



Mangalore University

National Education Policy-2020 (NEP-2020)

**Curriculum Structure for Degree Program
B. Sc. in Zoology
(Basic and Honours)**

**Syllabus and Scheme of Examination of
Discipline Core and Open Elective courses
For III and IV Semesters**

Academic Year 2022-23 onwards

Syllabus for B.Sc. (Basic & Honours) in Zoology

Name of the Degree Program: **B. Sc. (Basic & Hons)**
Discipline Core: **Zoology**
Total Credits for the Program: **50/100/142/184/268**
Starting year of implementation: **2021-22 (I & II sem)**
2022-23 (III & IV sem)

Progressive Certificate, Diploma, Bachelor Degree or Bachelor Degree with Honours Provided at the End of Each Year of Exit of the Four-year Undergraduate Programme/ Five-year Integrated Master's Degree Programme.

Introduction:

The curriculum framework takes into account the need to maintain globally competitive standards of achievement in terms of the knowledge and skills in Zoology and allied courses, as well as develop scientific orientation, spirit of enquiry problem solving skills and human and professional values which foster rational and critical thinking in the students. This course serves as a plethora of opportunities in different fields right from classical to applied Zoology.

AIMS AND OBJECTIVES OF UG PROGRAM IN ZOOLOGY

- The Program offers both classical as well as modern concepts of Zoology in higher education.
- It enables the students to study animal diversity in both local and global environments.
- To make the study of animals more interesting and relevant to human studies more emphasis is given to branches like behavioural biology, evolutionary biology and economic Zoology.
- More of upcoming areas in cell biology, genetics, molecular biology, biochemistry, genetic engineering and bioinformatics have also been included.
- Equal importance is given to practical learning and presentation skills of students.
- The lab courses provide the students necessary skills required for their employability.
- Skill enhancement courses in classical and applied branches of Zoology enhance enterprising skills of students.
- The global practices in terms of academic standards and evaluation strategies.
- Provides opportunity for the mobility of the student both within and across the world.
- The uniform grading system will benefit the students to move across institutions within India to begin with and across countries.
- It will also enable potential employers in assessing the performance of the candidates across the world.

**Course content under New Education Policy Year 2022-23 for III Semester B.Sc.
Zoology Core Course Content**

Course Title/Code: Molecular Biology, Bioinstrumentation & Techniques in Biology	Course Credits: 4
Course Code: BSCZOCN301	L-T-P per week: 4-0-0
Total Contact Hours: 56	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

At the end of the course the student should be able to understand:

1. After successful accomplishment of the course, the learners will be able to acquire better understanding and comprehensive knowledge regarding most of the essential aspects of Molecular Biology subject which in turn will provide a fantastic opportunity to develop professional skill related to the field of molecular biology.
2. The course will mainly focus on the study of principal molecular events of cell incorporating DNA Replication, Transcription and Translation in prokaryotic as well as eukaryotic organisms.
3. Acquiring knowledge on instrumentation and techniques in biology.

Semester III - Zoology Core Course Content:

Content	Hours
Unit -I	14
Chapter 1: Process of Transcription <ul style="list-style-type: none"> • Fine structure of gene: Cistron, Recon, Muton. • RNA polymerases: Types and functions. • Protein synthesis: Introduction, phases-transcription, translation. • Transcription in prokaryotes and eukaryotes: Steps involved, differences between prokaryote and eukaryote transcription. 	8
Chapter 2: Process of Translation <ul style="list-style-type: none"> • Genetic code: Definition, salient features. • Translation in prokaryotes and eukaryotes: Steps involved. 	6
Unit II	14
Chapter 3. Regulation of gene expression-I <ul style="list-style-type: none"> • Regulation of gene expression in prokaryotes: lac operon (inducible) and trp operon (repressible) in <i>E. coli</i>. • Regulation of gene expression in eukaryotes - Role of chromatin 	9

