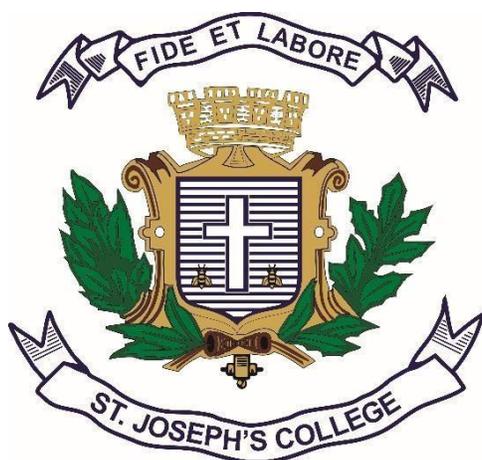


ST. JOSEPH'S COLLEGE (AUTONOMOUS)

BENGALURU-27



Re-accredited with 'A++' **GRADE** with **3.79/4 CGPA** by NAAC Recognized by UGC as College of Excellence

DEPARTMENT OF ZOOLOGY

SYLLABUS FOR UNDERGRADUATE PROGRAMME

FOR THE BATCH OF 2021-2024

Part A			
1	Title of the Academic Program	B. Sc,	
2	Program Code	CZ, BZ, EZ, MZ, BtZ&BChZ	
3	Name of the College	St. Joseph's College (Autonomous)	
4	Objective of the College	<ol style="list-style-type: none"> 1. Academic Excellence 2. Character Formation 3. Social Concern 	
5	Vision of the College	“Striving for a just, secular, democratic and economically sound society, which cares for the poor, the oppressed and the marginalized”	
6	Mission of the College	M 1	St. Joseph's College (Autonomous) seeks to form men and women who will be agents of change, committed to the creation of a society that is just, secular and democratic.
		M 2	The education offered is oriented towards enabling students to strive for both academic and human excellence.
		M 3	The college pursues academic excellence by providing a learning environment that constantly challenges the students and supports the ethical pursuit of intellectual curiosity and ceaseless enquiry.
		M 4	Human excellence is promoted through courses and activities that help students achieve personal integrity and conscientise them to the injustice prevalent in society.
7	Name of the Degree	Bachelor of Science (B.Sc.,)	
8	Name of the Department offering the program	Zoology	

9	Vision of the Department offering the program	The department aims to provide a multi-disciplinary course in zoology and train students in a wide range of science-based skills that provide the learning base for future courses.	
10	Mission of the department offering the Program	To train students for advanced studies and specialization in recently emerging technological and multi-disciplinary fields such as genetic engineering, biodiversity, biotechnology, bioinformatics, wildlife and conservation. We will strive to equip them with the knowledge and skills for better planning and management of animal resources, environment, health, medicine, agriculture and population	
11	Duration of the Program	3 years (6 semesters)	
12	Total No. of Credits	TO BE ANNOUNCED	
13	Program Educational Objectives (PEOs)	PEO1	
		PEO2	
		PEO3	
<p>Programme Educational Objectives: PEOs are statements that describe Institution's Mission aligned with the programme (To be Prepared in consultation with other departments (Languages and Optional subjects) 2-5 PEOs can be written.</p> <ul style="list-style-type: none"> • Guidelines for the PEOs <ul style="list-style-type: none"> – PEOs should be consistent with the mission of the Institution – The number of PEOs should be manageable – PEOs should be achievable by the program – PEOs should be specific to the program and not too broad 			

1 4	Graduation Attributes	<p>The Following graduate attributes reflect the particular quality and feature or characteristics of an individuals that are expected to be acquired by a graduate through studies at St. Joseph’s College.</p> <ul style="list-style-type: none"> ● Disciplinary knowledge ● Communication Skills ● Critical thinking ● Problem solving ● Analytical reasoning ● Research-related skills ● Cooperation/Teamwork ● Reflective thinking ● Information/digital literacy ● Self-directed learning and Lifelong learner ● Multicultural competence ● Moral and ethical awareness/reasoning ● Leadership readiness/qualities ● International Outlook 	
1 5	Program Outcomes (POs)	PO1	
		PO2	
		PO3	
		PO4	

Programme Outcomes: POs are statements that describe what the students graduating from any of the educational Programmes should be able to do (To be Prepared in consultation with other departments (Languages and Optional subjects. 4-10 POs can be written

- **Guidelines for the POs**

- Program outcomes basically describe **knowledge, skills and behavior** of students as they progress through the program as well as by the time of graduation.
- POs should not be too broad
- They must be aligned with the **Graduation Attributes**

16	Program Specific Outcomes (PSOs)	PS O1	Provide broad and deep understanding of the concepts, principles, techniques and applications of cell biology, genetics and allied topics.
		PS O2	
		PS O3	
		PS O4	
		PS O5	
		PS O6	

Programme Specific Outcomes: PSOs are statements that describe what the graduates of a specific educational Programme should be able to do.

