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UNIVERSITY OF CALICUT

Abstract

General and Academic - Faculty of Science - Syllabus of MSc Applied Zoology Programme under CCSS PG Regulations 2019 (University Teaching Departments) with effect from 2019 Admission onwards-Implemented- Orders-Issued.

G & A - IV - J

U.O.No. 11743/2019/Admn Dated, Calicut University.P.O, 30.08.2019

Read:-1. U.O No.4487/2019/Admn dated 26.03.2019

2. Item No. 1 of the minutes of the meeting of the Board of Studies in Zoology PG held on 28.06.2019

3. Remark from the Dean, Faculty of Science dated 30.07.2019.

ORDER

The Regulations under Choice-based Credit Semester System for Post Graduate Programmes (CCSS-PG-2019) of all Teaching Departments / Schools of the University of Calicut w.e.f. 2019 admissions has been implemented in the University of Calicut vide paper read first above.

The meeting of Board of Studies in Zoology PG held on 28.06.2019 has approved the Syllabus of M.Sc Applied Zoology Programme in tune with the new CCSS PG Regulations with effect from 2019 Admission onwards, vide paper read second above.

The Dean, Faculty of Science has approved the minutes of the meeting of the Board of Studies in Zoology PG held on 28.06.2019 vide paper read third above.

Under these circumstances , considering the urgency, the Vice Chancellor has accorded sanction to implement the Scheme and Syllabus of M.Sc Applied Zoology Programme in accordance with the new CCSS PG Regulations 2019, in the University with effect from 2019 Admission onwards,subject to ratification by the Academic Council.

The Scheme and Syllabus of M.Sc Applied Zoology Programme for Teaching Departments /Schools of the University of Calicut in accordance with CCSS PG Regulations 2019, is therefore implemented with effect from 2019 Admission onwards.

Orders are issued accordingly. (Syllabus appended).

Biju George K

Assistant Registrar

To

The HoD, Department of Zoology

Copy to: PS to VC/PA to PVC/ PA to Registrar/PA to CE/JCE I/JCE V/DoA/EX and EG Sections/GA I F/CHMK Library/Information Centres/SF/DF/FC

Forwarded / By Order

Section Officer

DEPARTMENT OF ZOOLOGY
UNIVERSITY OF CALICUT

CALICUT UNIVERSITY P.O.
KERALA, 673 635

RESTRUCTURED CURRICULUM AND SYLLABI FOR

M. Sc. APPLIED ZOOLOGY

(Choice based Credit Semester System – CCSS)

(w.e.f. 2019 admission)

2019

C O N T E N T S

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2. M. Sc. Applied Zoology Syllabus (CCSS)	
2.1. Semester I	10 – 29
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REGULATIONS AND SCHEME OF EXAMINATION (w.e.f. 2019 admission)

1. The syllabi and curriculum of Applied Zoology have been revised and restructured with effect from 2019 admissions.

2. The two-year Post Graduate Programme will be in the semester pattern. There will be four semesters in the entire course, with two semesters in each year. Each semester will have 90 instructional days with 6 hours of instructions each day under the five-day system. End-semester examinations will be held inside the 90 regular instructional days.

3. The programme shall include three types of courses, viz. Core courses, Elective courses and Audit courses. The papers in the first three semesters will constitute the core courses and in the third and fourth semesters there will be elective courses. Entomology is the broad area of elective courses offered in this department for the time being. There shall be a compulsory Project/Dissertation to be undertaken by all students.

4. In addition to the Core courses, Elective courses and compulsory Project/Dissertation, which are the mandatory requirement of the programme, each student should undergo Audit courses - Ability Enhancement Course (AEC) and Professional Competency Course (PCC) – each with 2 credits in the first two semesters of the programme. The student should undergo any one course listed under each category (AEC and PCC) in the respective semesters. Each student will be under the supervision of a faculty who will be responsible for monitoring the course and evaluation. The allotment of the faculty will be decided by the Department Council. The examination and evaluation for Professional competency course should focus on evaluating the skill component involved, and these courses are to be done within the first two semesters. The credits will not be counted for computing the overall SGPA/CGPA of the student. The concerned department shall conduct examination for these courses and shall intimate /upload the results of the same to the University on the stipulated date during the Third Semester. The student has to obtain only minimum pass requirements in these two courses. The broad frameworks of the compulsory audited courses are given hereunder.

5. SCHEME OF EVALUATION:

5.1. Evaluation of all semester theory/ practical papers will be done in two parts namely by continuous internal evaluation and external evaluation. 20% weight shall be given to the internal evaluation. The remaining 80% weight shall be for the end semester external evaluation. The internal evaluation shall be based on a predetermined transparent system involving periodic written tests, viva-voce, seminars and attendance in respect of theory courses and based on written tests, viva-voce and lab skill/records in respect of practical courses as detailed below:

Theory Paper	Marks	Practical Paper	Marks
Attendance*	3	Lab skill/ Quality of Records	5
Seminar	5	Practical Test	10
Test Paper	8	Viva-voce	5
Viva-Voce / Field work	4		
Total marks	20	Total marks	20

*90% & above: 3 marks, 80 to 89%: 2 marks, 75 to 79%: 1 mark, below 75%: Nil

The details of executing the internal evaluation shall be decided by the concerned Departmental Council. To ensure transparency of the evaluation process, photocopies of the answer scripts of the test papers shall be returned to the students within a week of the conduct of the tests. Any dispute regarding the internal evaluation shall be taken up with the concerned teacher within 48 hours. The internal assessment marks awarded to the students in each course in a semester shall be notified on the notice board at least one week before the commencement of external examination.

5.2. The external examination in theory courses is to be conducted with question papers set by external examiners. The evaluation of the answer scripts shall be done by the teacher offering the course and an external expert based on a well-defined scheme of valuation framed by them.

5.3. The external examination in practical courses shall be conducted and evaluated by two examiners - one internal and an external.

5.4. The valuation scheme for Project/Dissertation shall be jointly done by the supervisor of the project in the department and an External Expert from the approved panel, based on a well-defined scheme of valuation framed by them. The following break-up is suggested for the

valuation. The concerned Department Council / BoS may decide on alternative break-up, if required, specific to the discipline of study.

Sl. No.	Particulars	Weightage (%)
1	Review of Literature and Formulation of the Research Problem/Objective	20
2	Methods and Description of the techniques used	15
3	Analysis and Discussion of results	30
4	Presentation of the report, organization, linguistics style, references etc.	15
5	Viva Voce examination based on the Project work/Dissertation	20
Total		100

6. Attendance: The minimum requirement of attendance during a semester shall be 75% for each course. Attendance shall be maintained by the course teacher. 10% condonation can be granted on the attendance requirements by the Chairman of the Academic Committee on genuine grounds, provided it is also recommended by the Department Council. A fee for this purpose may be collected as prescribed by the Academic Committee and approved by the Syndicate. Candidates who do not satisfy the required minimum attendance in a course shall be awarded zero grade point in that course

7. GRADING SYSTEM: The indirect absolute grading system where the marks are compounded to grades based on pre-determined class intervals and letter grades based on 10-point grading system as recommended by UGC shall be followed. Based on the % marks scored (internal and external marks put together), the students are graded in each course applying the following grading system:

Range of Marks (%)	**Grade Point**	**Letter Grade**
85-100	8.5 - 10.0	**O** (Outstanding)
75 – 84.99	7.5 - 8.49	**A+** (Excellent)
65 – 74.99	6.5 - 7.49	**A (**Very Good)
55 – 64.99	5.5 - 6.49	**B+** (Good)
50 – 54.99	5.0 - 5.49	**B (**Above Average)
45 – 49.99	4.5 - 4.99	**C** (Average)
40 – 44.99	4.0 – 4.49	**P** (Pass)
0 - 39	0 – 3.99	**F** (Failed)/ RA(Reappear)

-	0	**I** (Incomplete)
-	0	**Ab** (Absent)

SCHEME OF EXAMINATION
M.Sc. APPLIED ZOOLOGY (2019 admission onwards)

SUMMARY OF COURSES

Semester	Course Type	Course Mode	No. of Course	Credits/ course	Marks/ course	Total Credits	Total Marks
FIRST	Core	Theory	4	4	100	16	600
	Core	Practical	2	2	100	4	
SECOND	Core	Theory	4	4	100	16	600
	Core	Practical	2	2	100	4	
THIRD	Core	Theory	2	4	100	8	600
	Core	Practical	1	2	100	2	
	Elect	Theory	2	4	100	8	
	Elect	Practical	1	2	100	2	
FOURTH	Core	Project	1	8	200	8	600
	Elect	Theory	2	4	100	8	
	Elect	Practical	2	2	100	4	
Grand Total						**80**	**2400**

Total credits: Core course : Theory - 40; Practical - 10; Total - 50
Elective course : Theory - 16; Practical - 06; Total - 22
Project : 08
Grand total : 80

SEMESTER-WISE DETAILS

FIRST SEMESTER

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 1C 01- BIOCHEMISTRY	80 hrs	4	80	20	100
ZOO 1C 02 – BIOPHYSICS & BIOSTATISTICS	80 hrs	4	80	20	100
ZOO 1C 03 – BIOSPHERE ECOLOGY	80 hrs	4	80	20	100
ZOO 1C 04- SYSTEMATICS & ANIMAL BEHAVIOUR	80 hrs	4	80	20	100
ZOO 1C 05 – BIOCHEMISTRY, BIOPHYSICS & BIOSTATISTICS PRACTICAL	60 hrs	2	80	20	100
ZOO 1C 06 – SYSTEMATICS, BEHAVIOUR & BIOSPHERE ECOLOGY PRACTICAL	60 hrs	2	80	20	100
Total for First Semester		**20**	**480**	**120**	**600**

SECOND SEMESTER

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 2C 07- CYTOGENETICS & EVOLUTION	80 hrs	4	80	20	100
ZOO 2C 08 – MOLECULAR BIOLOGY	80 hrs	4	80	20	100
ZOO 2C 09 – BIOTECHNOLOGY	80 hrs	4	80	20	100
ZOO 2C 10- ANIMAL PHYSIOLOGY & ENDOCRINOLOGY	80 hrs	4	80	20	100
ZOO 2C 11 - CYTOGENETICS & ANIMAL PHYSIOLOGY PRACTICAL	60 hrs	2	80	20	100
ZOO 2C 12 - MOLECULAR BIOLOGY & BIOTECHNOLOGY PRACTICAL	60 hrs	2	80	20	100
Total for Second Semester		**20**	**480**	**120**	**600**

THIRD SEMESTER

Code No. & Course	Teaching Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 3C 13- DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS	80 hrs	4	80	20	100
ZOO 3C 14 – MICROBIOLOGY & IMMUNOLOGY	80 hrs	4	80	20	100
ZOO 3E 15 – GENERAL ENTOMOLOGY	80 hrs	4	80	20	100
ZOO 3E 16- INSECT PHYSIOLOGY & BIOCHEMISTRY	80 hrs	4	80	20	100
ZOO 3C 17 - DEVELOPMENTAL BIOLOGY, MICROBIOLOGY & IMMUNOLOGY PRACTICAL	60 hrs	2	80	20	100
ZOO 3E 18 - GENERAL ENTOMOLOGY & INSECT PHYSIOLOGY BIOCHEMISTRY PRACTICAL	60 hrs	2	80	20	100
Total for Third Semester		**20**	**480**	**120**	**600**

FOURTH SEMESTER

Code No. & Course	Allotted Hours	Credits	Ext. Marks	Int. Marks	Total Marks
ZOO 4C 19- PROJECT	160 hrs	8	160	40	200
ZOO 4E 20 – AGRICULTURAL ENTOMOLOGY & ACAROLOGY*	80 hrs	4	80	20	100
ZOO 4E 21 – INSECT PESTS – CONTROL AND MANAGEMENT*	80 hrs	4	80	20	100
ZOO 4E 22 – ECOLOGY & ETHOLOGY OF INSECTS*	80 hrs	4	80	20	100
ZOO 4E 23 – MEDICAL, VETERINARY & FORENSIC ENTOMOLOGY*	80 hrs	4	80	20	100
ZOO 4E 24 – PRACTICAL ON 4E 20*	30 hrs	2	80	20	100
ZOO 4E 25 – PRACTICAL ON 4E 21*	30 hrs	2	80	20	100
ZOO 4E 26 – PRACTICAL ON 4E 22*	30 hrs	2	80	20	100
ZOO 4E 27 – PRACTICAL ON 4E 23*	30 hrs	2	80	20	100
Total for Fourth Semester		**20**	**480**	**120**	**600**

C - Core course; E - Elective course

* Elective Courses (Any Two Theory course and its Practical is to be opted by the student)

Allotment of Teaching hours per Week in Each Semester

Course/ Activity	Hours allotted per Week				
	First Semester	**Second Semester**	**Third Semester**	**Fourth Semester**	**Total**
Core Theory	4 hrs X 4 courses = 16 hrs	4 hrs X 4 courses = 16 hrs	4 hrs X 4 courses = 16 hrs	--	48 hrs
Core Practical	2 Practical X 2 courses = 12 hrs	2 Practical X 2 courses = 12 hrs	2 Practical X 2 courses = 12 hrs	--	36 hrs
Elective Theory	--	--		4 hrs X 2 courses = 8 hrs	12 hrs
Elective Practical	--	--		2 Practical X 1 course = 6 hrs	6 hrs
Seminar/ Assignment	2 hrs	2 hrs	2 hrs	2 hrs	8 hrs
Project/ Dissertation	--	--	--	14 hrs	14 hrs
Total hrs per week	**30 hrs**	**30 hrs**	**30 hrs**	**30 hrs**	

FIRST SEMESTER

ZOO 1C 01 BIOCHEMISTRY

1. **Introduction** **(4 h)**
   - 1.1. Structure of atoms, molecules and chemical bonds.
2. **Water: its effect on dissolved bio molecules** **(6 h)**
   - 2.1. Water as an ideal biological solvent: Hydrogen bonds; Ionisation of water.
   - 2.2. Weak acids and weak bases; Equilibrium constant; pH and pH scale. Problems involving the determination of pH and pKa .
   - 2.3. Buffers and buffer action. Henderson-Hasselbalch equation; Phosphate and bicarbonate buffer system in biological system.
3. **Enzymes** **(8 h)**
   - 3.1. Introduction, classification and nomenclature.
   - 3.2. Specificity and regulation of enzymes
   - 3.3. Enzyme kinetics and Michaelis-Menten equation, Lineweaver-Burk plot.
   - 3.4. Factors influencing velocity of enzyme catalysed reactions.
   - 3.5. Enzyme inhibition-reversible and irreversible (competitive and non-competitive) with examples. Enzyme inhibition in the treatment of AIDS.
   - 3.6. Regulatory enzymes -Allosteric enzymes, Key enzymes.
   - 3.7. Zymogens, Isozymes and Co-enzymes
   - 3.8. Ribozymes
4. **Bioenergetics** **(6 h)**
   - 4.1. Bioenergetics: Laws of thermodynamics and biological system, Entropy, Enthalpy, Concept of free energy. Standard Free energy change and equilibrium constant. Coupled reactions.
   - 4.2. High-energy compounds. Role of ATP as a free energy carrier in the biological system.
5. **Carbohydrates: Structure and Reactions** **(6 h)**
   - 5.1. Structure of Monosaccharides, Disaccharides, Oligosaccharides and polysaccharides (chitin, bacterial cell wall and glycogen)
   - 5.2. Physical and chemical properties of monosaccharides: Isomerism and optical activity. Oxidation, reduction, ester formation, osazone formation.
6. **Metabolism of Carbohydrates** **(7 h)**
   - 6.1. Glycolysis; Gluconeogenesis; HMP pathway; Glycogenolysis; Glycogenesis.
   - 6.2. Regulation of glycogen synthesis and breakdown.