(euchromatin and heterochromatin) in gene expression.	
<ul style="list-style-type: none"> • Post-transcriptional modification: capping, splicing, polyadenylation. • Concept of RNA editing (mRNA), gene silencing, and, RNAi (RNA interference). 	
Chapter 4. Regulation of gene expression-II	
<ul style="list-style-type: none"> • Post-translational modifications: purpose, advantages and significance; glycosylation, methylation, phosphorylation, and acetylation. • Intracellular protein degradation (lysosomal autophagy and ubiquitin proteasome pathway). 	5
Unit III	14
Chapter 5: Microscopy	
<ul style="list-style-type: none"> • Principles and applications of Light microscopy, Dark field microscopy, Phase contrast microscopy, Fluorescence microscopy, Confocal microscopy and Electron microscopy (SEM and TEM). 	9
Chapter 6: Centrifugation and Chromatography	
<ul style="list-style-type: none"> • Centrifugation: Principles, types and applications. (High speed and Ultracentrifugation) • Chromatography: Principle and applications of TLC and HPLC and GC. 	5
Unit IV	14
Chapter 7: Biochemical Instrumentation	
<ul style="list-style-type: none"> • Colorimetry and Spectrophotometry: Definition, principle and applications. Beer-Lambert's law, UV-Vis Spectrophotometer. • pH meter, measurement of pH. • Principle, applications and safety measures of Radio-tracer techniques - Autoradiography. 	6
Chapter 8: Molecular Techniques	
<ul style="list-style-type: none"> • Principle and applications of Agarose gel-electrophoresis, SDS-PAGE, DNA Sequencing (Sanger's Dideoxy method), • PCR, DNA Fingerprinting, ELISA, Southern Blotting and Western Blotting. 	8

Suggested Reading:

1. Chromatography: <https://microbenotes.com/chromatography-principle-types-and-applications/>
2. David Freifelder. 2003. Molecular Biology, 2nd edition, Narosa Publishing House, New Delhi.
3. E.D.P. De Robertis, E.M.F. De Robertis, Jr. 2001. Cell and Molecular Biology, 8th edition, Wolters Kluwer (India) Pvt. Ltd, New Delhi.
4. Gurdeep R. Chatwal, Sham K. Anand. 2007. Instrumental methods of chemical analysis, Himalaya Publishing House, Bangalore.
5. H. Kaur. 2016. Instrumental methods of chemical analysis, XII edition, Pragati Prakashan, Meerut.
6. H.D. Kumar. Molecular Biology, 2nd edition, Vikas publishing house Pvt Ltd, New Delhi.
7. Lodish, Berk, Matsudaira, Kaiser, Krieger, Scott, Zipursky, Darnell. 2003. Molecular Biology, 5th edition, W.H. Freeman and Company, New York.

8. Neal U, Thorpe. 1984. Cell Biology-Methods in Cell Biology, John Wiley & Sons, Inc. USA.
9. P.K. Gupta. 2015. Cell and Molecular Biology, 4th edition, Rastogi Publications, Meerut.
10. Primrose SB, Richard M, Twyman RM and Old RW. 2002. Principles of Gene Manipulation, 6th edition, Blackwell Publishers.
11. R.C. Dubey. 2010. A text book Biotechnology. S Chand and Company Ltd, New Delhi.
12. S.C. Rastogi. 2009. Biotechnology-Principles and Applications, Narosa publication. New Delhi.
13. U. Satyanarayana. 2006. Biotechnology, Books and Allied (p) Ltd, Kolkata (India).

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Written Assignment/Presentation/Project /Term Papers/Seminar	15
Class performance/Participation	05
Total	40

Scheme of Examination: Theory (Semester III)

Question No.	PART - A	Marks
I	Answer any SIX Questions out of EIGHT Questions (2 questions of 2 marks from each unit)	6 x 2 = 12
	PART - B	
	Unit - I	
II	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
III	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - II	
IV	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
V	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - III	
VI	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
VII	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - IV	
VIII	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
IX	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Total	60

Zoology Core Course Lab Content

Semester III

Course Title: Molecular Biology, Bioinstrumentation and Techniques in Biology	Course Credits: 2
Course Code: BSCZOPN302	L-T-P per week: 0-0-4
Total Contact Hours: 56	Duration of ESA: 3 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

At the end of the course the student should be able to:

1. At the end of the course, students will be able to understand the applications of biophysics and principle involved in bio-instruments.
2. Understand the methodology involved in bio techniques.
3. Students can demonstrate knowledge and practical skills of using instruments in biology and medical field.
4. They can perform techniques involved in molecular biology and diagnosis of diseases.