These statements are to be written by individual departments offering optional programmes. In addition, Language departments also write general statements for BA, BSc and Commerce Programs. For the Microbiology optional for MCB/MCZ PSOs have been shown as examples.

4-10 PSOs can be written

- **Guidelines for the PSOs**
 - Program Specific outcomes basically describe **knowledge and skills** of students as they progress through the program as well as by the time of graduation.
 - POs should not be too broad
 - They must be aligned with the **Graduation Attributes**

Part B

B.Sc CZ, BZ, EZ, MZ, BtZ & BChZ Curriculum

Courses and course completion requirements	No. of credits
General English	
Second language: Introductory Kannada/Kannada/ Hindi/ Sanskrit/ Tamil/ Additional English/French/German.	
Microbiology/Biotechnology/environmental science	
Chemistry/biochemistry	
Zoology	04
Open elective courses.	
Foundation courses	
Term paper	
Soft skills (IGNITORS)	
Human resource development (HRD)/Theology	
Outreach activity	
Extra and Co-curricular activities	

DEPARTMENT OF ZOOLOGY (UG)

(2021-2024)

Paper type	Code Number	Title	No. of hours of Instruction	No. of teaching hours/week	No. of credits	Continuous Internal Assessment (CIA) Marks	End Semester Marks	Total marks
SEMESTER I								
Theory	ZO121	Cytology and Genetics	56	04	04	40	60	100
Practical	ZO1P1	Cytology and Genetics	56	04	02	15	35	50
SEMESTER II								
Theory	ZO221	Biochemistry and Physiology	56	04	04	40	60	100
Practical	ZO2P1	Biochemistry and Physiology	56	04	02	15	35	50
SEMESTER III								
Theory	ZO321	Molecular Biology, Tools and Techniques in Biology	56	04	04	40	60	100
Practical	ZO3P1	Molecular Biology, Tools and Techniques in Biology	56	04	02	15	35	50
Total Number of credits: 06								
SEMESTER IV								
Theory	ZO421	Histology, Immunology and Gene technology	56	04	04	40	60	100
Practical	ZO4P1	Histology, Immunology and	56	04	02	15	35	50

		Gene technology						
Total Number of credits:06								

SUMMARY OF CREDITS IN ZOOLOGY

CORE COURSES (CC)	
Course Title	Code Number
Cytology and Genetics	ZO121
Cytology and Genetics	ZO1P1
Biochemistry and Physiology	ZO221
Biochemistry and Physiology	ZO2P
Molecular Biology, Tools and Techniques in Biology	ZO321
Molecular Biology, Tools and Techniques in Biology	ZO3P1
Histology, Immunology and Gene technology	ZO421
Histology, Immunology and Gene technology	ZO4P1

Course Outcomes and Course Content

Under New Education Policy – Year 2021-22 for

I Semester B.Sc., Zoology

Core Course Content

Course Title/Code: Cytology and Genetics	Course Credits: 4
Course Code: ZO121	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs. self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Core Course prerequisite: To study Zoology in undergraduate, student must have studied Biology or equivalent subject in Class 12.

Course Outcomes (COs):

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

- The structure and function of the cell organelles.
- The chromatin structure and its location.
- The basic principle of life, how a cell divides leading to the growth of an organism and also formation of its progeny.
- How a cell communicates with its neighboring cells.
- The principles of inheritance, Mendel's laws and the deviations.
- How the environment plays an important role by interacting with genetic factors.
- Detect chromosomal aberrations in humans and study of pedigree analysis.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C C T 1	C C 2	C C 3	C C 4	C C 5	C C 6	C C 7	C C 8	C C 9	C C 10	C C 11
I Core competency	X										
II Critical thinking	X										
III Analytical reasoning	X										
IV Research skills	X										
V Team work	X										

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark ‘X’ in the intersection cell if a course outcome addresses a particular program outcome.