6.3. Citric acid cycle; Electron transport chain; Oxidative phosphorylation, Chemiosmotic hypothesis; Uncouplers; Inhibitors of electron transport chain.

7. **Lipids: Structure and Reactions** **(6h)**

7.1. Classification of lipids, classification of fatty acids.

7.2. Physical and chemical properties of lipids: Reactions-Hydrolysis, Saponification, Rancidity. Iodine number.

7.3. Structural lipids in membranes, Sphingolipids in biological recognition.

8. **Metabolism of Lipids** **(6h)**

8.1. Oxidation of fatty acids: Beta oxidation, alpha oxidation and omega oxidation. Ketone bodies.

8.2. Biosynthesis of fatty acids.

8.3. Steroids: Biologically important steroids-cholesterol, Vitamin D, Bile acids, Biosynthesis of cholesterol.

8.4. Prostaglandins: structure, types, synthesis and functions.

9. **Amino acids: Structure, Classification and Reactions** **(6h)**

9.1. Structure of different amino acids in proteins.

9.2. Classification of proteins

9.3. Physical and chemical properties of amino acids: Zwitter ions. Isoelectric point.Reactions of carboxyl group, amino group and side chains. Colour reactions of amino acids and proteins. Peptide bonds.

10. **Metabolism of Amino acids** **(6h)**

10.1. Metabolism of amino acids: Synthesis of amino acids

10.2. Degradation of amino acids.

10.3. Transamination, decarboxylation and deamination reactions in the biological system.

11. **Proteins structure and classification** **(6h)**

11.1. Structure of proteins. Ramachandran plot

11.2. Classification of proteins, Glycoprotein and proteoglycans.

11.3. Sequencing of proteins.

11.4. Nitrogen excretion & urea cycle.

12. **Nucleic acids** **(7h)**

12.1. Structure of nucleic acids: Structure of DNA and RNA

12.2. Biosynthesis of nucleic acids

12.3. Degradation of nucleic acids.

12.4. Sequencing of DNA.

13. **Vitamins: Classification, structure and functions** **(6h)**

13.1. Classification and structure of vitamins

13.2. Functions of vitamins

13.3. Role of B-complex vitamins as coenzymes.

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ZOO 1C 02 BIOPHYSICS & BIOSTATISTICS

PART A: BIOPHYSICS

1. **Principles of Biophysical chemistry** **(5 h)**

   1.1. pH, buffer, Electromagnetic determination of pH

   1.2. Colligative properties: relative lowering of vapour pressure, elevation of boiling point, depression of freezing point, osmotic pressure

   1.3. Diffusion: Fick's law and diffusion coefficient, Stoke-Einstein's law, Application of diffusion processes in biology: hemolysis, cyclosis, plasmolysis

   1.4. Osmosis: Vant Hoff's laws, Osmotic concentration, osmotic gradient, Electro-osmosis, Electrolytic and ionic balance in biological fluid

   1.5. Viscosity: Factors affecting viscosity, Determination of viscosity of liquids, significance

   1.6. Stratifications of cellular components against gravity

2. Radiation Biology **(5 h)**

   2.1 Radioactivity, ionizing radiations, interaction of radiation with matter

   2.2 Properties of different types of radioisotopes normally used in biology

   2.3 Detection, measurement and incorporation of radioisotopes in biological tissues and cells

      2.3.1 Radiation dosimetry

      2.3.2 G.M. counter

      2.3.3 Ionizing chambers

      2.3.4 Autoradiography

      2.3.5 Cerenkov radiation

      2.3.6 Liquid Scintillation

   2.4 Molecular imaging of radioactive material in nuclear medicine: MRI, FMRI, PET

   2.5 Safety guidelines

3. Electrophysiological methods **(4 h)**

   3.1 Single neuron recording

   3.2 Patch-clamp recording

   3.3 Electro Cardio Graphy (ECG)

   3.4 Brain activity recording - Lesion and stimulation of brain

   3.5 EEG, CAT

4. Biophysical methods **(6 h)**

   4.1 Spectroscopy

4.1.1 UV/visible

4.1.2 Fluorescence

4.1.3 Circular dichroism

4.1.4 NMR and ESR spectroscopy

4.1.5 Multiwell spectrometry

4.2 Structure determination using X-ray diffraction and NMR

4.3 Analysis using light scattering: Static Light scattering

4.4 Different types of mass spectrometry

4.5 Surface Plasmon Resonance (SPR) methods

5. Microscopic techniques **(7 h)**

5.1 Resolving powers of different microscopes

5.2 Visualization of cells and subcellular components by light microscopy

5.3 Microscopy and detection of molecules in living cells

5.4 Electron microscopy: Scanning and transmission (SEM and TEM)

5.4.1 Different fixation and staining techniques for Electron Microscope

5.4.2 Freeze-etch and freeze-fracture methods for Electron Microscope

5.4.3 Confocal microscopy

5.5 Cytophotometry

5.6 Immunofluorescence microscopy

5.6.1 Fluorescence Activated Cell Sorting (FACS)

6. Chromatography **(5 h)**

6.1 Principle and applications:

6.2 Adsorption chromatography

6.3 Partition chromatography

6.4 Column chromatography

6.5 Paper chromatography

6.6 Thinlayer chromatography

6.7 Gel-filtration

6.8 Ion-exchange

6.9 Gas chromatography

6.10 Affinity chromatography

6.11 HPLC

7. Electrophoresis **(5 h)**

7.1 Paper electrophoresis

7.2 Disc electrophoresis

7.3 PAGE - Two-dimensional PAGE

7.4 High voltage and immuno electrophoresis

7.5 Isoelectric focusing

8. Principles and applications of **(3 h)**

8.1 Micrometry

8.2 Flow cytometry

8.3 Histochemical technique

8.4 Cryotomy

PART B: BIOSTATISTICS

1. **Introduction** **(3 h)**

1.1 Sample and test biostatistics

1.2 Role of biostatistics in modern research

1.3 Descriptive and Inferential biostatistics

1.4 Limitations of statistical methods

1.5 Applications of biostatistics

1.6 Attributes and variables

2. **Measures of Central tendency** **(5 h)**

2.1 Characteristics

2.2 Arithmetic mean, Geometric mean and Harmonic mean

2.3 Correcting incorrect arithmetic mean

2.4 Combined arithmetic mean

2.5 Merits and demerits

2.6 Median

2.7 Mode

3. **Measures of dispersion or variability** **(5 h)**

3.1 Variability or dispersion

3.2 Importance of dispersion

3.3 Range

3.4 Mean deviation

3.5 Standard deviation

3.6 Quartile deviation

3.7 Variance

3.8 Standard error

3.9 Co-efficient of variation

3.10 Lorenz curve – construction

4. **Probability distribution** **(6 h)**

4.1 Normal distribution

4.1.1 Skewness and Kurtosis

4.1.2 Nature of Skewness

4.1.3 Measures of Skewness

4.1.4 Fitting of normal curves

4.2 Binomial distribution

4.2.1 Properties and Fitting of binomial distribution

4.3 Poisson distribution

5. **Statistical inference** **(7 h)**

5.1 Test of significance

5.2 Test of hypothesis

5.3 Level of significance

5.4 Degree of freedom

5.5 Critical region

5.6 Parametric and Non-parametric test

5.7 Type I and Type II error

5.8 Type of t-tests

5.9 Chi-square test

6. **Analysis of Variance** **(4 h)**

6.1 Assumptions and techniques of ANOVA

6.1.1 One-way classification

6.1.2 Two-way classification

6.2 Basic introduction to Multivariate statistics

7. **Correlation and Regression analysis** **(5 h)**

7.1 Types of correlation

7.1.1 Graphic methods – Scatter diagram, Simple graph, Correlogram

7.1.2 Mathematical methods – Karl Pearson’s co-efficient of correlation, Spearman’s Rank correlation co-efficient

7.1.3 Tied ranks and Repeated ranks

7.1.4 Co-efficient of concordance

7.2 Types of regression

7.2.1 Graphic method and Algebraic method

7.2.2 Regression lines

7.2.3 Regression equation

8. **Methods in field biology** **(5 h)**

8.1 Methods of estimating population density of animals and plants

8.2 Ranging patterns through direct, indirect and remote observations

8.3 Sampling methods

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ZOO 1C 03 BIOSPHERE ECOLOGY

1. **Population Ecology** **(8 h)**

   1.1. Population growth –Chaotic systems, Catastrophic theory. Intrinsic rate of natural increase, r- and k-selection

   1.2. Human population growth – consequences and solutions

   1.3. Life tables and survivorship curves.

   1.4. Meta population dynamics

2. Ecological modeling

   2.1 Introduction

   2.2 Statistical Models

   2.3 Non-statistical models

      2.3.1 Analytical model

      2.3.2 Simulation model

2.3 Validation of models **(3 h)**

3. Molecular ecology

3.1 What is molecular ecology?

3.2 Emergence of molecular ecology

3.3 Applications of molecular ecology in Agriculture **(4 h)**

4. Ecosystem studies **(9 h)**

4.1 Ecology of Wetlands: Uses, threats and management

4.2 Ecology of Coral Reefs: Uses, threats and management

4.3 Ecology of Tropical Rain Forests: Vegetation structure, Productivity and nutrient cycling in forests, Uses, threats and management

5. Conservation Ecology **(8 h)**

5.1 Impact of major ecosystem process like habitat degradation and loss, fragmentation, over exploitation, species invasion and land use changes on biodiversity.

5.2 Restoration Ecology

5.3 Sustainable development

5.4 Ecological foot printing

6. Environmental issues **(7 h)**

6.1 Global environmental issues – Ozone hole, effects on human life

6.2 Human mediated Global climate change – Greenhouse effect and its impact

7. Soil Biology **(4 h)**

7.1 Mechanism of erosion

7.2 Soil conservation: Managing topography

8. Remote sensing as a tool for the study and the Management of ecosystems **(5 h)**

8.1 Physical basis for remote sensing

8.2 Role of remote sensing in ecological research

9. Pollution **(8 h)**

9.1 Environmental Impact Assessment

9.2 Brief account of Environmental laws

10. Taxasphere and inventorying **(12 h)**

10.1 Reason for undertaking inventorying, priority conservation area recognition

10.2 Indexing of world's known species, *species2000*

10.3 Evaluation of biodiversity indices – Shannon- Weiner indices, Similarity and dissimilarity index, Association index

11. Environmental Biotechnology (12 h)

11.1 Cleaner technologies: sewage treatment, Solid waste and soil pollution management, Bioremediation, Bioreactors for liquid waste treatment, Biofilters, Vermicomposting, Biomethanation, Removal of oil spills

11.2 Environmental monitoring and biomonitoring

11.3 Ecological impact of genetically modified plants and other organisms

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2. Alfred, J.R., Das, B. and A.K. Sanyal (1998) Faunal diversity in India. En Vis Centre. Zoological Survey of India
3. Bhandari, S.C. and Somani, L.L. (1994) Ecology and Biology of Soil organisms. Agrotech Publ. Acad., Udaipur
4. Bossel, Earth at a crossroads- Path for a sustainable future. CambridgeUniversity Press.
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26. Peter, S. (2002) Ecology: Theories and Applications. Prentice Hall of India
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31. Smith, R. (1996) Ecology and Field Biology. Addison Wesley, USA
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38. Wilson, E.O. (1988) Biodiversity. Academic Press, Washington

ZOO 1C 04 SYSTEMATICS AND ANIMAL BEHAVIOUR

PART A: SYSTEMATICS

1. **Definition and basic concepts in Systematics and Taxonomy** **(3 h)**

1.1. Systematics and Taxonomy

1.2. Historical resume of Systematics

1.3. Levels of Taxonomy: Alpha, beta and gamma taxonomy

1.4. Place, importance and applications of taxonomy

1.5. Goals of taxonomy

2. **Classification** **(4 h)**

2.1. Practice of classification – purpose of classification

2.2. Use of classification – storage of data, recovery of data.

2.3. Theories of biological classification – hierarchy of categories.

2.4. Types of classification – evolutionary and phylogenetic classification- typological classification, phenetic classification, omnispective classification, horizontal and vertical classification.

2.5. Components of classification.

3. Taxonomic procedures (6 h)

3.1. Taxonomic collections – types of collections, value of collections.

3.2. Curation – preservation of collection in field and laboratory.

3.3. Recording of field data, storage of collection, labeling and cataloguing of collection.

3.4. Identification-methods of identification, Use of keys-kinds of keys, their merits and demerits

3.5. Taxonomic descriptions: Presentation of findings.

3.6. Kinds of taxonomic publications.

4. **Species concepts (4 h)**

4.1. Species category – different species concepts: typological, nominalistic, biological, evolutionary, recognition, ontological (theoretical) and operational (epistemological) species concepts

4.2. Taxonomic diversity within species, different kinds of species, subspecies and other infraspecific categories, hybrids.

