, H.A. (1998). Bio-fertilizers and organic Farming. Akta Prakashan, Nadiad
7. Somani, L.L. (2004). Handbook of Biofertilizers. Agrotech Publishing Academy, Udaipur 313002
8. Khosla, R. (2017). Biofertilizers and Biocontrol Agents for Organic Farming Kojo Press
9. Trueman's Biofertilizers. (2018). Trueman Book Company, Jalandhar.

M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC2: HOUSEHOLD PESTS AND THEIR MANAGEMENT

Unit - I

Introduction to household pests and mode of disease transmission Housefly: Systematic position, Morphology and identification characters, life cycle, mode of disease transmission, control

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measures Silverfish: Systematic position, Morphology and identification characters, life cycle, their damage and control

Unit -II

Mosquito: Systematic position, Morphology and identification characters, life cycle, role of the mosquito in virus/ protozoan borne diseases, control measures-preventive and curative, WHO initiated programmes Ants: Systematic position, Morphology and identification characters, castes and social life, ant mounds, their mode of damage and control

Unit -III

Termite: Systematic position, Morphology and identification characters, castes and social life, termitarium, their mode of damage and control Crickets: Systematic position, Morphology and identification characters, life cycle, control measures

Unit-IV

Cockroach: Systematic position, Morphology and identification characters, life cycle, spread of diseases carrying pathogens, control measures Bedbug: Systematic position, Morphology and identification characters, life cycle, inflammation and their control measures Pediculus: Systematic position, Morphology and identification characters, life cycle, Pediculus borne disease and their control measures

Suggested Books and References –

1. Medical and Veterinary Entomology by Gary R. Mullen and Lance A. Durden, 3rd Edition 2009, ISBN 978-0-12-814043-7,
2. Insect-Borne Diseases in the 21st Century by Marcello Nicoletti,2020, ISBN 978-0-12-8187067
3. Pests and vector-borne diseases in the livestock industry by Garros, Claire, editor.; Bouyer, Jérémy, editor.; Takken, Willem, editor.; Smallegange, Renate C., 2018, ISBN: 9789086868636
4. Biological and environmental control of disease vectors by Cameron, M. M. (Mary M.), editor.; Lorenz, L. M. (Lena M.), 2013, ISBN: 9781845939861

M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC3: VERMICOMPOSTING

Unit - I

Earthworms – Taxonomic position, external features- shape, size, colour, segmentation, setae& clitellum. Reproductive system-Male & Female, copulation, cocoon formation & fertilization,; ecological grouping – Epigeic species, Endogeic species and Anecics.

Unit -II

Vermiculture – definition, scope and importance; common species for culture; Environmental parameters; culture methods – wormery – breeding techniques; indoor and outdoor cultures - monoculture and polyculture – merits and demerits; Limiting factors-climatic factors, pH, humidity, Temperature, gases, xenobiotics

Unit -III

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Vermicomposting of wastes in field pits, ground heaps, tank method, roof shed method, wedges & bin method; harvesting the compost, storage, Vermiwash-Preparation and application vermicomposting harvest and processing. Nutritional composition of vermicompost; Comparison with other fertilizers.

Unit-IV

Applications of vermiculture –use of vermicastings in organic farming/horticulture, earthworms for management of municipal/selected biomedical solid wastes; as feed/bait for capture/culture fisheries; forest regeneration.

Suggested Books and References –

1. Sultan Ahmed Ismail, 2005. The Earthworm Book, Second Revised Edition. Other India Press, Goa, India.
2. Bhatnagar & Patla,2007. Earthworm vermiculture and vermin-composting, Kalyani Publishers, New Delhi.
3. Mary Violet Christy,2008. Vermitechnology, MJP Publishers, Chennai.
4. Aravind Kumar, 2005.Verms &Vermitechnology, A.P.H. Publishing Corporation, New Delhi.
5. Jordan & Verma,2009. Invertebrate Zoology, Chand & Company Ltd. 6. Edwards, C.A & J.R Lofty Vermicoloogy – The Biology of earthworm, 1997 Chapman & Hall Publications N.Y.U.S.A.

M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC4: DISASTER MANAGEMENT

Unit I

Introduction to Disaster Definition and types. Concept of hazard, risk and vulnerability. Causes and effects of disasters. Disaster Profile of India. Natural and Man-made Disasters

Unit II

Natural: Causes and impacts of earthquakes, floods, droughts, volcanic eruptions, tsunamis, landslides, avalanches, cyclones, tornadoes. Man-made: Impacts of wars, dam failure, nuclear disasters, industrial disasters, fire, epidemics, accidents, and terrorism. Related case studies.