Content	Hours
Unit I	14
<p>Chapter 1. Structure and Function of Cell Organelles - I in Animal cell</p> <ul style="list-style-type: none"> • Plasma membrane: Fluid-Mosaic model, chemical structure—lipids, proteins, carbohydrates and their role in maintaining structural integrity. <p>Functions: Selective permeability, Transport (Passive transport - Diffusion, facilitated diffusion, Osmosis. Active transport - carrier and channel proteins and bulk transport.</p> <ul style="list-style-type: none"> • Endomembrane system: <p>Endoplasmic Reticulum, Golgi apparatus, Lysosomes - synthesis and cis/trans sides of membranes, organization, transport, endocytosis and exocytosis.</p>	
<p>Chapter 2. Structure and Function of Cell Organelles - II in Animal Cell</p> <ul style="list-style-type: none"> •Cytoskeleton: Structure and function - microtubules, microfilaments, intermediate filaments •Mitochondria: Structure, oxidative phosphorylation; electron transport system •Peroxisome and Ribosome: structure and function (self study) 	
Unit II	14
<p>Chapter 3. Nucleus and Chromatin Structure</p> <ul style="list-style-type: none"> •Structure and function of nucleus in eukaryotes • Structure of chromosome • Nucleosome model (chromatin organization) 	
<p>Chapter 4. Cell cycle, Cell Division and Cell Signaling</p> <ul style="list-style-type: none"> • Cell cycle and regulation • Cell division: mitosis (self-study) and meiosis • Apoptosis 	

<ul style="list-style-type: none"> • Signal transduction: cell surface receptors, primary and secondary messengers (G-protein linked receptors-epinephrine) • Cell-cell interaction: cell adhesion molecules, cellular junctions 	
Unit-III	14
<p>Chapter 5. Mendelism and Extensions of Mendelism</p> <ul style="list-style-type: none"> • Basic principles of heredity: Mendel's laws- monohybrid cross and dihybrid cross, test cross, back cross (self study) • Penetrance and expressivity. • Extensions of Mendelism: Incomplete dominance, Co-dominance and Multiple alleles- ABO blood groups in man, Rh factor, Rh incompatibility complication Erythroblastosis foetalis • Interaction of genes- Dominant Epistasis comb patterns in fowl; problems. - plumage in white leghorn and white Plymouth breed of fowls. Polygenic inheritance- skin colour in man, Pleiotropy 	
<p>Chapter 6. Linkage and Sex Determination</p> <ul style="list-style-type: none"> • The Interaction Between Sex and Heredity: Sex-Influenced and Sex-Limited Characteristics: Autosomal vs. sex linked inheritance, Autosomal traits influenced by sex (baldness, color blindness, etc) • Cytoplasmic inheritance, Genetic Maternal Effects- coiling of shell, kappa particle in paramecium <ul style="list-style-type: none"> • Chromosomal Sex Determination: XX-XY, XX-XO, ZZ-ZW and ZZ-ZO types. • Dosage Compensation- Barr body, Lyon's hypothesis, Genic balance theory of Bridges, gynandromorphs and free martins. • Sex-linked characteristics in humans and dosage compensation. 	
Unit-IV	14
<p>Chapter 7. Human Chromosomes and Patterns of Inheritance</p> <ul style="list-style-type: none"> • Patterns of inheritance: autosomal dominance, autosomal recessive, X-linked recessive, X-linked dominant. • Chromosomal anomalies: Structural and numerical aberrations (Non-disjunction of Sex chromosomes- Turner's syndrome, Klinefelter's syndrome. Autosomal anomalies - Down syndrome and Cri-du-chat syndrome (self study)) • Human karyotyping and Pedigree analysis. 	

Chapter 8. Gene-environment interaction and Epigenetics

- Interaction between Genes and Environment: Environmental Effects on GeneExpression, Complex traits (Diabetes and CVD).
- Epigenetic landscape - introduction to Waddington's model.
- Introduction to heritability Introduction to norm of reaction - California experiment.