5. **Taxonomic characters (9 h)**

5.1. Different kinds of taxonomic characters.

5.2. Functions of taxonomic characters.

5.3. Taxonomic characters and classification.

5.4. Taxonomic characters and evolution.

6. **Zoological nomenclature (10 h)**

6.1. International Code of Zoological Nomenclature, development of Code of Zoological Nomenclature: its operative principles, interpretation and application of important rules in the formation of scientific names of various taxa.

6.2. Principle of priority: Homonymy and Synonymy.

6.3. Type method and its significance: Different kinds of types in descriptive taxonomy.

7. **Newer trends in systematics (8 h)**

7.1. Chemo and serotaxonomy

7.2. Cytotaxonomy

7.3. Numerical taxonomy

7.4. Cladistics

7.5. Molecular systematics.

8. **Ethics in taxonomy** **(3 h)**

8.1. Ethics related to collections: Credit, Lending and borrowing of specimens, Loan of material, Exchange of materials, Collaboration and co-operation with co-workers, Use of language

8.2. Ethics related to taxonomic publication: Authorship of taxonomic papers, Correspondence, Suppression of data, Undesirable features of taxonomic papers

8.3. Taxonomists and user communities

9. **Taxonomic impediments** **(3 h)**

9.1. Impediments to build up taxonomic collections and maintenance

9.2. Shortage of man power, Lack of funding for taxonomic research, Lack of training in taxonomy, Lack of library facilities.

9.3. Impediments in publishing taxonomic work

9.4. Solutions to overcome the impediments: International co-operation, Development of taxonomic centers

9.5. Need for efficient international networking

9.6. The Desired end product

PART B: ANIMAL BEHAVIOUR

1. Mechanisms of animal behaviour (2 h)

1.1. Definition and Methodology

1.2. Ethology and its relation to other schools of studying animal behaviour.

2. Development of behavior **(10 h)**

2.1 Behavioural development – Genes and Environment

2.1 Environmental difference and Behavioural differences

2.2 Genetic differences and Behavioural differences

2.3 Single-Gene effects on behaviour

2.4 Experimental methods demonstrating genetic basis of behaviour

3. Nerve cells and behaviour **(6 h)**

3.1. Neural basis of behaviour

3.2. Stimulus filtering and behaviour

4. Physiology of behavior **(5 h)**

4.1. Hormonal influence on behaviour

4.2. Factors influencing effects of hormones on behaviour

5. Biological communications **(4 h)**

5.1. Pheromones in mammals: Lee Boot effect, Whitten effect, Bruce effect, Coolidge effect, Vandenbergh effect

6. Sociobiology (3 h)

6.1 Altruism and Kinship selection

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2. Boulenger, E.G. (1993) An Introduction to Animal Behaviour. Discovery Publ., N.Delhi.

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8. Postlewait, J.H. and Hopkins, B.L. (1995) Nature of life. McGraw Hill.

9. Salim,A (1996) Book of Indian Birds. BNHS, India

10. Slater, P.J.B. and Halliday, T.R. (1994) Behaviourand Evolution. Cambridge Univ. Press. Lond.

11. Slater, P.J.B. (1995) An Introduction to Ethology. Cambridge Univ. Press. Lond.

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ZOO 1C 05 – BIOCHEMISTRY, BIOPHYSICS & BIOSTATISTICS PRACTICAL

BIOCHEMISTRY

1. Comparison of the capacities of two buffers of the same pH.
2. Estimation of blood glucose.
3. Estimation of blood/serum cholesterol
4. Estimation of serum urea
5. Estimation of serum/blood bilirubin
6. Determination of alkaline phosphatase activity in serum
7. Estimation of total carbohydrates by phenol-sulphuric acid method.
8. Estimation of protein by Biuret method.
9. Estimation of protein by Bradford’s method.
10. Isolation of casein from milk.
11. Saponification value of fat.
12. Estimation of total lipids in the serum
13. Determination of salivary amylase activity and effect of substrate concentration

14. Effect of pH on salivary amylase activity.
15. Electrophoresis (PAGE).
16. Determination of molecular weight of proteins by SDS-Polyacrylamide Gel Electrophoresis.
17. Two dimensional gel electrophoresis.

REFERENCES

1. An Introduction to Practical Biochemistry Plummer, David T, (2007) III Ed. Tata Mc Graw-Hill, New Delhi.
2. Principles and Techniques of Biochemistry and Molecular Biology.(2006) VI Ed. Wilson Keith and Walker John.
3. Oser, B.L. (1965). Hawk's Physiological Chemistry. McGraw Hill Book Co.
4. Standard Methods of Biochemical Analysis, S. K. Thimmaiah (ed), Kalyani Publishers, Ludhiana ISBN 81-7663-067-5.
5. Practical Clinical Chemistry, Harold Varley, CBS Publishers and Distributors, New Delhi.
6. Introductory Practical biochemistry, S. K. Sawhney & Randhir Singh (eds) Narosa Publishing House, New Delhi, ISBN 81-7319-302-9.

BIOPHYSICS

1. Absorption spectrum of potassium permanganate. Determination of absorption coefficient and concentration of unknown solutions by calibration as well as by absorption coefficient.
2. Separation of mixtures of sugars and amino acids by paper/thinlayer chromatography.
3. Measurement of size of microscopic objects using stage and ocular micrometers.
4. Demonstration of working principle of Light,Phase contrast and Fluorescence microscope, Camera lucida and Photomicrographic equipment, HPLC.
5. Determination of coefficient of viscosity using Ostwald's Viscometer.
6. Determination of pH of biological fluids using pH meter.
7. Demonstration of cryosectioning.
8. Densitometric documentation of electrophoretogram - determination of proteinconcentration and molecular weight.

REFERENCES

1. Ackerman, E. (1962) Biophysical Chemistry, Prentice Hall Inc.
2. White, D.C.S. (1974) Biological Physics, Chapman and Hall, London.
3. Hoppe, W. (ed.) (1983) Biophysics, Springer Verlag.

4. Slayter, E.M. (1970) Optical Methods in Biology
5. Gassey, E.J. (1962) Biophysics Concepts and Mechanics. Van Norstrant Reinhold Co.
6. Daniel, M. (1998) Basic Biophysics for Biolgists. Agro Botanica, Bikaner.
7. Das, D. (1987) Biophysics and Biophysical Chemistry. Academic Publishers, Calcutta.

BIOSTATISTICS

1. Computation of measures of central tendency and dispersion in anthropometric data of school children.
2. Simulation of binomial and Poisson distributions.
3. Estimation of the mean number of children per family from selected populations
4. Designing of an experiment for the comparison of efficacy of a few diets on different types of animals by the method of ANOVA.
5. Regression analysis and correlation analysis of a data of heights and weights of a group of students.
6. Data Analysis by SPSS.

REFERENCES

1. John T. (2002). Practical Statistics for Environmental and Biological Scientists. John Wiley & Sons

ZOO 1C 06 – SYSTEMATICS, BEHAVIOUR & BIOSPHERE ECOLOGY PRACTICAL

SYSTEMATICS

1. Preparation of dichotomous keys with reference to the following insect orders:

1.1. ORTHOPTERA : Dichotomous key to selected families

1.2. HEMIPTERA: Dichotomous key to selected families.

1.3. COLEOPTERA : Dichotomous key to selected families

1.4. DIPTERA: Dichotomous key to selected families

1.5. HYMENOPTERA: Dichotomous key to selected families

2. Identification and classification of given 5 species of insects up to family level.

REFERENCES

1. Heywood, V.H and Watson, R.T. (1995). Global biodiversity assessment. UNEP, Cambridge University Press.

2. Mayr, E., Linsley, E.G. and Usinger, R.L. (1953) Methods and Principles of Systematic Zoology. McGraw Hill Book Company, Inc., New York, 336 pp.
3. Mayr, E. (1969) Principles of Systematic Zoology. McGraw Hill Inc., New York.
4. Kapoor, V. C. (1998) Theory and Practice of Animal Taxonomy. Oxford & IBH, Publ., Co., New Delhi.

ANIMAL BEHAVIOUR

1. Foraging behaviour of ants
2. Demonstration of Phototacticbehaviour in earthworms.
3. Field study on the identification and behaviour of birds (with emphasis on feeding behaviour)
4. Study of behaviour modifications in animals under stress.

REFERENCES

1. Goodenough, J., Mc. Guire, B. and Robert, W. (1993). Perspectives on Animal Behaviour. John Wiley press.

2. Manning, A. and Dawkins, M.S. (1995). An introduction to Animal Behaviour. Cambridge Press.

3. Bonnie J. Ploger and Ken Yasukawa (2003) Exploring Animal Behaviour in Laboratory and Field. Academic press.

BIOSPHERE ECOLOGY

1. Determination of primary productivity in pond water-light and dark method.
2. Separation and Identification of soil micro arthropods applying Berlese funnel
3. Small scale field inventorying on biodiversity and calculation of richness and evenness: Simpson’s diversity index
4. Demonstration of GPRS based land mapping
5. Tabulation and preparation of species diversity indices using field inventorying data.
6. Intertidal studies: rocky shores, sandy (marine) shore, muddy shore and estuaries.
7. Preparing a report on invasive plant species in your locality
8. Estimation of salinity, phosphates, chlorides and silicates in water samples.
9. BOD in polluted water
10. COD open reflex in two water samples
11. Methane index calculation in different substrates. E.g. starch, canteen waste, liquid waste
12. Volatile fatty acid (VFA) estimation in anaerobic fermenting system
13. Estimation of total organic and inorganic substance in solid waste
14. Estimation of total dissolved solids in waste water
15. Estimation of total suspended solids in waste water

***Study tour**: A study tour is to be conducted for the purpose of field observation of animals belonging to different niches other than local area and study of their actual habitat conditions and their behaviour. A report of the field study is to be included in the practical record to be submitted at the time of examination*

REFERENCES

1. Michael, P. (1984). Ecological methods for field and laboratory investigations. Tata – McGraw –Hill Publ. Company.
2. Grainer, J.M. and Lynch , J.M. 1984. Microbial methods for environmental biotechnology. Academic Press
3. Manual on sewerage and sewage treatment, Ministry of Works and Housing, new Delhi
4. Metcalf and Eddy. Waste water engineering. INC Tata McGraw Hill.
5. Webber, W.J. physic-chemical; process of water quality control. Wiley inter-science
6. Arceivala. Waste water treatment for pollution control. Tata McGraw hill.
7. Indian standard for drinking water. BSI, New delhi

ZOO 1A 01 – AUDIT COURSE I

Ability Enhancement Course (AEC)

1. Documentation and scientific writing

2. Paper review on a topic of choice

3. Internship for a minimum of 40 hours

4. Industrial or Practical training for a minimum of 40 hours

5. Community linkage programme for a minimum of 40 hours.

6. Seminar presentation on a frontier area of biological research. *(The topic should be from outside the syllabus)*

SECOND SEMESTER

ZOO 2C 07 – CYTOGENETICS AND EVOLUTION

PART A: CYTOGENETICS

1. Cellular communication (6 h)

1.1 Regulation of hematopoiesis

1.2 General principles of cell communication

1.3 Cell-cell interactions – cell adhesion and roles of different adhesion molecules

1.4 Extracellular matrix: Basal membrane and Laminin, Collagen, Proteoglycan, Fibronectin

1.5 Interaction of cells with extracellular matrix: Integrins. Focal adhesion and hemidesmosomes.

1.6 Interaction of cells with other cells: Selectins, Immunoglobulins, Cadherins, Adherens.

1.7 Neurotransmission and its regulation

2. Cell signaling (7 h)

2.1 Hormones and their receptors

2.2 Signal transduction

2.3 Concept of cell-signaling

2.4 Signaling through intracellular receptors

2.5 Signaling through cell surface receptors: G protein linked receptors; signaling via cAMP, PKA, IP3, Ca^{++}/calmodulin, PKC, Ca-MK, ion channels, Enzyme linked receptors, Receptor tyrosine kinase (RTK), signaling of growth factors, Tyrosine kinase associated receptors, JAK-STAT signaling pathway, Receptor protein tyrosine phosphatase (PTP), Receptor serine/threonine kinase, Receptor guanyl cyclase, cGMP, PKG, Histidine kinase associated receptors, bacterial chemotaxis and quorum sensing

2.6 Receptor desensitization

2.7 Signaling by nitric oxide, carbon monoxide

2.8 Signaling network

2.9 Impairment of signaling mechanism: Tumorigenesis: Role of oncogenes and oncoproteins, NIDDM: low level of receptors

3. Apoptosis and its significance (5 h)

3.1 Necrosis; Programmed and induced cell death

3.2 Process of apoptosis: Initiation, Execution: cytochrome C, caspases, Phagocytosis

3.3 Regulation of apoptosis - Extracellular and Intracellular

3.4 Apoptosis in *Caenorhabditis elegans*, Drosophila, mammals and bacterial population

3.5 Mechanism of cell death

3.6 Genes involved in apoptosis

3.7 Therapeutic interventions of apoptosis

4. Organization of genes and chromosomes (5 h)

4.1 Interrupted genes and gene families

4.2 Structure of chromatin and chromosomes

4.3 Unique and repetitive DNA

4.4 Heterochromatin and euchromatin

4.5 Concept of gene: Allele, multiple alleles, pseudoallele, complementation tests

4.6 Extra chromosomal inheritance: Inheritance of mitochondrial and chloroplast genes, maternal inheritance.

5. Mendelian principles and extension of Mendelian principles (5 h)

5.1 Law of dominance, Law of segregation, Law of independent assortment, Non - Mendelian inheritance

5.2 Extension of Mendelian principles: Co-dominance, Incomplete dominance, Gene interactions, Pleiotropy, Genomic imprinting, Penetrance and Expressivity, Phenocopy

5.3 Linkage and crossing over – Coupling and repulsion theory, Cytological basis of crossing over – tetrad analysis

5.4 Sex linkage, sex limited and sex influenced characters

6. Gene mapping methods and Human genetics (7 h)

6.1. Genome maps: Linkage maps, Cytogenetic maps and physical maps, LOD score for linkage testing

6.2. Techniques of restriction mapping

6.3. Mapping with molecular markers: RFLPs, RAPDs, AFLPs, STS, Minisatellites, Microsatellites, Mapping by using somatic cell hybrids