Lab Course Content

List of labs to be conducted	56 Hours
1. To study the principle and applications of simple, compound and binocular microscopes.	1
2. To study the principle and applications of various lab equipments- Electronic balance, Vortex mixer, use of glass and micropipettes, Laminar air flow, Incubator, shaker, Water bath and centrifuge.	2
3. Calibration of pH meter and determination of pH of natural samples (milk, honey, urine).	1
4. To prepare Buffer solutions (Phosphate, Citrate, Tris-HCl buffer).	1
5. To learn working of Colorimetry and Spectrophotometry (using cadmium chloride).	1
6. To estimate amount of RNA by Orcinol method.	1
7. To estimate amount of protein by Lowry's method (liver tissue).	1
8. To estimate amount of DNA by di-phenylamine (DPA) method.	1
9. Demonstration of differential centrifugation techniques to fractionate components in a given mixture (blood or liver tissue).	1
10. To identify different unknown amino acids using ascending paper chromatography (using amino acid kit).	1
11. Extraction of DNA using suitable animal tissue sample.	1
12. Study of different forms of DNA (A, B and Z) and types of RNA (t, r, m): Models or Photos.	1

Suggested Reading:

1. Bal Ram Singh, Raj Kumar. 2022. Practical Techniques in Molecular Biotechnology, Cambridge University Press, USA.
2. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, and Peter Walter 2002. Molecular Biology of the Cell, 4th edition. New York: Garland Science.
3. Daniel L. Hartl and Maryellen Ruvolo. 2012. Genetics: Analysis of Genes and Genomes, 8th edition. Burlington, Mass.: Jones & Bartlett Learning.
4. Gerald Karp. Cell and Molecular Biology. 2008. Concepts and Experiments, 5th edition. Wiley Publication.
5. Harvey Lodish, Arnold Berk, Paul Matsudaira, Chris A. Kaiser, Monty Krieger, Freeman. 2003. Molecular Cell Biology, 5th edition. W. H. & Company.
6. Herman Sunil D Souza, Shyam Prasad Sajankila, K Satyamoorthy. 2012. Manipal University Press, Manipal, India.
7. James D. Watson, Tania A. 2003. Baker, Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick. Molecular Biology of the Gene, 5th edition. Cold Spring Harbor Laboratory Press.
8. Stryer, Lubert. 1981. Biochemistry, 2nd edition. W. H. Freeman and Company, New York.

Pedagogy: Written Assignment/Presentation/Project / Term Papers/Seminar

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	10
Project*	05
Class performance/Participation	05
Record writing and timely submission	05
Total	25

***Topic for the project may be selected from the practical syllabus**

**Course Title/Code: Molecular Biology, Bioinstrumentation and Techniques in Biology
(BSCZOPN302)**

**Scheme of Practical Examination
B.Sc. Zoology III Semester**

Duration: 3 hours

Max. Marks: 25

I. Extraction of DNA from the given animal tissue.

(Flow chart of the procedure-2 Marks; principle-1 Mark; DNA Isolation-4 Marks; Report-1Mark)

OR

Estimation of DNA / RNA / Proteins.

08

(Flow chart of the procedure-2 Marks; principle-1 Mark; conducting the experiment-4 Marks;
Report-1 Mark)

II. Separate and identify the given unknown amino acids by using ascending paper chromatography.

06

(Procedure-2 Marks; conducting the experiment-2 Marks; Identification & Report-2 Marks)

III. Identify and give the working principle of the spotters A and B.

(Equipments/photographs of the instruments).

3X2=06

(Identification-1 Mark; working principle-2 Marks)

IV. Class record

05

Total=25

Note: Questions must be framed as per the scheme provided.