References:

1. Alberts et al: Molecular Biology of the Cell: Garland (2002).
2. Cell-Biology by C. B. Pawar, Kalyani Publications
3. Cooper: Cell: A Molecular Approach: ASM Press (2000).
4. Delves Peter J., Martin Seamus J., Burton Dennis R., Roitt Ivan M. Roitt's Essential Immunology, 13th Edition. Wiley Blackwell(2017).
5. Economic Zoology by Shukla and Upadhyaya
6. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman (2004).
7. Lewin B. Genes VIII. Pearson (2004).
8. Lodish et al: Molecular Cell Biology: Freeman & Co, USA (2004).
9. Principles of Genetics by B. D. Singh
10. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman (2007).
11. Watson et al. Molecular Biology of the Gene. Pearson (2004).

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

End Semester Examination Question Paper Pattern:

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (4 questions)	30
TOTAL		60

PAPER CODE ZOP1
ZOOLOGY SEMESTER-I
PRACTICAL II
ZO 1P1: CYTOLOGY AND GENETICS

Zoology Core Lab Course Content

Course Title: Cytology & Genetics	Course Credits:2
Course Code: ZO1P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs):

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

- To use simple and compound microscopes.
- To prepare stained slides to observe the cell organelles.
- To be familiar with the basic principle of life, how a cell divides leading to the growth of an organism and also reproduces to form new organisms.
- The chromosomal aberrations by preparing karyotypes.
- How chromosomal aberrations are inherited in humans by pedigree analysis in families. The antigen-antibody reaction.

**Course Articulation Matrix: Mapping of Course Outcomes (COs)
with Program Outcomes (POs)**

Course Outcomes (COs) / Program Outcomes (POs)	C C P 1	C C 2	C C 3	C C 4	C C 5	C C 6	C C 7	C C 8	C C 9	C C 10	C C 11
I Core competency	X										
II Critical thinking	X										
III Analytical reasoning	X										
IV Research skills	X										
V Team work	X										

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome

Lab Course Content

List of labs to be conducted	44hrs.
<ol style="list-style-type: none"> 1. Understanding of simple and compound microscopes. 2. To study different cell types such as buccal epithelial cells, neurons, striated muscle cells using Methylene blue/any suitable stain (virtual/slaughtered tissue). 3. To study the different stages of Mitosis in the root tip of <i>Allium cepa</i>. 4. To study the different stages of Meiosis in grasshopper testis (virtual). 5. To check the permeability of cells using salt solution of different concentrations. 6. To learn the procedures of preparation of temporary and permanent stained slides, with available mounting material. 7. Study of mutant phenotypes of <i>Drosophila</i> sp. (from Cultures or Photographs). 8. Preparation of polytene chromosomes (<i>Drosophila</i> larva). 9. Preparation of human karyotype and study the chromosomal structural and numerical aberrations from the pictures provided. (Virtual/optional). 10. To prepare family pedigrees. 11. Revision Lab <ul style="list-style-type: none"> • https://www.vlab.co.in • https://zoologysan.blogspot.com • www.vlab.iitb.ac.in/vlab • www.onlinelabs.in • www.powershow.com • https://vlab.amrita.eduhttps://sites.dartmouth.edu/ 	

References:

1. Alberts et al: Molecular Biology of the Cell: Garland(2002).
2. Cooper: Cell: A Molecular Approach: ASM Press(2000).
3. Karp: Cell and Molecular Biology: Wiley (2002). Pierce B. Genetics. Freeman(2004).
4. Kesar, Saroj and Vasishta N.2007 Experimental Physiology: Comprehensive Manual. Heritage Publishers, NewDelhi.
5. Lodish et al: Molecular Cell Biology: Freeman & Co, USA(2004).
6. Thomas J. Kindt, Richard A. Goldsby, Barbara A. Osborne, Janis Kuby- Kuby Immunology. W H Freeman(2007).

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	35
Practical Internal Assessment	15
Total	50

Course Outcomes and Course Content

under New Education Policy – Year 2021-22 for

II Semester B.Sc., Zoology

Core Course Content

Course Title: Biochemistry and Physiology	Course Credits: 4
Course Code: ZO221	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs. self-study)	Duration of ESA: 3 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Course outcomes:

The student at the completion of the course will learn:

- 1) To develop a deep understanding of structure of biomolecules like proteins, lipids and carbohydrates.
- 2) How simple molecules together form complex macromolecules.
- 3) To understand the thermodynamics of enzyme catalyzed reactions.
- 4) Mechanisms of energy production at cellular and molecular levels.
- 5) To understand various functional components of an organism.
- 6) To explore the complex network of these functional components.
- 7) To comprehend the regulatory mechanisms for maintenance of function in the body.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C C T 1	C C 2	C C 3	C C 4	C C 5	C C 6	C C 7	C C 8	C C 9	C C 10	C C 11
I Core competency	X										
II Critical thinking	X										
III Analytical reasoning	X										
IV Research skills	X										
V Team work	X										

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark ‘X’ in the intersection cell if a course outcome addresses a particular program outcome.