6.4. Cytogenetic maps using molecular markers: PFGE, dissection, Radiation hybrids

6.5. FISH

6.6. Quantitative Genetics: Polygenic inheritance, Heritability and its measurements, QTL mapping

6.7. Physical and transcript mapping: Low resolution and high resolution physical mapping, Physical maps using molecular markers: STS/EST based mapping, BAC/YAC based mapping, Integrated genomic maps

6.8. Pedigree analysis

6.9. Karyotyping

6.10. Genetic disorders: Down's, Klinefelter's and Turner's syndromes

7. Chromosomal aberrations (5 h)

8.1 Deletion, duplication, inversion, translocation, ploidy and their genetic implications

8.2 Homologous and non-homologous recombination, transposition, site-specific recombination

8. Mutation (5 h)

8.1 Types, causes and detection, mutant types – lethal, conditional, biochemical, loss of function, gain of function

8.2 Germinal and somatic mutants, insertional mutagenesis

9. Transposable genetic elements (5 h)

9.1 Classification of transposable elements: Class I and Class II

9.2 Transposons in bacteria – Is elements, Composite transposons, Tn family, medical significance

9.3 Transposons in eukaryotes – P elements in *Drosophila*

9.4 Retrotransposon type transposition – Yeast Ty elements, Alu family

PART B: EVOLUTION

1. Emergence of evolutionary thoughts (8 h)

1.8 Lamarck; Darwin–concepts of variation, adaptation, struggle, fitness and natural selection

1.9 Evolutionary time scale; eras, periods and epoch

1.10 Major events in the evolutionary time scale; origins of unicellular and multicellular organisms; major groups of plants and animals

1.11 Stages in primate evolution including human.

2. Molecular Evolution (10 h)

2.10 Concepts of neutral evolution and Neo Darwinism

2.11 Evolution of gene families

2.12 Molecular divergence and molecular clocks

2.13 Molecular tools in phylogeny:

2.14 Phylogenetic tree: Distance and Parsimony methods

2.15 Classification and identification: protein, amino acid and nucleotide sequence analysis,Immunological techniques, DNA – DNA hybridizations, Repetitive DNA sequences, Restriction enzyme sites

2.16 Origin of new genes and proteins; gene duplication and divergence.

2.17 Micro and macro evolution

3. Mechanisms of evolution (12 h)

3.1 Variations: Phenotypic and Genetic

3.2 Population genetics – populations, gene pool, gene frequency

3.3 Hardy-Weinberg law; concepts and rate of change in gene frequency through natural selection

3.4 Migration and random genetic drift

3.5 Meiotic Drive

3.6 Adaptive radiation and modifications

3.7 Isolating patterns and mechanisms

3.8 Speciation: allopatric, parapatric and sympatric, recombinational

3.9 Convergent evolution; sexual selection; co-evolution.

REFERENCES

CYTOGENETICS

1. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter (2002). Molecular Biology of the Cell. 4th Edition, Garland Science, New York.
2. Becker WM, Reece JB, Poenie MF. The World of the Cell, 4th edition, 1999/2000, Benjamin/Cummings Publishing Co.
3. E.D.P. De Robertis and E.M.F. De Robertis, Jr., Cell and Molecular Biology, Eighth Edition, B.I. Waverly Pvt Ltd, New Delhi, 1996.
4. Karp G. (2002) Cell and Molecular Biology. John Wiley, New York.
5. Principles of Cell and Molecular Biology (Second Edition) By L J Kleinsmith and V M Kish. HarperCollins College Publishers New York. 1995.
6. Benjamin Lewin Genes IX (2008). Jones & Bartlett Learning Publishers, New York.
8. Purves WK, Orians GH and Heller HC. 1995. Life: The Science of Biology, 4th Edition. Sinauer Associates, Sunderland.
9. Sheeler Philip and Donald E Bianchi. (1987) Cell and Molecular Biology. III Ed. John Wiley.
10. D Peter Snustad and Michael J Simmons (2000) Principles of Genetics. 2nd Ed. John Wiley & Sons Inc.
11. Robert H. Tamarin (2002) Principles of Genetics, 7th Edition, Tata McGraw-Hill Education Pvt Ltd, New York, New Delhi.
12. Watson JD, Hopkins NH, Roberts JW, Steits JA and Weiner AM. (1987). Molecular Biology of the Gene 4th Edition. The Benjamin/Cumming Publishing Company. Menlo Park, California.

EVOLUTION

1. Brian, K. Hall and Benedikt, Hallgrimsson (2008). Strickberger's Evolution, 4th Edition. Jones and Bartlett Publishers Intenational, London

2. Dobzhansky, T.H. (1951) Genetics and Origin of Species, Columbia University Press.

3. Dobzhansky, T.H., F.J. Ayala, C.L. Stebbines and J.M. Valentine. (1977) Evolution. Freeman, San Francisco.

4. Futuyama, D. J. (1998). Evolutionary Biology, Sinauer Associates, INC Publishers, Dunderland.

5. Futuyama, D. J. (2005). Evolution. Sinauer Associates Inc. Sunderland, Massachusetts.

6. Hartl, D. L. and Calrk, A.G. (1989). A Primer of Population Genetics, 2nd edn. Sinauer Associates, Inc., Massachusetts.

7. King, M. (1993) Species Evolution: the role of chromosomal change. The Cambridge University Press, Cambridge.

8. Merrel, D. J. (1962). Evolution and Genetics. Holt, Reinhart and Winston. Inc.

9. Ohta, T. and Aoki (1985). Population Genetics and Molecular Evolution, Japanese Scientific Society Press, Japan.

10. Strikberger, M. W. (2000) Evolution. Jones and Bartett Publishers, London.

ZOO 2C 08 – MOLECULAR BIOLOGY

1. **Genes and genomes** **(5 h)**
   - 1.1 Genomes of prokaryotes and eukaryotes
   - 1.2 Organelle genomes: Mitochondrial and Chloroplast
2. **Topology of nucleic acids** **(6 h)**
   - 2.1 Different forms of DNA (A, B, C & Z)
   - 2.2 Supercoiling and Topoisomerases.
   - 2.3 Classification and mechanism of action of topoisomerases.
3. **Replication of DNA** **(8 h)**
   - 3.1 Models of DNA replication: Semiconservative mode(Experiments of Messelson and Stahl and that of Cairns), rolling circle mode and D-loop mode of replication. Role of antisense RNA in replication initiation in plasmids
   - 3.2 Okazaki fragments and semidiscontinuous synthesis.
   - 3.3 Enzymes and accessory proteins involved in DNA replication.
   - 3.4 Replication origin and replication fork, fidelity of replication and extra chromosomal replicons
4. **Restriction and modification** **(6 h)**
   - 4.1 Restriction enzymes: Classification and nomenclature of restriction enzymes
   - 4.1 Role of restriction enzymes in bacteria
   - 4.3. Restriction fragment length polymorphism (RFLP), DNA finger printing.

5. **DNA repair** **(6 h)**

5.1 DNA repair mechanisms in bacteria and higher organisms. Base Excision repair, Nucleotide Excision repair. mismatch repair and SOS response

6. **The genetic code** **(7 h)**

6.1 Characteristic features of the genetic code (triplet, comma less, non-overlapping a universal nature of the code)

6.2 Deciphering the code

6.3 Degeneracy of the code: Wobble hypothesis.

6.4 Reading frame and frame shift

6.5 Special feature of the genetic code in ciliates and mitochondria.

6.6 Mutations and the genetic code (frame –shift, point and suppressor mutations)

6.7 Suppressor *t* – RNA and frame shift suppression.

6.7 Evolution of the genetic code

7. **RNA synthesis and processing** **(8 h)**

7.1 Transcription factors and machinery

7.2 Formation of initiation complex

7.3 Transcription activators and repressors

7.4 RNA polymerases, capping, elongation and termination

7.5 RNA processing, RNA editing, splicing, polyadenylation

7.6 Structure and function of different types of RNA

7.7 RNA transport

8. **Protein synthesis and processing** **(6 h)**

8.1 Ribosome - formation of initiation complex

8.2 Initiation factors and their regulation

8.3 Elongation and elongation factors, termination

8.4 Aminoacylation of tRNA, tRNA-identity, aminoacyl tRNA synthetase

8.5 Translational proof-reading, translational inhibitors

8.6 Post- translational modification of proteins

9. **Regulation of gene expression in bacteria and phages** **(6 h)**

9.1 The operon model. : *lac* operon, *lac* repressor negative and positive control

9.2 Constitutive mutants

9.3 Catabolite repression

9.4 Basic features of tryptophan operon: Operator-repressor regulation and attenuation regulation

9.5 Regulation of gene expression in phages

10. **Regulation of gene expression in eukaryotes** **(6 h)**

10.1 Interaction with RNA, DNA binding proteins, gene dosage, gene amplification, regulatory transcription factors, Histones acetylation and deacetylation, epigenetic effects.

10.2 Regulation at transcriptional level: Activation of transcription, Repression of transcription

10.3 Regulation at translational level

10.4 Regulation by alternate pathways of transcript splicing.

10.5 Anti - sense RNA strategies for regulating gene expression.

10.6 si RNA, mi RNA

11. **Characteristic features of eukaryotic genome** **(6 h)**

11.1 Unique, moderately repetitive and highly repetitive DNA sequences

11.2 Reassociation kinetics of the above types of DNA

11.3 Cot value and complexity of the genome

11.4 Satellite DNA and selfish DNA.

12. **Human genome** **(4 h)**

12.1 Human genome mapping

12.2 Sequencing human genome

13. **Molecular biology of Cancer** **(6 h)**

13.1 Biology and causes of cancer

13.2 Gene Mutations in cancer and Genetic rearrangements in progenitor cells

13.3 Oncogenes and tumor suppressor genes

13.4 Virus-induced cancer

13.5 Alteration of cell cycle regulation in cancer

13.6 Metastasis and angiogenesis in cancer.

13.7 Therapeutic interventions of uncontrolled cell growth –Immunotherapy and Gene therapy

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ZOO 2C 09 – BIOTECHNOLOGY

1. Introduction (2 h)

1.1. History, Scope and importance of biotechnology

2. Cloning and expression vectors (6 h)

2.1. Plasmids, phages, cosmids, transposons, P1, BACs, YACs, Binary and Shuttle vectors

2.2. Expression vectors for high level of expression of cloned genes (use of promoters and expression cassettes including Baculovirus)

3. Blotting and Hybridization techniques
(6 h)

3.1. Southern, Northern and Western blotting techniques; Dot and Slot blots

3.2. Molecular probes and hybridization

4. Polymerase Chain Reaction (PCR) (8 h)

4.1. Basic PCR and its modifications: Inverse PCR, Anchored PCR, PCR for mutagenesis, Asymmetric PCR

4.2. Real time PCR and its applications

4.3. RACE

4.4. Applications of PCR in biotechnology and genetic engineering.

5. Cloning in bacteria and eukaryotes
(8 h)

5.1. Steps in gene cloning, Restriction endonucleases, Construction of chimaeric DNA, Transfection, Selection and screening of the transformed cells, Blue-white screening, Colony hybridization methods, Reporter genes, Fusion proteins.

5.2. Construction and screening of genomic and cDNA libraries

7. Sequencing of whole genomes
(7 h)

7.1. BAC/YAC Genomic libraries

7.2. The methodology for DNA Sequencing

7.3. Sequence assembly by the clone contig approach

7.4. Sequence assembly and analysis.

7.5. Next generation sequencing and direct sequencing of genomes

8. Genotyping techniques and its applications
(7 h)

8.1. Polymorphic DNA

8.2. SNP analysis

8.3. DNA fingerprinting

8.4. PCR based genotyping

8.5. Clinical diagnosis

8.6. Prenatal diagnosis

8.7. Paternity/maternity testing

8.8. Forensic analysis

8.9. Molecular taxonomy

8.10. Phylogeny analysis.

9. Gene therapy and other molecular genetic-based therapeutic approaches
(7 h)

9.1. Principles of molecular genetic-based therapies

9.2. General gene therapy strategies

9.3. Therapeutics based on targeted inhibition of gene expression and mutation correction *in vivo*

9.4. Gene therapy for inherited disorders

9.5. Gene therapy for neoplastic and infectious diseases

9.6. Ethics of human gene therapy

9.7. Genetic counseling

9.8. Drug designing, delivery and targeting

10. Gene silencing techniques and Transgenic animals (6 h)

10.1. RNAi
10.2. DNAi
10.3. Intrabodies
10.4. Aptamers
10.5. Transgenic animals and Gene knockouts
10.6. Knockout vectors
10.7. Knockout mouse.

11. Animal Tissue Culture, Hybridoma and Monoclonal antibodies (8 h)

11.1. Organ Culture, Cell cultures, Culture media, Initiation of cell cultures, Evolution of cell lines, Large scale culture of cell lines: Monolayer and suspension cultures
11.2. Hybridoma technology and the production of monoclonal antibodies
11.3. Antibody engineering using genetic manipulations (Fv, Fab, Fc)
11.4. Alternatives to hybridoma technology
11.5. Production of human and humanized antibodies
11.6. Uses of monoclonal antibodies (diagnosis, imaging, therapy, vaccines, abzymes).

12. Intellectual Property Rights (lPR) and Protection (IPP) (5 h)

12.1. Intellectual property rights
12.2. Patents
12.3. Trade secrets
12.4. Copyright
12.5. Trademarks
12.6. Choice of intellectual property protection
12.7. IPR and plant genetic resources (PGR)
12.8. GATT and TRIPs
12.9. Biosafety concepts and issues. General guidelines for recombinant DNA research activity.