Open Elective Course Content

Zoology

Semester: III

Course Title: Endocrinology	Course Credits: 3
Course Code: BSCZOEN301	
Total Contact Hours: 42	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

At the end of the course the student should be able to:

Differentiate among endocrine, paracrine and autocrine systems.

1. Describe the different classes and chemical structures of hormones.
2. Identify the glands, organs, tissues and cells that synthesize and secrete hormones, hormone precursors and associated compounds.
3. Identify and discuss the integration of the endocrine system in general with focus on specific interactions.
4. Explain the consequences of under- and overproduction of hormones.

Course Content

Content	Hours
Unit I	14
Chapter 1. Endocrine glands <ul style="list-style-type: none"> • Endocrine glands and classifications of hormones. • Characteristics and transport of hormones. Chapter 2. Hypothalamus - Hypophysis <ul style="list-style-type: none"> • Hypothalamus as a neuroendocrine organ. • Pituitary gland: Structure and functions. • Pituitary hormones: Chemical nature, mode of action and functions. • Pituitary disorders. Chapter 3. Pineal gland <ul style="list-style-type: none"> • Structure and functions. • Hypo and hyperactive states. 	
Unit II	14
Chapter 4. Thyroid and parathyroid glands <ul style="list-style-type: none"> • Chemical nature, mode of action and functions of the hormones. • Hypo and hyperactive states. Chapter 5. Adrenal gland <ul style="list-style-type: none"> • Hormones: Chemical nature and functions. • Hypo and hyperactive states. Chapter 6: Prostaglandins <ul style="list-style-type: none"> • Chemical nature and functions. 	
Unit – III	14
Chapter 7: Pancreas <ul style="list-style-type: none"> • Pancreatic islets: Chemical nature and functions. Hormonal control of blood sugar. • Hyperinsulinism and diabetes mellitus. 	

Chapter 8: Gastro-intestinal hormones

- Functions and regulation of secretion.

Chapter 9: Different types of rhythms

- Ultradian, circadian, infradian. Different zeitgebers and their relation with circadian clock.
- Sleep-wakefulness cycle. Time keeping genes. Jet-lag and shift work.

Suggested Reading:

1. Eric Widmaier and Hershel Raff and Kevin Strang. 2019. Vander's Human Physiology, McGraw-Hill, Higher Education.
2. H.E. De Wardener. 1985. The Kidney: An Outline of Normal and Abnormal Function, 5th revised edition, Churchill Livingstone.
3. Knut Schmidt- Nielsen. 1998. Animal Physiology: Adaptation and environment, 5th edition, Cambridge University Press.
4. Leslie J. De Groot, J. Larry Jameson, Leslie J. Degroot, J. Larry Jameson. 2001. Endocrinology (3-Volume Set) 4th edition.
5. Mac Hadley, Jonathan Levine. 2006. Endocrinology, 6th edition, Pearson.
6. Mohan P. Arora. Animal physiology, Himalaya Publishing house, 5th edition, Bangalore.
7. R. Nagabhushanam, M.S. Kodarkar. 1978. A text book of Animal Physiology, Oxford & IBH publishing Company, New Delhi.
8. R.A. Agarwal, Anil K, Srivastava, Kaushal Kumar. 2015. Physiology and Biochemistry, S. Chand and Company Pvt Ltd, New Delhi.
9. S.C. Rastogi. 2001. Essentials of Animal Physiology, 3rd edition, New age international (P) Ltd, New Delhi.
10. Shlomo Melmed, Kenneth Polonsky, P. Reed Larsen, Henry Kronenberg. 2016. Williams Textbook of Endocrinology, 13th edition, An Imprint of Elsevier.
11. Sujit Kumar Chaudhuri. 2011. Concise Medical Physiology, New Central Book Agency.

Pedagogy: Chalk and Talk, PPT, Group discussion, Seminar.