Content	Hours
Unit-I	14
<p>Chapter 1. Structure and Function of Biomolecules:</p> <ul style="list-style-type: none"> • <i>Carbohydrates</i>: Structure and Biological importance of carbohydrates (Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates). • <i>Lipids</i> (saturated and unsaturated Fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids and Steroids) • <i>Proteins</i>: Structure, Classification and General Properties of α-amino acids; , Levels of organization in proteins; Simple and conjugate proteins. Essential and non-essential amino acids (Self study) 	
<p>Chapter 2. Enzyme Action and Regulation</p> <ul style="list-style-type: none"> • Nomenclature and classification of enzymes; Cofactors; Specificity of enzyme action. • Isozymes; Mechanism of enzyme action • Enzyme kinetics; Factors affecting rate of enzyme-catalyzed reactions ; Equation of Michaelis - Menten, Concept of K_m and V_{max}, Enzyme inhibition • Allosteric enzymes and their kinetics; Regulation of enzyme action. 	
Unit 2	14
<p>Chapter 3. Metabolism of Carbohydrates and Lipids</p> <ul style="list-style-type: none"> • Metabolism of Carbohydrates: glycolysis, citric acid cycle, gluconeogenesis, phosphate pentose pathway, Glycogenolysis and Glycogenesis. Lipids Biosynthesis of palmitic acid; Ketogenesis, • β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms. 	

<p>Chapter 4. Vitamins and Metabolism of Proteins</p> <ul style="list-style-type: none"> • Vitamins - Types and Functions (Self-study) • Metabolism of amino acids: Peptide linkages, Transamination, Deamination and Urea cycle. 	
<p>Unit 3</p>	<p>14</p>
<p>Chapter 5. Digestion and Respiration in humans</p> <ul style="list-style-type: none"> • Structural organization and functions of gastrointestinal tract and associated glands. • Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins. • Definition & Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood, Respiratory pigments, Dissociation curves and the factors influencing it. • Nervous control of respiration. 	
<p>Chapter 6. Circulation and Excretion in humans</p> <ul style="list-style-type: none"> • Components of blood and their functions; hematopoiesis • Blood clotting- mechanism, <p>Blood groups: Rh-factor, ABO and MN (Self-study)</p> <ul style="list-style-type: none"> • Structure of mammalian heart; Cardiac cycle - Cardiac output and its regulation, Blood pressure and its regulation and Electrocardiogram • Structure of kidney and its functional unit <p>Mechanism of urine formation.</p>	
<p>Unit IV</p>	<p>14</p>
<p>Chapter 7. Nervous System and Endocrinology in humans</p> <ul style="list-style-type: none"> • Structural organization of the nervous system. Types of neurons • Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers. Types of synapse 	

<ul style="list-style-type: none"> •Endocrinology: Endocrine glands - Structure and Function - Pineal, Pituitary, Thyroid, Parathyroid, Pancreas and Adrenal. • Classification of hormones; Mechanism of Hormone action - Protein (Epinephrine) & Steroid (Testosterone). • <i>Diabetes insipidus</i> and <i>Diabetes mellitus</i>. • Growth hormone disorders- Acromegaly, Gigantism and Dwarfism (Self-study) • Hypothyroidism (Goitre and Cretinism) and Hyperthyroidism (Grave's disease). 	
<p>Chapter 8. Muscular System in humans</p> <ul style="list-style-type: none"> •Histology of different types of muscle; Ultrastructure of skeletal muscle; <p>Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus</p>	

References:

1. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (2016).
2. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
3. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology, XI Edition, Harcourt AsiaPTE Ltd. /W.B.Saunders Company. (2006).
4. Hill, Richard W., et al. Animal physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
5. Nelson & Cox: Leininger's Principles of Biochemistry: McMillan (2000)
6. Murray et al: Harper's Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press
7. Tortora, G.J. & Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
8. Voet & Voet: Biochemistry Vols 1 & 2: Wiley (2004)
9. Zubay et al: Principles of Biochemistry: WCB (1995)