13. Patenting of biological material (4 h)

13.1. International conventions
13.2. International cooperation
13.3. Obligations with patent applications
13.4. Implications of patenting
13.5. Patents for higher plants and higher animals
13.6. Patenting transgenic organisms and isolated genes
13.7. Patenting of genes and DNA sequences
13.8. Patentability of vectors
13.9. Patent of research tools

14. Bioinformatics (7 h)

14.1. Biological databases : DNA, RNA, Protein
14.2. Nucleic acids and amino acid codes used in database formats

14.3. Sequence alignment and its evolutionary basis
14.4. Searching the database for sequence similarity
14.5. Search programmes with special reference to FASTA, BLAST and CLUSTAL W
14.6. Application of bioinformatics in phylogenetic analysis
14.7. Phylogentic tree construction
14.8. Protein visualization and modelling

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ZOO 2C 10 – ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

1. The Nature and levels of Adaptation (6 h)

1.1 Comparative, environmental, and evolutionary physiology

1.2 The meaning of environment and adaptation

1.3 Comparative methods to detect adaptation

2. The problem of Size and Scale (6 h)

2.1 Principle of similarity: isometric scaling

2.2 Allometric Scaling

2.3 Scaling of metabolic rate

2.4 Scaling of locomotion

3. Nutrition, Digestion and Absorption (8 h)

3.1. Adaptations to special dietary pattern, ruminant and non ruminant herbivory

3.2. Nutritional disorders – obesity, starvation, Anorexia, vitamin deficiency.

3.3. Neuronal and hormonal regulation of nutritional intake, secretion of digestive enzymes, hunger drive, thirst, glucostatic and hepatostatic theories of hunger drive.

3.4. Adaptation of gut to metabolic rates and diets. Balanced diet - a human perspective

3.5. Physiology of gastro-intestinal disorders- ulcer, constipation

4. Circulation (6 h)

4.1. Haemopoiesis, Blood buffers, Blood groups and RH factor.

4.2. Cardiac cycle and ECG, Neurohormonal and chemical regulation of cardiac amplitude and frequency, Myocardial infarction, Atherosclerosis, Cerebral circulation, blood brain barrier and cerebrospinal fluids, Placental circulation

5. Respiration (5 h)

5.1. Respiratory muscles, surfactants.

5.2. Regulation of respiration – respiratory centres, neural and chemical regulating respiration.

6. Excretion (7 h)

6.1. Mechanism of tubular reabsorption and secretion, Regulation of urine formation,

6.2. Composition of human urine, Concept of plasma clearance

6.3. Kidney disorders – acute renal failure, chronic renal failure-glomerulonephritis, pyelonephritis, nephritic syndromes and kidney stones, Artificial kidney.

7. Nerve physiology (6 h)

7.1. Synaptic transmission, Mechanism of excitatory and inhibitory pathway (AchE, GABA)

7.2. Electrical and chemical transmission

7.3. Parkinson's disease, Epilepsy, Schizophrenia, Alzheimer's syndrome, Dyslexia.

8. Sensory and effector physiology (5 h)

8.1. Structural and functional classification, modality intensity exteroceptors, interoceptors, secondary sense cells, relationship between stimulus, intensity and response, sensory coding.

8.2. Mechanoreceptors-hair cell, organs of equilibrium, vertebrate ear.

9. Muscle (5 h)

9.1. Amoeboid movement and ultrastructure of ciliary movement

9.2. Skeletal muscle, ultrastructure and molecular organization of muscle, protein components of muscle (mechanism and theory), energetic of muscle contraction.

10. Sports physiology (6 h)

10.1 Muscles and exercise

10.2 Respiration and cardiovascular system in exercise

10.3 Dope test, drug abuse.

11. Endocrinology (5 h)

11.1 Morphology and anatomy of major human endocrine glands

11.2 Classification, biosynthesis, secretion and function of hormones

11.3 Regulation of hormone secretion

12. **Functional Endocrinology (10 h)**

12.1. Hormones as signal transducers

12.2. Hormones in developmental process

12.3. Role of hormones in behaviour of animals

12.4. Control of chromatophores: Pituitary, pineal

12.5. Role of hormone in reproduction seasonal breeders and continuous breeders

12.6. Hormone therapy in reproductive impairments

13. **Disorders of hormonal imbalance (3 h)**

14. **Endocrine disruptors in the environment (2 h)**

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28. Wolfe, S. L. (1993) Molecular and Cellular Biology, Wadsworth, Belmont, CA.

ZOO 2C 11 – CYTOGENETICS & ANIMAL PHYSIOLOGY PRACTICAL

CYTOGENETICS

1. Gene mapping of *Drosophila melanogaster*, using text book problems
2. Preparation of chromosomes from rat or mouse bone marrow or human or any other lymphocyte cultures.
3. Analysis of metaphase chromosomes from rat or mouse bone marrow or any other suitable material by means of G and C banding.
4. Preparation of human karyotype from photographs (Xerox copies would be sufficient) of chromosome spreads – Normal and abnormal
5. Identification of human blood cell types and demonstration of drumstick on neutrophils, employing any suitable stain.
6. Staining of human buccal epithelial smear to demonstrate Barr body.
7. Preparation and analysis of salivary gland polytene chromosomes of *Drosophila* larvae.

REFERENCES

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2. Jayaraman, J. (1981) Laboratory Manual in Biochemistry. Wiley Eastern Ltd.
3. Neidharth, F.C. and R.F. Beyd (1965) Cell Biology – A Laboratory Text. Burgees Publishing Co.

ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

1. Detection of digestive enzymes in the hepatopancreas of crab.
2. Effect of temperature on salivary amylase activity.
3. Diffusion of substances through the chick intestine.
4. Demonstration of osmotic stress on human RBC.
5. Estimation of haemoglobin by Sahli’s method
6. Determination of haemolymph ammonia concentration of crab with ambient temperature fluctuation.
7. Effect of osmotic stress on rate of respiration.
8. Determination of ventilatory response in fish.
9. Estimation of ammonia level in human blood.
10. Determination of oxygen consumption in fish.
11. Staging of fish chromatophores and effect of adrenaline *in vivo* and Acetylcholine *in vivo*.
12. Blood sugar regulation in the crab- role of eye stalk.
13. Identification of human endocrine gland (histological examination).
14. Endocrine glands of crustaceans – (crab)

15. Laboratory Measurement of T4, T3

16. Laboratory estimation of FSH

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1. Charles F. Lytle and John R. Meyer 2005 Laboratory Manual**:** Required: "General Zoology Laboratory Guide" (14th ed.)

2. Dounersberger Anne B. Lesak Anne C. and Timmons, Maichael J. (1992). A Laboratory Text Book of Anatomy and Physiology. 5th edition. D.C. Heath and Co.

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ZOO 2C 12 – MOLECULAR BIOLOGY & BIOTECHNOLOGY PRACTICAL

MOLECULAR BIOLOGY

1. Estimation of DNA by diphenyl amine method/ UV absorption
2. Estimation of RNA by orcinol method/ UV absorption
3. Estimation of Protein by Lowry's method.
4. *E. coli* growth curve.
5. Isolation of plasmid DNA from bacterial culture
6. Isolation of genomic DNA
7. Isolation of RNA from Yeast.
8. Preparation of restriction fragments and their separation by electrophoresis
9. Transformation of *E. coli* with plasmids.
10. Gene cloning

REFERENCES

1. Brown T.A. (1998). Molecular biology Lab Fax. Vol. 1. Recombinant DNA. II Ed. Academic Press.
2. Brown, T.A. (2007). Essential Molecular Biology a practical approach Vol.2. II Ed. Oxford University press.

3. Plummer, David T (2007) An introduction to Practical Biochemistry,III Ed. Tata Mc Graw-Hill, New Delhi.
4. Sambrook, M.J. and Russel., D.W. (2006).The condensed Protocols from Molecular cloning: A Laboratory Manual. Cold Spring Harbor laboratory Press, Cold Spring Harbor, New York.

BIOTECHNOLOGY

1. Isolation of genomic DNA.
2. Isolation of total RNA from tissues.
3. Separation of DNA by electrophoresis.
4. Isolation and cloning in plasmid.
5. Bacterial transformation technique
6. α- Complementation in plasmids
7. Southern, Northern, Western, Dot and Slot blotting - demonstration
8. PCR amplification of genomic DNA
9. Cell immobilization technique
10. Search databases for getting nucleotide sequence of genes and amino acid sequence of proteins.
11. BLAST search to compare gene sequences.
12. Multiple sequence alignment and construction of phylogenetic tree

REFERENCES

1. Ausubel, F.M., Brebt, R., Kingston, R.E., Moore, D.D., Seidman, J.G., Smith, J.A. and Struht, K. (2002). Short Protocols in Molecular Biology. John Wiley and Sons, Inc.
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3. Wilson Keith and Walker John (2006). Principles and Techniques of Biochemistry and Molecular Biology VI Ed. , Cambridege University Press, New York.

ZOO 2A 02 – AUDIT COURSE II

Professional Competency Course (PCC)

1. Statistical (SPSS/R/any software relevant to the programme of study) softwares
2. Museum curation skills (Taxidermy etc.)

THIRD SEMESTER

ZOO 3C 13 – DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS

1. An Overview of Gametogenesis and Fertilization (12 h)

1.1. Origin, migration and fate of primordial germ cells

1.2. Spermatogenesis, Factors controlling spermatogenesis, Gamete specific gene expression and genomics, Male infertility

1.3. Oogenesis , Vitellogenesis (Insects and Amphibians) Gene activity (Insects and Amphibians)

1.4. Hormonal Control of gametogenesis

1.5. Biology of Sex determination and sex differentiation

1.6. Fertilization - Biochemical and Physiological aspects, Egg – sperm interactions, Species specific binding of gametes, Cortical reactions, Polyspermy and prevention of polyspermy, Activation of egg, Embryo Transfer (ET) and *In Vitro* Fertilization (IVF) in Humans and Livestock, superovulation and embryo culture

2. Cleavage, Blastulation and Gastrulation (8 h)

2.1. Creating multicellularity, Cleavage types, mechanisms and influence of yolk

2.2. Chemical changes associated with cleavage

2.3. Cytoskeletal mechanisms of cleavage, Midblastula transition

2.4. Morphogenetic movements of cells and epithelia, Exogastrulation

2.5. Metabolic events during gastrulation.

3. **Cell interactions (8 h)**

3.1. Concept of Primary organizer, embryonic induction and competence, neural induction: regional specificity, double gradient model, secreted protein from the organizer, molecular correlates of neural induction, Nieuwkoop centre, Default model of neurulation, inductive cascades

3.2. Mesodermal induction

3.3. Growth factors

4. **Cell interactions at a distance (3 h)**

4.1. Amphibian Metamorphosis

4.2. Insect Metamorphosis

5. **Morphogenetic determinants (6 h)**

5.1 Germ cell determinants

5.2 Regulation of cell determination by ooplasmic determinants, Mosaicdevelopment

5.3 Cell position and gradients in development, Regulative development

6. **Cell differentiation** **(8 h)**

6.1 Equivalence of nuclei and genome constancy

6.2 Transcriptional regulation of gene expression

6.3 Translational control of gene expression

6.4 Levels of differentiation, dedifferentiation, hormones and differentiation

7. **Stem cells** **(5 h)**

7.1 Embryonic stem cells

7.2 Adult stem cells

7.3 Medical application

8. **Genetics of axis formation** **(8h)**

8.1. Genetics axis specification in *Drosophila*, maternal effect genes, determination of dorso-ventral and anterior-posterior axis, zygotic gene activity in development

8.2. Patterns of homeotic gene expression, Homeobox concept in different phylogenic groups

8.3. Axis specification in amphibian and chick

9. **Regeneration** **(5 h)**

9.1 Regenerative ability in various groups of animals

9.2 Histological and biochemical changes in regeneration of various invertebrates and vertebrates

9.3 Epimorphic regeneration

9.4 Determination of Polarity and role of gradients in regeneration, neural and endocrine influences

10. **Ageing** **(2 h)**

10.1. Cellular ageing:Senescence genes, role of free radicals, hormones and ageing

10.2. Extracellular ageing

11. **Teratogenesis** **(2 h)**

11.1. Teratological effects of xenobioticsc

12. **Animal Ethics** **(13 h)**

12.1 Bioethics, GLP and Bioethics,

12.2 Ethical principles – Beneficence, Least Harm, Respectfor Autonomy

12.3 Theories on animals and ethics - Deontology, Utilitarianism, Casuist ethical theory, Virtue ethical theory, Rights Theory

12.4 Animals as Property; Animals as Food; Animals in entertainment

12.5 Animals in Research - Experimenting on animals, Specism, Methods to reduce animal numbers in research, Animal Rightsand HumanAnimal repression - Activism and Advocacy

12.6 Animal welfare – Bioethics,Environmental ethics and Government ethics

12.7 Animal protection – Laws and Rules; IAEC – Rules and Regulation

12.8 Ethics on cloning and stem cell research

12.9 CPCSEA Guidelines for Laboratory Animal Facility Veterinary care, Animal procurement, Quarantine, Sterilization and separation, Surveillance, diagnosis, treatment and control of disease

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ZOO 3C 14 – MICROBIOLOGY AND IMMUNOLOGY

PART A: MICROBIOLOGY

1. **History and scope of microbiology** **(2 h)**

1.1. Discovery of microorganisms

1.2. Discovery of microbial effects on organic and inorganic matter.

1.3. The composition of microbial world.

1.4. The scope and relevance of microbiology.

2. **Microbial taxonomy** **(5 h)**

2.1 Major characteristics.

2.2 Genetic analysis and molecular characteristics.

2.3 Numerical taxonomy.

2.4 Phylogenetic studies

2.5 Phenetic classification and Bergey's manual.

2.6 The kingdom of organisms.

3. Prokaryotic cell structure and function **(8 h)**

1.1 Plasma membrane and internal systems: Cytoplasmic matrix, Inclusion bodies, Ribosomes, Nucleoid

1.2 Bacterial cell wall: Peptidoglycan structure, Gram positive and gram negative cell wall, Mechanism of Gram staining

3.1. Components external to cell wall: Pili and fimbriae, Capsule and slime layers, Flagella and motility

4. Microbial nutrition and growth
(8 h)

4.1. Common nutrient requirement.

4.2. Autotrophs and heterotrophs.

4.3. Culture media and types of media

4.4. Microbial growth: Growth curve, Rearrangement of microbial growth, Continuous culture of microorganisms, Influence of environmental factors on growth.