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Written Assignment / Case Presentation/Project/ Seminar	15
Class performance/Participation	05
Total	40

Scheme of Examination: Open elective (Semester III)

Question No.	PART - A	Marks
I	Answer any SIX Questions out of NINE Questions (3 questions of 2 marks from each unit)	6 x 2 = 12
	PART - B	
	Unit - I	
II	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
III	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - II	
IV	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
V	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - III	
VI	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
VII	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Total	60

**Course content under New Education Policy-Year 2022-23
For IV Semester B.Sc., (Hons)**

Zoology Core Course Content

Course Title/Code: Gene Technology, Immunology and Computational Biology	Course Credits: 4
Course Code: BSCZOCN401	L-T-P per week: 4-0-0
Total Contact Hours: 56	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Acquaint knowledge on versatile tools and techniques employed in genetic engineering and recombinant DNA technology.
2. An understanding on application of genetic engineering techniques in basic and applied experimental biology.
3. To acquire a fundamental working knowledge of the basic principles of immunology.
4. To understand how these principles, apply to the process of immune function.
5. Use, and interpret results of, the principal methods of statistical inference and design; helps to communicate the results of statistical analyses accurately and effectively; helps in usage of appropriate tool of statistical software.

Core Course content:

Course Content	56 Hrs.
Unit I	14
Chapter 1: Principles of Gene Manipulation	
<ul style="list-style-type: none"> • Recombinant DNA Technology: Introduction, steps involved. • Restriction enzymes, Ligases and Nucleic acid modifying enzyme. • Gene cloning vector: Concept of plasmids-pBR322, Lambda phage vectors, cosmids. • Gene transfer techniques (Direct and indirect). • Screening and selection of recombinant colonies. 	07
Chapter 2: Applications of Genetic Engineering	07
<ul style="list-style-type: none"> • Transgenic animals (Transgenic cow, Transgenic fish); Transgenic plants (cry protein); Gene silencing (Knock out and Knock in mouse). • Production of Human Recombinant insulin and • Hybridoma technology: Synthesis and applications of Monoclonal antibodies. • Gene Therapy: Definition, types (In vivo and ex vivo), application (SCID). • Biosensors: Definition, applications. 	
Unit II	14

Chapter 3: Introduction to the Immune System <ul style="list-style-type: none"> Types of immunity: Innate, acquired, active and passive immunity. Cells of the immune system: Macrophages, neutrophils, eosinophils, basophils, lymphocytes, APC's. Organs of the immune system: Bone marrow, Thymus, Spleen, Lymph node; Small intestine (Peyer's patches). Primary and secondary immune response. Role of B and T-lymphocytes. 	07
Chapter 4: Antigens and Antibodies <ul style="list-style-type: none"> Antigens, haptens and immunogen: Definitions, intrinsic properties (foreignness, molecular size, heterogeneity). B and T cell epitopes: Definitions. Structure of IgG and functions of different classes of immunoglobulins. Major histocompatibility complex -Structure of MHC I & II. 	07
Unit III	14
Chapter 5: Clinical Immunology <ul style="list-style-type: none"> Immunity against diseases of viral (Hepatitis B), bacterial (TB) and protozoan infections (Malaria). Vaccines: Types and Uses-Immunization schedule for children. Transplantation immunology: Transplantation of organ- Types, graft rejection and Immuno-suppressors. 	07
Chapter 6: Bioinformatics <ul style="list-style-type: none"> Scope and applications of Bioinformatics. Databases: Definition, Biological databases – Nucleotide databases (Gene bank, EMBL, DDBJ), Protein databases (Swiss-PROT, TrEMBL, PROSITE). Sequence analysis (homology): Pairwise and Multiple Sequence alignment- BLAST, CLUSTALW, FASTA. 	07
Unit IV	14
Chapter 7: Biostatistics I <ul style="list-style-type: none"> Measures of central tendency: Mean, Median, Mode. Data summarizing: Frequency distribution, Graphical presentation - bar diagram, pie diagram, histogram. Elementary idea of probability and its applications. 	07
Chapter 8: Biostatistics II <ul style="list-style-type: none"> Measures of dispersion: Range, Standard Deviation, Variance. Correlation and Regression. Tests of significance: F-test, ANOVA, t-test and Chi square test. 	07