Unit III

Disaster Management Disaster Management Cycle, Capacity building, Training programs, mock drills. Disaster risk reduction. Disaster Mitigation Measures (structural and non-structural mitigation measures).

Unit IV

National Response Mechanism on Disaster Management Policy and Act. National Disaster Management Authority. National Institute of Disaster Management (NIDM), National Disaster Response Force (NDRF), State Disaster Management Authority (SDMA).

Suggested Books and References –

प्रभारी अकादमिक प्रधान

1. Coppola D.P. (2007). Introduction to International Disaster Management. Butterworth Heinemann.
2. Pine J.C. (2009). Natural Hazards Analysis: Reducing the Impact of Disasters. CRC Press, Taylor and Francis Group.
3. Schneid, T.D. & Collins, L. (2001). Disaster Management and Preparedness. Lewis Publishers, New York, NY.
4. Shaw R., and Krishnamurthy, R.R. (2009). Disaster: Global Challenges and Local Solutions.
5. Smith K. (2001). Environmental Hazards: Assessing Risk and Reducing Disaster. Routledge Press.

M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC5: APICULTURE

Unit – I

Biology of Bees: Historical background of apiculture, classification, diversity and biology of honey bees, social organization of bee colony, behavioural pattern (bee dance, swarming, absconding etc.); products of apiculture (honey, bees wax, propolis, royal jelly, pollen etc.) and their uses.

Unit -II

Rearing of Bees: Artificial bee rearing (Apiary), beehive- Newton and Langstronth; bee pasturage; selection of bee species for apiculture (Apis cerana indica and A. mellifera), methods and equipment (indigenous and modern) for beekeeping and extraction of honey bee products and their processing; apiary management- honey flow and lean period.

Unit -III

Problems Related Apiculture and Their Management: Bee diseases, control and preventive measures; enemies of bees and their management; effects of pollutions on honeybees

Unit-IV

Economy of Beekeeping: Pollination: significance of beekeeping in horticultural gardens and agricultural fields; employment opportunities, economics, scope of women empowerment in apiculture industry; role of small- and large-scale beekeeping in growth of Indian economy (honey production in India); honey mission and sweet kranti; organisations and training institutes involved in beekeeping in India.

Suggested Books and References –

1. Singh, S (1962). Beekeeping in India, Indian Council of Agricultural Research, New Delhi.
2. Mishra, R. C. (1995). Honeybees and their management in India. Indian Council of Agricultural Research, New Delhi.
3. Prodt, P. J. (1962). Apiculture. Oxford and IBH, New Delhi.
4. Rahman, A. (2017). Beekeeping in India. Indian Council of Agricultural Research, New Delhi.
5. Gupta, J. K. (2016). Apiculture, Indian Council of Agricultural Research, New Delhi.

M.SC. ZOOLOGY
SKILL ENHANCEMNENT COURSE
ZOL SEC6: INTRODUCTION OF NANOTECHNOLOGY

UNIT-I

1. Introduction to Nano-biotechnology; Concepts, historical perspectives.
2. Nanoparticles and synthesis approach of nanoparticles, Physical synthesis of nanoparticles, Green synthesis approach for different nanoparticles applications and uses.
3. Applications and limitations using physical and chemical approach.

UNIT-II

1. Characterization of synthesized nanoparticles using XRD, SEM, TEM, HR-TEM, FTIR, UV spectrophotometer, Dynamic light scattering etc.,
2. Different types of nanoparticles and applications with examples, Safety and toxicity aspects of nanoparticles.

UNIT-III

1. Nanoparticles for drug delivery, concepts, optimization of nanoparticle properties for suitability of administration through various routes of delivery, advantages, strategies for enhanced permeation through various anatomical barriers.
2. Nanoparticles for diagnostics and imaging (theranostics); Clinical Applications of Nanopaticles, Nanotech and cancer.

UNIT-IV

1. Environmental impact of nanomaterials – Exposure and risk assessment – Mechanism of toxicity, Toxicological impacts of Nanomaterials-Ecotoxicological impact of Nanomaterials, Nanotechnology in Agriculture, Nanofactories

Recommended Books: -

1. Gero Decher, Joseph B. Schlenoff, (2003); Multilayer Thin Films: Sequential Assembly of Nanocomposite Materials, Wiley-VCH Verlag GmbH & Co. KGaA
2. David S. Goodsell, (2004); Bionanotechnology: Lessons from Nature; Wiley-Liss
3. Neelina H. Malsch (2005), Biomedical Nanotechnology, CRC Press
4. Greg T. Hermanson, (2013); Bioconjugate Techniques, (3rd Edition); Elsevier
5. Recent review papers in the area of Nanomedicine

अकादमिक प्रथम