4.5. Control of microorganisms using physical agents: Heat, Filtration and Radiation

4.6. Control of microorganisms using chemical agents: Phenolics, Alcohols, Halogens, Quarternary ammonium compounds, Aldehydes and Sterilizing gases

4.7. Detection of effect of antimicrobial agents.

5. Virology
(5 h)

5.1. Morphology and classification of viruses.

5.2. DNA viruses.

5.3. RNA viruses

5.4. Enveloped viruses.

5.5. Virus-host interactions.

5.6. Lytic and lysogenic life cycles

6. Microbial diseases (4 h)

6.1. Recognition of the role of microbes in diseases.

6.2. Major human microbial diseases: bacterial, viral, fungal

7. Use of microbes in industry and agriculture (8 h)

7.1. Isolation and culture of micro-organisms

7.2. Production of organic compounds by microbial fermentation (ethanol, acetone, butanol, gluconic acid, etc.)

7.3. Production of enzymes by micro-organisms (alpha amylases, proteases, lipases)

7.4. Production of antibiotics by micro-organisms

7.5. Bioreactors (Fermenters)

7.6. Microbial transformations

7.7. Single cell proteins (SCP) from micro organisms

7.8. Biohydrometallurgy and biomineralization

7.9. Biofertilizers

7.10. Bioinsecticides

7.11. Energy and fuel using micro-organisms: Hydrogen production using hydrogenase and nitrogenase, Hydrocarbon production

7.12. Genetically Engineered Microbes

PART B: IMMUNOLOGY

1. Overview of immune system (3 h)

1.1. Types of immunity: Innate and acquired, Active and passive.

1.2. Cells and organs of immune system: haematopoiesis, lymphoid organs

1.3. Cell mediated and humoral immunity.

2. Antigens and MHC molecules (6 h)

2.1. Characteristic features of antigens and super antigens

2.2. Factors affecting antigenecity

2.3. Antigen processing and presentation- Endogenous and Exogenous pathways

2.4. Structure and function of Class I and II MHC molecules

2.5. Regulation of MHC expression

3. Antibodies and Generation of antibody diversity (8 h)

3.1. Different classes: Structure and functions

3.2. Organization of immunoglobulin genes

3.3. VD (J) rearrangements

3.4. Expression and secretion of Immunoglobulin.

3.5. Monoclonal antibodies and applications.

3.6. Antibody engineering

4. Complement System (3 h)

4.1. Components of complement system

4.2. Complement activation: Classical, Alternate and Lectin pathways**,** Formation of Membrane Attack Complex

4.3. Functions of complements

5. Immune Effector Mechanisms (4 h)

5.1. Inflammatory cells

5.2. Types of Inflammation- acute and chronic

5.3. Cytokines and their role in immune system

5.4. Properties and functions of cytokines

5.5. Therapeutic applications of cytokines

6. Hypersensitivity reactions (3 h)

6.1. Type I, II and III hypersensitivity

6.2. Delayed type hypersensitivity.

7. Vaccines (2 h)

7.1. Principle of vaccination

7.2. Different types: Live attenuated vaccines, Recombinant vaccines, Peptide vaccines, DNA vaccines.

8. Transplantation immunology (4 h)

8.1. Immunologic basis of graft rejection

8.2. General and specific immunosuppressive therapy.

8.3. Transplantation antigens

9. Auto immunity and Immunodeficiency (3 h)

9.1. Organ specific and systemic autoimmune diseases with examples.

9.2. Treatment of autoimmune diseases.

9.3. Primary and secondary immunodeficiency diseases with examples

10. Antigen - Antibody interactions and applications (4 h)

10.1. Antigen – Antibody interaction: Primary and asecondary

10.2. Agglutination and Precipitation reactions with examples

10.3. Other diagnostic tests: ELISA, RIA, Immunoprecipitation, Immunofluorescence, Immunoelectrophoresis, FACS, Western blotting.

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ZOO 3E 15 – GENERAL ENTOMOLOGY

1. **Insect Morphology** **(25 h)**

   1.1. Division and segmentation of body

   1.2. Morphology of head, thorax and abdomen.

   1.3. Mouth parts – various modifications, feeding mechanisms.

   1.4. Antennae – structure, various types and modifications

   1.5. Locomotion - Movement on or Through a Substrate, Walking, Jumping, Crawling and Burrowing, Movement on or Through Water, Surface Running, Swimming by means of Legs.

   1.7 Wings – structure, venation, pteralia, wing coupling, wing movements and flight, wing modifications.

   1.8 Sound-producing organs - Stridulatory structures in various insects, auditory tympanum.

2. **Insect reproduction and development** **(15 h)**

2.1. Reproductive system – morphology, structure and diversity of male and female external genitalia and genital organs.

2.2. Eggs – structure and adaptation.

2.3. General pattern of embryonic development.

2.4. Causal analysis of insect embryogenesis – Growth & development

2.5. Viviparity

2.6. Polyembryony, Parthenogenesis, Paedogenesis.

3. **Taxonomy and biology of insects** **(40 h)**

3.1. Objectives of classification

3.2. General classification with diagnostic features of subclasses, divisions and orders

3.3. Classification of orders up to and including families with diagnostic features and biology of orders, superfamilies and families (only important families):

3.3.1. Collembola

3.3.2. Protura

3.3.3. Diplura

3.3.4. Microcoryphia

3.3.5. Zygentoma

3.3.6. Ephemeroptera

3.3.7. Odonata

3.3.8. Plecoptera

3.3.9. Embioptera

3.3.10. Dictyoptera

3.3.11. Isoptera

3.3.12. Grylloblattodea

3.3.13. Dermaptera

3.3.14. Phasmida

3.3.15. Mantophasmatodea

3.3.16. Orthoptera

3.3.17. Psocoptera.

3.3.18. Phthiraptera

3.3.19. Hemiptera

3.3.20. Thysanoptera

3.3.21. Mecoptera

3.3.22. Diptera

3.3.23. Siphonaptera

3.3.24. Trichoptera

3.3.25. Lepidoptera

3.3.26. Megaloptera

3.3.27. Raphidioptera

3.3.28. Neuroptera

3.3.29. Coleoptera

3.3.30. Strepsiptera

3.3.31. Hymenoptera

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ZOO 3E 16 – INSECT PHYSIOLOGY AND BIOCHEMISTRY

1. Insect integument (6 h)

1.1. Organization of insect integument

1.2. Major components of insect cuticle

1.3. Moulting

1.4. Sclerotisation and melanisation of insect cuticle

2. Digestive system (7 h)

2.1. General structure of alimentary canal: foregut, midgut, hindgut and their modifications

2.2. Digestive enzymes and physiology of digestion

2.3. Specialized digestion: Digestion of wood, keratin wax and silk, Extra-intestinal digestion

2.4. Role of micro flora/ fauna in insect digestion

2.5. Assimilation.

3. Circulatory system (7 h)

3.1. General structure: Heart, dorsal and ventral vessels, pulsatile organs

3.2. Composition and functions of haemolymph

3.3. Heart beat rate and control of heart beat

3.4. Course of circulation of haemolymph

4. Respiratory system (5 h)

4.1. Structure and modification of respiratory system

4.2. Closed and open tracheal system

4.3. Physical gill and plastron respiration

4.4. Diffusion, ventilation, control of ventilation, cyclic release of carbon dioxide

4.5. Respiratory pigments

5. Excretory system (5 h)

5.1. Malpighian tubules, Nephrorectal complex and labial glands

5.2. Physiology of excretion

5.3. Synthesis of uric acid and formation of excreta

6. Nervous system (10 h)

6.1. General structure and organization of central and peripheral nervous system

6.2. Anatomy and histology of brain, ganglia and nerves

6.3. Reception of stimuli and transmissionof nerve impulses, transmission at synapse

6.4. Sense organs – anatomy, histology and physiology of mechanoreceptors, chemoreceptors and photoreceptors.

7. Muscular system (4 h)

5.1. Histomorphology of insect muscles

5.2. Neuromuscular junctions

5.3. Excitation of muscle fibres, activation of muscle fibres, role of fast and slow axons

8. Fat body and Intermediary Metabolism (5 h)

8.1. Structure of fat body - anatomy, histology and development

8.2. Role of fat body in storage of reserves

8.3. Intermediary metabolism - Glycolysis, Glycerol phosphate shuttle, Trehalose biosynthesis

9. Endocrine system (6 h)

8.1. Histomorphology of neurosecretory cells and major endocrine glands (corpora cardiaca, corpora allata and prothoracic glands)

8.2. Types of insect hormones and their functions

8.3. Mechanisms of hormone action

10. Insect Toxicology (7 h)

10.1. Chemical insecticides: General classification

10.2. Nerve poisons and their effects on acetyl choline esterase, membrane receptors, synapses, nerve axons

10.3. Metabolic poisons

10.4. Other inhibitors

10.5. Inhibitors of chitin synthesis

11. Detoxification mechanism in insects (8 h)

11.1. Phase I reactions – mixed function oxidases, reduction, hydrolysis, epoxide hydrases, DDT-dehydrochlorinase

11.2. Phase II reactions – glutathione conjugation, glucoside formation, amino acid conjugation, sulfate conjugation, other conjugations

11.3. Role of detoxification enzymes in insecticide resistance

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ZOO 3C 17 - DEVELOPMENTAL BIOLOGY, MICROBIOLOGY & IMMUNOLOGY PRACTICAL

DEVELOPMENTAL BIOLOGY

1. Hormonal Control of Amphibian metamorphosis: Effect of thyroxine

2. Removal of blastoderm and preparation of stained whole mounts

3. Vital staining experiments on chick embryos employing the window method and tracing the development of stained parts.

4. Collection, identification and study of invertebrate/vertebrate larval forms

5. Histological preparations of stained slides of chick and amphibian embryos

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MICROBIOLOGY AND IMMUNOLOGY

1. Preparation and sterilization of media
2. Preparation of broth and agar media and agar slants
3. Antibiotic sensitivity test – Disc diffusion method
4. Isolation of bacteria using pour plate method and spread plate method
5. Streak plate method for isolation of pure culture
6. Maintenance of *E. coli* culture (Shake and surface cultures) and quantitative evaluation (number of cells/ml) of a given sample of culture by dilution and plating.
7. Aseptic transfer of microorganisms
8. Staining techniques – Gram staining, spore staining
9. Motility testing using semi-solid medium and hanging drop method
10. Oxidase and Catalase tests
11. Oxidation/fermentation (O/F) test
12. Estimation of bacterial load in a given sample
13. Water quality testing using MPN coliforms
14. Blood group determination using agglutination reaction
15. WIDAL test
16. VDRL test
17. ELISA
18. Biochemical estimation of fermentation food by-products

19. Microbial degradation of xenobiotic pollutants

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ZOO 3E 18 – GENERAL ENTOMOLOGY & INSECT PHYSIOLOGY BIOCHEMISTRY PRACTICAL

GENERAL ENTOMOLOGY

1. Dissection and display of organ systems (digestive, nervous and reproductive) of available specimens belonging to different orders.

2. Dissection of different types of mouth parts.

3. Dissection and comparison of legs of different insects.

4. Dissection of sound-producing organs of Orthopterans.

5. Preparation of whole mounts of spiracles, gills, siphons, external genital organs in different insects.

6. Preparation of whole mounts of air sac, pulsatile organs, dorsal aorta, malpighian tubules, mandibular glands, ovarioles, accessory sex glands, rectal pads/ papilla in different insect groups.

7. Preparation of keys for identification of insects up to family level (common families of Orders Orthoptera, Homoptera, Heteroptera and Coleoptera).

8. Collection and preservation of insects. {Students shall submit insects belonging to 50 families (including 10 whole mounts) at the time of practical examination}.

9. A study tour for the purpose of collecting insects belonging to different ecological niches other than local is required with a report of the field study which is to be included in the record of drawing for evaluation at the practical examination.

10. Use of Y-tube olfactometer to study responses to olfactory cues.

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Reineheart & Winston, New York.

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INSECT PHYSIOLOGY AND BIOCHEMISTRY

1. Preparation of stained slides of insect haemolymph and identification of haemocytes.
2. Estimation of digestive carbohydrases in the alimentary canal of insect.
3. Analysis of the uptake of dye by the insect malpighian tubules.
4. Estimation of total protein in the body of insects from different orders.
5. Effect of corpora cardiaca extract on the lipid release from the fat body of insects – dose response.
6. Qualitative and quantitative estimation of total free amino acids in the haemolymph / fat body of insects from different orders.
7. Estimation of glucose content in the body of insects from different orders.
8. Estimation of amino transferase activity in the insect haemolymph.
9. Estimation of catalase activity in the insect haemolymph.
10. Preparation of stained serial section of various organs from different insects.

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FOURTH SEMESTER

ZOO 4C 19 – COMPULSORY PROJECT/DISSERTATION

ZOO 4E 20 – AGRICULTURAL ENTOMOLOGY & ACAROLOGY

1. Insect Pests **(4 h)**

1.1. Kinds of insect pests (major and minor) - Sporadic pests, endemic pests, exotic pests, seasonal pests, occasional pests, regular pests, persistent pests.

2. Pest outbreak **(5 h)**

2.1. Causes of pest outbreak: Destruction of forests, Favourable weather conditions, Large scale monoculture practices-extensive and intensive cultivation of crops, Improved agronomic practices, Introduction of new crops, Introduction of new pests, Indiscriminate use of pesticides, Destruction of natural enemies

2.2. Pest resurgence(pest flare back) and replacement (secondary pest outbreak)

2.3. Causes and Management of resurgence and replacement

2.4. Forecasting pest outbreaks and surveillance: Short-term and long-term forecasting, Forecasting based on observations – climatic and empirical factors.

3. Insect population **(5 h)**

3.1. Methods of assessment of insect population, Stage to be counted, nature of sample

3.2. Methods of collection – net sweeping, sudden trapping, screen traps, narcotized collections, light traps, water traps, suction traps, sight counting, crop samples, emergence cages – marking and recapture

3.3. Methods of sampling and number and size of samples

4. Estimation of damage caused by insect pests to crops **(4 h)**

4.1. Estimates from general observation.

4.2. Estimates based on survey.

4.3. Estimates from experimental plots.

4.4. Other methods such as cage experiments.

5. Insect pests of agricultural and other economically important plants. **(15 h)**

Diagnosis, nature of damage and control measures of the pests of Paddy, Vegetables, pulses, oil seeds, fibre crops, sugarcane, fruit crops, spices and condiments, plantation crops,Insect pests of stored foods and grains

6. **Other destructive insects** **(5 h)**

6.1. Locusts and their control – diagnosis, life history, damage, methods of control.

6.2. Termites and their control – diagnosis, damage, control measures, protective measures for furniture and other wooden structures, fence, posts etc.