Suggested Reading:

1. Anil Kumar, Ashwani Pareek, Sanjay Mohan Gupta. 2013. Biotechnology in Medicine and Agriculture: Principles and Practices, I.K. International Publishing house Pvt Ltd, Bangalore.
2. Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to Bioinformatics, Published by Prentice Hall.
3. B.D. Singh. 2010. Biotechnology Expanding Horizon, Kalyani Publishers, New Delhi.
4. C.S.V. Murthy. 2016. Bioinformatics, Himalaya Publishing House.
5. C.V. Rao. 2002. An Introduction to Immunology. Narosa Publishing house, New Delhi.
6. Desmond S.T. Nicholl. 2002. An Introduction to Genetic Engineering, 2nd edition, Cambridge University press.
7. Gurumani N. 2015. An Introduction to Biostatistics, 2nd edition, MJP Publisher.
8. Hepsyba, Hemalatha. 2019. Basic Bioinformatics. MJP Publishers; 1st edition.
9. K Visweswara Rao. 1999. Biostatistics: A Manual of statistical methods for use in health, nutrition and anthropology, Jaypee Brothers- Medical Publishers (p) Ltd, New Delhi.
10. Kumaresan, Sundaralingam. 2021. Bioinformatics, Saras Publication.
11. P K Gupta. 2008. Elements of Biotechnology, Rastogi Publications, New Delhi.
12. P. Joshi. 2003. Genetic Engineering and its Applications. Agro Botanica, India.
13. Philip L. Carpenter. 1965. Immunology and Serology, 2nd edition, W.B. Sanders Company Philadelphia and London Toppan Company, Limited Tokyo, Japan.
14. R.C. Dubey. 2010. A text book Biotechnology. S Chand and Company Ltd, New Delhi.
15. Ramakrishnan P. Biostatistics. Saras Publication.
16. U. Satyanarayana. 2006. Biotechnology, Books and Allied (p) Ltd, Kolkata (India).
17. Wayne W. Daniel, Chad L. Cross. 2013. Biostatistics: A Foundation for Analysis in the Health Sciences.

Pedagogy: Lectures, Presentations, Videos, Assignments and Weekly Formative Assessment Tests.

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Written Assignment/Presentation/ /Project/ Term Papers/Seminar	15
Class performance/Participation	05
Total	40

Scheme of Examination: Theory (Semester IV)

Question No.	PART - A	Marks
I	Answer any SIX Questions out of EIGHT Questions (2 questions of 2 marks from each unit)	6 x 2 = 12
	PART - B	
	Unit - I	
II	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
III	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - II	
IV	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
V	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - III	
VI	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
VII	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Unit - IV	
VIII	3 Marks Questions (Answer any TWO out of THREE)	3 x 2 = 6
IX	6 Marks Questions (Answer any ONE out of TWO)	6 x 1 = 6
	Total	60

Zoology Semester IV Core Course Lab Content

Course Title/Code: Gene Technology, Immunology and Computational Biology	Course Credits: 2
Course Code: BSCZOPN402	L-T-P per week: 0-0-4
Total Contact Hours: 56	Duration of ESA: 3 Hours
Formative Assessment Marks: 25	Summative Assessment Marks: 25

Course Outcomes (COs):

At the end of the course the student should be able to:

1. Accurately, safely and appropriately use all the equipment regularly used in Molecular Biology (DNA manipulation, including balances, pipettes, electrophoresis and centrifuges).
2. Prepare chemical solution and reagents to the precision appropriate to the task.
3. Demonstrate knowledge of the biochemical basis underpinning the molecular biology.

Course Content:

List of labs to be conducted	56 Hours
1. To study Restriction enzyme digestion using teaching kits (Demonstration only).	1
2. To detect genetic mutations by Polymerase Chain Reaction (PCR) using teaching kits (Demonstration only).	1
3. Demonstration of agarose gel electrophoresis for detection of DNA.	1
4. Demonstration of Polyacrylamide Gel Electrophoresis (PAGE) for detection of proteins.	1
5. Determination of ABO Blood group and Rh factor.	1
6. Identification of cells of Immune system- Macrophages, neutrophils, eosinophils, basophils, lymphocytes, APC's (slides/photographs).	1
7. Identification of organs of immune system – Bone marrow, Thymus, Lymph nodes, Spleen, Peyer's patches (slides/photographs).	1
8. To calculate molecular weight of unknown DNA and protein fragments from gel pictures. (https://youtube/mCiCiO0cfbg)	1
9. Calculate the mean, median, mode and standard deviation (with suitable examples).	1
10. Representation of data by bar diagram, pie diagram and histogram.	1
11. Measure the height and weight of all students in the class and apply statistical measures (Correlation, Regression, ANOVA, t-test).	1
12. To learn nucleotide sequence database (GenBank, EMBL, DDBJ).	1
13. To learn sequence alignment: Pairwise alignment (Protein/ DNA).	1
14. BLAST, CLUSTALW, FASTA Programme colour charts for identification.	1

Suggested Reading:

1. Attwood, T.K. and Parry-Smith, D.J. 1999. Introduction to Bioinformatics, Published by Prentice Hall.
2. C.S.V. Murthy. 2016. Bioinformatics, Himalaya Publishing House.

3. Gurumani N. 2015. An Introduction to Biostatistics, Kindle Edition, 2nd edition, MJP Publisher.
4. Hepsyba, Hemalatha. 2019. Basic Bioinformatics. MJP Publishers; 1st edition.
5. K Visweswara Rao. 1999. Biostatistics: A Manual of statistical methods for use in health, nutrition and anthropology, Jaypee Brothers- Medical Publishers (p) Ltd, New Delhi.
6. Kumaresan, Sundaralingam. 2021. Bioinformatics, Saras Publication.
7. Orpita Bosu, Simminder Kaur Thukral. 2007. Bioinformatics: databases, tools, algorithms. Oxford University Press, New Delhi.
8. P Joshi.2006. Genetic Engineering. Agrobios (India).
9. Ramakrishnan P. Biostatistics. Saras Publication.
10. Sandhya Mitra. 2015. Genetic Engineering: Principles and Practice, 2nd edition, McGraw Hill Education (India) Private Limited.
11. Sharma, Munjal, Shanker. 2018. A text book of Bioinformatics. Rastogi publications.
12. Sundar Rao, J. Richard. 2006. Introduction to Biostatistics and Research Methods. Prentice-Hall of India Pvt. Limited.
13. Wayne W. Daniel, Chad L. Cross. 2013. Biostatistics: A Foundation for Analysis in the Health Sciences.

Pedagogy: Lectures, Presentations, Videos, Labs, Assignments, Tests, Individual or group Field oriented Project Report.

Formative Assessment	
Assessment Occasion	Weightage in Marks
Test	10
Project*	05
Participation in class	05
Record writing and timely submission	05
Total	25

***Topic for the project may be selected from the practical syllabus**

**Course Title/Code: Gene Technology, Immunology and Computational Biology
(BSCZOPN402)
Scheme of Practical Examination
B.Sc. Zoology IV Semester**

Duration: 3 hours

Max. Marks: 25

- I.** Identify the ABO and Rh blood group of the given blood sample and comment on the significance of blood typing. **04**
(Identification of ABO and Rh blood group- $\frac{1}{2}+\frac{1}{2}=1$ Mark; Reasons- $1+1=2$ Marks; significance-1 Mark)
- II.** Identify and comment on the spotter A (Immune cells and organs-slides/photographs). **02**
(Identification-1 Mark, comments-1)
- III.** Biostatistics problem on Chapter 7 **04**
- IV.** Biostatistics problem on Chapter 8 **04**
- V.** Identify and comment on the given spotters B, C and D. **3X2=06**
(PCR/PAGE/Restriction enzyme kit/ BLAST, CLUSTALW, FASTA/Database)
(Identification - 1 Mark; comments -1 Mark)
- VI.** Class record **05**

Total= 25

Note: Questions must be framed as per the scheme provided.