7. Types of insect injury to crops (6 h)

7.1. Injury by chewing insects, Injury by piercing and sucking insects- yellowing, silvering, wrinkling, curling, injury by internal feeders.

7.2. Galls – types of galls, gall formation and gall forming insects.

7.3. Role of allelochemicals in insect plant interaction.

8. Productive, useful and beneficial insects (15 h)

8.1. Honey bees, lac insects, silkworm moths.

8.2. Apiculture, sericulture, lac cultivation

8.3. Insect pollinators, dung beetles.

8.4. Other insects of use.

9. Introduction to Agricultural Acarology (13 h)

9.1. Mite pests of agricultural importance-Spider mites, false spidermites, Eriophyid mites, Tarsonemid mites.

9.2. Diagnosis, nature of damage and control measures of important mite pests of cereals, millets, pulses, vegetables, sugarcane, oil seeds and horticultural plants.

10. Beneficial mites. (8 h)

10.1. Mites as predators and parasites of insect/mite pests.

10.2. Mites as biocontrol agents of weeds.

10.3. Mites in biodegradation-direct and indirect role of mites in enhancement of soil fertility.

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ZOO 4E 21 – INSECT PESTS: CONTROL AND MANAGEMENT

1. Insect Pests
(4h)

1.1. Kinds of insect pests (major and minor)- Sporadic pests, endemic pests, exotic pests, seasonal pests, occasional pests, regular pests, persistent pests

2. Pest outbreak (4 h)

2.1. Causes of pest outbreak

2.2. Pest resurgence and replacement (secondary pest outbreak).Causes and Management of resurgence and replacement.

2.3. Forecasting pest outbreak and surveillance: Short-term and long-term forecasting,Forecasting based on observations –climatic and empirical factors.

3. Insect pests of agricultural and other economically important plants (13 h)

3.1. Diagnosis, nature of damage, life history and control measures of important insect pests of paddy, vegetables, coconut , cotton, oilseeds, fruit crops, plantation crops

4. Methods of pest control (8 h)

4.1. Natural and Artificial - Physical, mechanical, cultural, legal, chemical, Biological, Microbial, Behavioural and Biotechnological.

5. Chemical control (10 h)

5.1. Chemical insecticides – natural, synthetic, inorganic and organic

5.2. Insecticide appliances and application.

5.3. Insecticide formulations.

5.4. Insecticide hazards – Resistance, resurgence and residue – pesticides in the environment.

6. Biopesticides (4 h)

6.1. Plant based insecticides.

6.2. Allelochemicals, allomones, synomons and their importance in pest control.

7. Principles of behavioural control (10 h)

7.1. Pheromonal considerations, orientation.

7.2. Theories of orientation.

7.3. Use of hormone analogues and other insect growth and behaviour regulators in insect control programmes.

7.4. Use of repellants and antifeedants.

7.5. Autocidal control – use of chemosterilants and radiations.

8. Biological control (9 h)

8.1. History and Principles of Biological control, Ecological basis of biological control.

8.2. Strategies in biological control

8.3. Biological control of pests-. Importance of parasitic Hymenoptera, and other parasitic insects in Biological control.

8.4. Different types of parasitism, Phoresy. Behaviour of parasitioids.

9. Microbial control (8 h)

9.1. Bacteria, viruses, fungi – merits and demerits

10. Biological control of weeds (2 h)

10.1. Some successful projects

11. Pest management strategies (8 h)

11.1. Concepts of economic levels, Concepts of pest management, definition and characteristics of pest management

11.2. Pest management strategies and techniques.

11.3. Development of pest management programmes: Integrated Pest Management.

11.4. Ecological management of crop environment

11.5. Ecological backlash and its management.

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ZOO 4E 22 – ECOLOGY & ETHOLOGY OF INSECTS

1. Scope of Insect Ecology and Ethology (3 h)

2. Multitrophic interactions (9 h)

2.1 The trophic level concept

2.2 Plant characteristics that effect enemy-prey interactions

2.2.1 Secondary metabolites

2.2.2 Nutritional resources

2.2.3 Morphology

2.3 Intraguild predation

2.4 Trophic cascades

3. Herbivory (9 h)

3.1 Types and Patterns of Herbivory

3.1.1 Herbivore Functional Groups

3.1.2 Measurement of Herbivory

3.1.3 Spatial and Temporal Patterns of Herbivory

3.2 Effects of Herbivory

3.2.1 Plant Productivity, Survival and Growth Form

3.2.2 Community Dynamics

3.2.3 Water and Nutrient Fluxes

4. Pollination (8 h)

4.1 Types and Patterns of Pollination

4.1.1 Pollinator Functional Groups

4.1.2 Measurement of Pollination

4.1.3 Spatial and Temporal Patterns of Pollination

4.2 Effects of Pollination

4.3 Floral scent, olfaction, and scent-driven foraging behaviour

5. Seed Predation and Seed Dispersal (7 h)

5.1 Types and Patterns of Seed Predation and Dispersal

5.1.1 Seed Predator and Disperser Functional Groups

5.1.2 Measurement of Seed Predation and Dispersal

5.1.3 Spatial and Temporal Patterns of Seed Predation and Dispersal

5.2 Effects of Seed Predation and Dispersal

6. Pheromone-mediated communication in parasitoids (10 h)

6.1 Pheromones and sexual behaviour

6.1.1 Volatile sex attractants

6.1.2 Female-derived courtship pheromones

6.1.3 Male-derived courtship pheromones

6.1.4 Marking pheromones

6.1.5 Putative alarm and appeasement pheromones

6.1.6 Aggregation pheromones

6.1.7 Anti-aggregation pheromones

7. Insect dispersal and migration (7 h)

7.1 Factors Affecting Dispersal Behavior

7.1.1 Life History Strategy

7.1.2 Crowding

7.1.3 Nutritional Status

7.1.4 Habitat and Resource Conditions

7.1.5 Mechanism of Dispersal

7.2 Insect invasions

8. Chemical ecology of insect natural enemies (6 h)

8.1 Essential elements in parasitoid chemical ecology

8.2 Manipulation of the population levels of natural enemies bysemiochemicals

8.3 Recruitment of predators and parasitoids by herbivore-injured plants

8.4 The use of synthetic HIPVs in pest management

8.5 Arthropod pest management strategies used in organic farming

9. Behavioural Ecology (6 h)

9.1 Patterns of behaviour

9.2 Mating and courtship

9.3 Oviposition strategies in terrestrial and aquatic insects

9.4 Food finding mechanism

9.5 Evolution of feeding behaviour

10. Introduction to Insect Diversity Conservation (9 h)

10.1 Ethical foundation for insect conservation

10.2 Mapping, inventorying, and monitoring insect diversity

10.3 Insects and the conservation of ecosystem processes

10.4 Insects and the Climate Change: Process patterns and implications forConservation

10.5 Responses by insects to changes in land use, degradation and fragmentation of Ecosystems

10.6 Conserving and Managing Insect Diversity: Methods, approaches, and Prioritization

10.7 Impediments in insect conservation

10.8 Insects for food security, livelihood and Environment

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ZOO 4E 23 – MEDICAL, VETERINARY AND FORENSIC ENTOMOLOGY

1. **Medical Entomology** **(30 h)**

1.1. Introduction – History, definition, objectives, training; importance of insects as vectors, feeding mechanisms and modifications of insect mouth parts.

1.2. Evolution of tissue feeding and pathogen transfer by insects

1.3. Origin of parasitism.

1.4. Adaptations of vectors: Morphological, Reproductive and Biochemical.

1.5. Biology of important vectors: Mosquitoes, Simuliids, Ceratopogonids, Tabanids, Fleas, Tsetse flies, Syrphids, Chloropids, Houseflies, Bird lice, Head lice and Body lice

1.6. Diagnostic and clinical features and epidemiology of various arthropod-borne diseases: Malaria, filariasis, dengue fever, Japanese encephalitis, yellow fever, chickungunya, trypanosomiasis, plague, typhus and pink eye disease.

1.7. Other insects of medical importance – bugs, bees, ants, wasps, lepidopterans and beetles. Clinical features of their bites and stings; treatment.

2. **Veterinary Entomology** **(25 h)**

2.1. Introduction – Insects as vectors of animal diseases

2.2. Insect groups of veterinary importance

2.3. Taxonomy and Biology of insects of veterinary importance: Lice, Tabanids, Hippoboscids,Calliphorids, Sarcophagids, Stomoxydidae, Oestridae, Pulicidae

2.4. Important diseases of domestic animals – clinical features, treatment.

2.5. Myiasis – definition, insects causing myiasis, different types of myiasis and treatment

3. **Forensic Entomology** **(25 h)**

3.1. Introduction: Insects of forensic importance

3.2. Insects as tools in forensic science.

3.3. Crime detection using entomological science.

3.4. Taxonomy & Biology of forensically important insects

3.4.1. Coleoptera – General characters, taxonomy and biology of Silphidae (carrion beetles), Staphylinidae (rove beetles), Histeridae (clown beetles), Dermestidae (hide & skin beetles).

3.4.2. Diptera - General characters, taxonomy and biology of Calliphoridae, Sarcophagidae, Phoridae, Muscidae, Fannidae.

3.5. Ecology of forensically important flies and beetles

3.6. DNA techniques in forensic entomology

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ZOO 4E 24 – AGRICULTURAL ENTOMOLOGY & ACAROLOGY PRACTICAL

1. Collection, identification and preservation of pests of local crops. The collection should include a minimum of 25 crop pests. The collection has to be submitted during the practical examination.
2. Preparation and submission of wet collections of pest damaged portions of crop plants (at least 5 collections are to be submitted for examination).
3. Preparation of dichotomous keys to any 5 species of insect pests.
4. Study of salient features of any 10 major insect pests.
5. Study of life histories of insect pests (at least two)
6. and the damages caused by them.
7. Study of stained sections of normal and galled leaves.
8. Morphological description of any one species of insect pests.
9. Collection, preservation and preparation of slide mounts of 10 species of mite pests (5 slides are to be submitted for examination).
10. Preparation of dichotomous key to any 5 species of major mite pests.

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ZOO 4E 25 – INSECT PESTS: CONTROL & MANAGEMENT PRACTICAL

1. Collection, identification and preservation of pests of local crops. The collection should include a minimum of 20 pests and has to be submitted during practical examination.
2. Study of external morphology of at least two economically important parasitoids.
3. Study of various insecticides (Natural and synthetic) and their mode of action on their target pests.
4. Study of various insecticide appliances and their applications in the field.
5. Whole mount preparation of at least 10 insect pests of agricultural/medical/ veterinary importance
6. Role of IGRs and their influence in the morphology of pest.
7. Study of life histories of insect pests (at least two) and the damage caused.
8. Visit to an organic farm and the report on activities is to be included in the record and has to be submitted during practical examination.

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ZOO 4E 26 – ECOLOGY & ETHOLOGY OF INSECTS PRACTICAL

1. Study of courtship and mating behaviour in insects
2. Managing pheromone traps
3. Setting up and collection of insects with Malaise trap, Pitfall traps, Light trap, Sweep net, Yellow pan trap
4. Insect culture methods (Hosts, parasitoids and predators)
5. Field observation on insect pollination on any focal plant
6. Dissection and display of pollen gathering apparatus in hymenopterans
7. Use of Y-tube olfactometer to study responses to olfactory cues in insects
8. Feeding preference studies in some common pests

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ZOO 4E 27 – MEDICAL, VETERINARY, FORENSIC ENTOMOLOGY PRACTICAL

1. Preparation of keys for the identification of major species of mosquitoes
2. Collection and identification of eggs/larvae of mosquitoes (Genus level).
3. Mounting of mouth parts of blood feeding insects.
4. Collection of insects associated with carcasses. Write brief write-ups of the different life stages of these insects
5. Dichotomous keys for the identification of families belonging to the orders : Coleoptera and Diptera.
6. Population density studies (mosquitoes/houseflies/Tabanids)
7. Preparation of whole mounts of animal ectoparasites.
8. Students are required to submit a collection of a minimum of 25 specimens of medical/veterinary/forensically important arthropods

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Model Question Papers

FIRST SEMESTER M. Sc. DEGREE EXAMINATION, OCTOBER 2019

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APPLIED ZOOLOGY

ZOO 1C 01 – BIOCHEMISTRY

Time: Three Hours Maximum: 80 Marks

I. **Write an essay on any *TWO* of the following:** **(2 X 15 = 30 marks)**

1. Glycolysis and its regulation.
2. Kinetics and regulation of Enzyme action.
3. Role of B-complex vitamins.
4. Fatty acid oxidation

II. **Write short essays on any *THREE* of the following:** **(3 X 10 = 30 marks)**

5. Separation and purification of proteins
6. Regulation of glycogen synthesis and degradation.
7. Role of ATP as a free energy carrier.
8. Sequencing of DNA.
9. Prostaglandins

III. **Write short notes on any *FIVE* of the following:** **(5 X 4 = 20 marks)**

10. Isozymes.
11. Ribozymes.
12. Chemiosmotic hypothesis.
13. Buffers
14. Enthalpy
15. Vitamin E
16. Disaccharides
17. Transamination

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APPLIED ZOOLOGY

ZOO 1C 02 – BIOPHYSICS & BIOSTATISTICS

Time: Three Hours Maximum: 80 Marks

Part A - Biophysics

I. **Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)**

1. Explain the principle,procedure andapplication of UV spectroscopy.
2. General account of electrophoresis.

II. **Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)**

3. Magnetic resonance imaging.
4. Affinity chromatography.
5. Liquid scintillation counter and its applications.
6. Immuno fluorescence microscopy.

III. **Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)**

7. X- Ray diffraction.
8. EEG.
9. Fick's law and diffusion coefficient.
10. HPLC.
11. Electro osmosis.

Part B - Biostatistics

IV. **Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)**

12. One-way and two-way classification of ANOVA.
13. Properties of normal distribution and fitting of normal curves.

V. **Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)**

14. Write a brief account on mathematical methods of correlation.
15. Mention the role of biostatisitics in modern research.
16. Chi square test.
17. What is sampling. Add a note on the methods of sampling.