Open Elective Course Content

Semester: IV Zoology

Course Title: Animal Behaviour Course Code: BSCZOEN401	Course Credits: 3
Total Contact Hours: 42	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course Outcomes (COs):

At the end of the course the students will be able to:

1. Examine and critically to evaluate the emergence of ideas that have shaped how we observe and collect data on animal behaviour.
2. Understand the main historical ideas that underpin animal behaviour theory
3. Critically review hypotheses to explain animal behaviour
4. Understand different methods for collecting data on animal behaviour
5. Have advanced their written and oral presentation skills.

Course Content

Content	42 Hrs.
Unit – 1	
Chapter 1. Introduction to Animal Behaviour <ul style="list-style-type: none"> • Contributions of Karl Von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen. • Proximate and ultimate causes of behaviour. Chapter 2. Patterns of Behaviour <ul style="list-style-type: none"> • Stereotyped Behaviours - Orientation and Reflex. • Individual Behavioural patterns: Instinct and Learned Behaviour. • Associative learning, classical and operant conditioning, Habituation, Imprinting. 	14
Unit – 2	14
Chapter 3. Social Behaviour <ul style="list-style-type: none"> • Social organization in termites and honey bees. • Social behaviour: Altruism. • Conflict behaviour. Chapter 4. Sexual Behaviour <ul style="list-style-type: none"> • Sexual dimorphism, Mate choice in peacock. • Intra-sexual selection (male rivalry in red deer). • Kinship theory: Relatedness & inclusive fitness. • Parental care in fishes (Nest building). 	
Unit – 3	14
Chapter 5. Chronobiology <ul style="list-style-type: none"> • Brief historical developments in chronobiology. • Adaptive significance of biological clocks. Chapter 6: Communications in animals <ul style="list-style-type: none"> • Bioluminescence in deep sea fishes and insects. • Territoriality in Monkeys and Dogs. 	

- Role of pheromones in animal communication- Insects and Vertebrates.
- Communication in Honey bees (Waggle Dance).

Suggested Reading:

1. D. S. Saunders , X. Vafopoulou C. G. H. Steel , R. D. Lewis . 2002. Insect Clocks, 3rd edition, Baren and Noble Inc. New York, USA.
2. Hosang S. Gundevia, Hare Govind Singh. 2001. A text book of Animal Behaviour, S Chand and Company Ltd, New Delhi.
3. Jay. C. Dunlap, Jennifer. J. Loros, Patricia J. DeCoursey. 2004. Chronobiology: Biological Timekeeping, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA.
4. John Alcock, Animal Behavior: An Evolutionary Approach, 4th edition, Sinauer Associate Inc., USA.
5. Lee C Drickamer, Stephen H Vessey. 2001. Animal Behavior: Mechanisms, Ecology, Evolution.
6. Mohan P. Arora. 2000. Animal Behaviour, Himalaya Publishing house, New Delhi.
7. Paul W. Sherman and John Alcock. Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.
8. Reena Mathur. 2018. Concepts of Animal Behaviour, Rastogi Publications, 1st edition, Meerut, India.
9. Vinod Kumar. 2002. Biological Rhythms, Narosa Publishing House, Delhi/ Springer-Verlag, Germany.

Pedagogy: Chalk and Talk, PPT, Group discussion, Seminar, Interaction, virtual lab, Lab visit

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test	20
Written Assignment / Project / Seminar	15
Class performance/Participation	05
Total	40

Scheme of Examination: Open elective (Semester IV)

Question No.	PART - A	Marks
I	Answer any SIX Questions out of NINE Questions (3 questions of 2 marks from each unit)	6 x 2 = 12
	PART - B	
	Unit - I	
II	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
III	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - II	
IV	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
V	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Unit - III	
VI	3 Marks Questions (Answer any THREE out of FOUR)	3 x 3 = 9
VII	7 Marks Questions (Answer any ONE out of TWO)	7 x 1 = 7
	Total	60