VI. **Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)**

18. Attributes
19. Quartile deviation
20. Skewness
21. Degree of freedom
22. Type I and Type II error

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APPLIED ZOOLOGY

ZOO 1C 03 – BIOSPHERE ECOLOGY

Time: Three Hours Maximum: 80 Marks

I. **Write an essay on any *TWO* of the following:** **(2 X 15 = 30 marks)**

1. Importance of coral reefs, threats faced by the coral reefs and conservation strategies.
2. With proper illustration elaborate on the different models of energy flow
3. Global warming and its impacts
4. Write an essay on cleaner technologies in waste management

II. **Write short essays on any *THREE* of the following:** **(3 X 10 = 30 marks)**

5. Habitat fragmentation and its impact
6. Ecological applications of remote sensing
7. Sustainable development
8. Ecological impact of genetically modified crops
9. Environmental Impact Assessment

III. **Write short notes on any *FIVE* of the following:** **(5 X 4 = 20 marks)**

10. Conservation tillage
11. Vermicomposting
12. Types of life table
13. Metapopulation
14. r and k selection
15. Biofilters
16. Simulation model
17. Species 2000

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APPLIED ZOOLOGY

ZOO 1C 04 - SYSTEMATICS AND ANIMAL BEHAVIOUR

Time: Three Hours Maximum: 80 Marks

Part A – SYSTEMATICS

I. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

1. Different kinds of taxonomic characters used in the discrimination of taxa.
2. International Code of Zoological nomenclature and the rules for naming taxa.

II. Write short essays on any *TWO* of the following: (2 X 10 = 20 marks)

3. History of taxonomy
4. Taxonomic procedures
5. Types of Zoological classification
6. Taxonomic key

III. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

7. Taxonomic publications
8. Cladistics
9. Types of classification
10. Molecular systematics
11. Chemotaxonomy
12. Phonetic classification
13. Alpha taxonomy

Part B – ANIMAL BEHAVIOUR

IV. Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)

14. Give an account how hormones influence behavior and the factors influencing hormonal effects on behaviour.
15. Discuss how genes and environment influence behaviour .

V. Write short notes on any *FIVE* of the following: (5 X 3 = 15 marks)

16. Lee Boot effect and Whitten effect
17. Brief account of altruism
18. Stimulus filtering
19. Give examples of experimental origin to demonstrate genetic basis of behaviour
20. Brief account of neural basis of behaviour
21. Imprinting
22. Circadian rhythm

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APPLIED ZOOLOGY (CCSS)

ZOO 2C 07 – CYTOGENETICS & EVOLUTION

Time: Three Hours Maximum: 80 Marks

Part A - Cytogenetics

I. **Write an essay on any *ONE* of the following:** **(1 X 15 = 15 marks)**

1. Transposons in bacteria
2. Apoptosis in *Caenorhabditis elegans* and the genes involved in it

II. **Write short essays on any *TWO* of the following:** **(2 X 10 = 20 marks)**

3. Signal transduction
4. Neurotransmission and its regulation
5. Extrachromosomal inheritance
6. Cytological basis of crossing over

III. **Write short notes on any *FIVE* of the following:** **(5 X 3 = 15 marks)**

7. Mutation
8. P elements
9. Down’s syndrome
10. Ploidy
11. Co-dominance
12. Euchromatin
13. cAMP
14. Linkage

Part B - Evolution

IV. **Write an essay on any *ONE* of the following:** **(1 X 15 = 15 marks)**

15. Molecular divergence in evolution and molecular clocks
16. Stages in human evolution

V. **Write short notes on any *FIVE* of the following:** **(5 X 3 = 15 marks)**

17. Genetic drift
18. Adaptive radiation
19. Hardy-Weinberg equilibrium
20. Neutral hypothesis
21. Speciation
22. Natural selection
23. Co-evolution

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APPLIED ZOOLOGY (CCSS)

ZOO 2C 08 – MOLECULAR BIOLOGY

Time: Three Hours Maximum: 80 Marks

1. **Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)**
    1. Models of DNA replication and Enzymes associated with DNA replication.
    2. Transcriptional regulation of gene expression
    3. DNA repair mechanism and Importance of DNA repair.
    4. Characteristic features of Genetic code.
2. **Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)**
    5. Gene therapy.
    6. RNA Splicing.
    7. Organelle genomes.
    8. Interrupted genes.
    9. SOS response.
3. **Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)**
    10. Promoter
    11. Wobble hypothesis
    12. Pesudogenes.
    13. Replicons
    14. Telomere.
    15. Restriction endonuleases
    16. Okazaki fragments
    17. Antisense RNA.

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APPLIED ZOOLOGY (CCSS)

ZOO 2C 09 – BIOTECHNOLOGY & BIOINFORMATICS

Time: Three Hours Maximum: 80 Marks

I. **Write an essay on any *TWO* of the following:** **(2 X 15 = 30 marks)**

1. Distinguish different types of blotting procedures
2. Genotyping techniques and its applications
3. Hybridoma technology, production and uses of monoclonal antibodies
4. Patenting of biological forms

II. **Write short essays on any *THREE* of the following:** **(3 X 10 = 30 marks)**

5. Applications of bioinformatics tools in phylogenetic analysis
6. Cloning vectors
7. Polymerase Chain Reaction
8. Molecular probes in hybridization
9. Transgenic systems

III. **Write short notes on any *FIVE* of the following:** **(5 X 4 = 20 marks)**

10. Real time PCR
11. Intellectual Property Rights
12. BLAST
13. Chimeric DNA
14. DNA fingerprinting
15. Expression vectors
16. Reporter genes
17. Dot and Slot blots

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APPLIED ZOOLOGY

ZOO 2C 10 – ANIMAL PHYSIOLOGY & ENDOCRINOLOGY

Time: Three Hours Maximum: 80 Marks

I. **Write an essay on any *TWO* of the following:** **(2 X 15 = 30 marks)**

1. Describe endocrine disruptors in the environment
2. Explain blood buffering and gas transport
3. Mechanism of urine formation, tubular reabsorption, secretion and counter current.
4. Describe ultra-structure and functional mechanism of skeletal muscle.

II. **Write short essays on any *THREE* of the following:** **(3 X 10 = 30 marks)**

5. Placental circulation.
6. Hormones as signal transducers
7. Role of hormones in developmental process
8. Allometric and isometric scaling.
9. Myocardial infarction.

III. **Write short notes on any *FIVE* of the following:** **(5 X 4 = 20 marks)**

10. Anorexia
11. Regulation of hormone secretion
12. Parkinson’s disease
13. Blood brain barrier.
14. Surfactants
15. Role of pituitary and pineal body in chromatophores expression
16. Hormones in behaviour of animals
17. Kidney stones

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APPLIED ZOOLOGY

ZOO 3C 13 – DEVELOPMENTAL BIOLOGY & ANIMAL ETHICS

Time: Three Hours Maximum: 80 Marks

I. **Write an essay on any *TWO* of the following:** **(2 X 15 = 30 marks)**

1. Discuss the role of hormones and senescence genes in cellular ageing.
2. Give an account of gamete specific gene expression and factors controlling oogenesis
3. Morphogenetic movements
4. Describe types of cleavage and associated chemical changes

II. **Write short essays on any *THREE* of the following:** **(3 X 10 = 30 marks)**

5. Cell position and gradients in development
6. Mesodermal induction
7. Explain the theories on animal ethics
8. Physiological aspects of fertilization
9. Proximate cell interractions

III. **Write short notes on any *FIVE* of the following:** **(5 X 4 = 20 marks)**

10. Regulative development
11. Mesodermal induction
12. Xenobiotics
13. Specism
14. Human Animal repression
15. Epimorphic regeneration
16. Embryonic stem cells
17. IVF

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APPLIED ZOOLOGY

ZOO 3C 14 – MICROBIOLOGY AND IMMUNOLOGY

Time: Three Hours Maximum: 80 Marks

Part A - Microbiology

I. **Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)**

1. The structure of prokaryotic cell wall and mechanism of Gram staining.
2. Describe the control of microorganisms using physical and chemical agents.

II. **Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)**

3. Influence of environmental factors on microbial growth.
4. Microbial growth and food spoilage.
5. Major types of culture media.
6. Uses of microbes in agriculture.

III. **Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)**

7. Pasteurization.
8. Numerical taxonomy.
9. Fermented foods.
10. Capsules and slime layers.
11. Reproduction in animal viruses

Part B - Immunology

IV. **Write an essay on any *ONE* of the following: (1 X 15 = 15 marks)**

12. Complement activation pathways.
13. Structure and functions of immunoglobulin.

V. **Write short essays on any *TWO* of the following: (2 X 8 = 16 marks)**

14. Hypersensitivity reactions.
15. Monoclonal antibodies and applications.
16. Autoimmune diseases.
17. MHC molecules.

VI. **Write short notes on any *THREE* of the following: (3 X 3 = 9 marks)**

18. ELISA
19. Vaccines and vaccination.
20. VD(J) rearrangements.
21. Primary lymphoid organs.
22. Cytokines

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APPLIED ZOOLOGY

ZOO 3E 15 – GENERAL ENTOMOLOGY

Time: Three Hours Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Write an essay on general structure and modifications of insect mouthparts with appropriate diagrams
2. Giving diagnostic features classify the order Embioptera
3. Sound producing mechanisms in insects
4. With suitable diagrams give an account of diversity of external reproductive organs in insects

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Wing coupling mechanism
6. Types of antennae
7. Give diagnostic characters of five families of Order Coleoptera
8. Give an account of diversity of wing venation in Order Hymenoptera
9. Insect embryogenesis

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Jumping apparatus in Collembola
11. Parthenogenesis
12. Give a brief account of objectives of classification
13. Modifications for predatory forms of life in Mantoidea
14. Economic importance of family Scarabaeidae
15. Secondary segmentation
16. Adaptations in insect eggs
17. Characteristics of Order Phasmida

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APPLIED ZOOLOGY

ZOO 3E 16 - INSECT BIOCHEMISTRY AND PHYSIOLOGY

Time: Three Hours Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Explain the mechanism of detoxification in insects.
2. Describe the composition and biochemistry of insect cuticle.
3. Write an essay on insect hormones and their role.
4. Structure and physiology of insect photoreceptors.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Insect haemocytes and their functions.
6. Digestive enzymes in insects.
7. Moulting and sclerotization in insects.
8. Describe the significance of insect fat body.
9. Physiology of insect muscles.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Physical gill and plastron respiration.
11. Insect chemoreceptors.
12. Glycerol phosphate shuttle.
13. Slow and fast axons.
14. Acetyl cholinesterase inhibitors.
15. Extra intestinal digestion.
16. Insect excretion.
17. Metabolic poisons.

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APPLIED ZOOLOGY

ZOO 4E 20- AGRICULTURAL ENTOMOLOGY & ACAROLOGY

Time: Three Hours Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Reasons and remedies for insect pest upset.
2. Biology and management of important insect pests of paddy in India.
3. Important groups of phytophagous mites.
4. Types of honey bee and methods in bee keeping.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Factors governing insect pest outbreaks.
6. Techniques in insect pests damage assessment.
7. Important borer pests of vegetables.
8. Types of insect damage to plants.
9. Damage caused by termites and control measures.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Sericulture.
11. Plant galls and insects.
12. Role of mites in biodegradation.
13. Insect pollinators.
14. Classification of insect pests based on occurrence.
15. Lac insect.
16. Predatory mites.
17. Light trap.

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APPLIED ZOOLOGY

ZOO 4E 21 – INSECT PESTS – CONTROL AND MANAGEMENT

Time: 3 hours Maximum: 80 marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Illustrate strategies in biological control and importance of parasitic insects.
2. Give an account of microbial formulations for control of insect pests.
3. Concepts of pest management and characteristics of pest management.
4. Write an account on pest resurgence, replacement and the management of these.

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Forecast of pest outbreak.
6. Behavioral manipulation of insect pest for the pest control programme.
7. Different strategies of pest management.
8. List out five major insect pests of oilseeds, its bionomics, damage & control measures.
9. Chemical insecticides, formulations & its hazards.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Ecological backlash
11. Repellents
12. Plant based insecticides
13. Antifeedants
14. Chemosterilents
15. Vegetable pests
16. Causes of pest outbreak
17. Kinds of insect pests

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APPLIED ZOOLOGY

ZOO 4E 22 – ECOLOGY AND ETHOLOGY OF INSECTS

Time: 3 hours Maximum: 80 marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. With suitable examples give an account pheromones mediated communication in parasitoids
2. Comment on nitrogenous and non-nitrogenous defense in plants
3. Give an account of pollination in plants
4. Write an essay on food finding mechanism in insects

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Effects of herbivory
6. Role of HIPVs in recruitment of insect natural enemies
7. Mechanism of seed dispersal and advantages
8. Oviposition strategies in terrestrial and aquatic insects
9. Factors affecting insect dispersal

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Intraguild predation
11. Insect response to fragmentation of ecosystems
12. Ethics in insect conservation
13. Pest management strategies used in organic farming
14. Pitfall trap
15. Chemicals influencing feeding behaviour
16. Invasive insects
17. Trophic cascades

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APPLIED ZOOLOGY

ZOO 3E 23 – MEDICAL, VETERINARY & FORENSIC ENTOMOLOGY

Time: Three Hours Maximum: 80 Marks

I. Write an essay on any *TWO* of the following: (2 X 15 = 30 marks)

1. Explain epidemiology, clinical aspects and treatment of malaria.
2. Methods in control of mosquitoes
3. Morphological adaptations of insect vector
4. DNA techniques in forensic entomology

II. Write short essays on any *THREE* of the following: (3 X 10 = 30 marks)

5. Treatment and preventive measures of Trypanosomiasis
6. Explain the use of insects as tools in forensic science
7. Insects of veterinary importance
8. Describe the taxonomy and biology of Tabanids
9. Different types of Myasis and its treatment.

III. Write short notes on any *FIVE* of the following: (5 X 4 = 20 marks)

10. Mechanical and biological vectors
11. Microfilariae
12. Dengue fever
13. Pink eye disease
14. Sleeping sickness
15. Japanese encephalitis
16. Maggot therapy
17. Pharmacological aspects of insect toxins