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

End Semester Exam Question Paper Pattern:

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (4 questions)	30
TOTAL		60

PAPER CODE ZO2P1
ZOOLOGY SEMESTER-II
PRACTICAL II
ZO 2P1: BIOCHEMISTRY AND PHYSIOLOGY

Zoology Core Lab Course Content

Course Title/Code: Biochemistry and Physiology	Course Credits: 2
Course Code: ZO2P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs):

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

- Basic structure of biomolecules through model making.
- Develop the skills to identify different types of blood cells.
- Enhance basic laboratory skills like keen observation, analysis and discussion.
Learn the functional attributes of biomolecules in the animal body.
- Know the uniqueness of enzymes in the animal body and their importance through enzyme kinetics.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C C P 1	C C P 2	C C 3	C C 4	C C 5	C C 6	C C 7	C C 8	C C 9	C C 10	C C 11
I Core competency		X									
II Critical thinking		X									
III Analytical reasoning		X									
IV Research skills		X									
V Team work		X									

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Course Content

List of labs to be conducted	Hours
	44
<ol style="list-style-type: none"> 1. Preparation of models of amino acids and dipeptides. 2. Qualitative analysis of Carbohydrates, Proteins and Lipids. 3. Qualitative analysis of Nitrogenous wastes – Ammonia, Urea and Uric acid. 4. Separation of amino acids or proteins by paper chromatography. 5. Action of salivary amylase under optimum conditions. 6. Quantitative estimation of Oxygen consumption by fresh water Crab. 7. Quantitative estimation of salt gain and salt loss by fresh water. 8. Estimation of Hemoglobin in human blood using Sahli's haemoglobinometer and Recording of blood glucose level by using glucometer. 9. Counting of RBC and WBC in blood using Hemocytometer 10. Differential staining of human blood corpuscles using Leishman stain. 11. Revision class <p>Virtual Labs (Suggestive sites)</p> <p>https://www.vlab.co.in</p> <p>https://zoologysan.blogspot.com</p> <p>www.vlab.iitb.ac.in/vlab</p> <p>www.onlinelabs.in</p> <p>www.powershow.com</p> <p>https://vlab.amrita.edu</p> <p>https://sites.dartmouth.edu</p>	

References:

1. Chatterjee CC Human Physiology Volume 1 & 2, 11th edition, CBS Publishers (20 16).
2. Christopher D. Moyes, Patricia M. Schulte. Principles of Animal Physiology. 3rd Edition, Pearson Education (2016).
3. Guyton, A.C. & Hall, J.E. Textbook of Medical Physiology, XI Edition, Hercourt Asia PTE Ltd. /W.B.Saunders Company. (2006).
4. Hill, Richard W., et al. Anima l physiology. Vol. 2. Sunderland, MA: Sinauer Associates, (2004).
5. Murray et al: Harper’s Illustrated Biochemistry: McGraw Hill (2003) Elliott and Elliott: Biochemistry and Molecular Biology: Oxford University Press
6. Nelson & Cox: Leininger’s Principles of Biochemistry: McMillan (2000)
7. Tortora, G.J. &Grabowski, S. Principles of Anatomy & Physiology. XI Edition John Wiley & sons (2006).
8. Voet&Voet: Biochemistry Vols 1 & 2: Wiley (2004)
9. Zubay et al: Principles of Biochemistry: WCB (1995)

Web References:

- Mammalian Physiology– www.biopac.com

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	35
Practical Internal Assessment	15
Total	50

Course Outcomes and Course Content

under New Education Policy – Year 2021-22 for

III Semester B.Sc., Zoology

Core Course Content

Course Title/Code: Molecular Biology, Tools and Techniques in Biology	Course Credits: 4
Course Code: ZO321	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs. self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	Summative Assessment Marks: 60

Core Course prerequisite: To study Zoology in undergraduate, student must have studied Biology or equivalent subject in Class 12.

Course Outcomes (COs):

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

1. The structure and molecular basis of Nucleic acids.
2. The Central Dogma of Molecular biology.
3. The basics of Gene expression and regulation
4. How DNA damage and Repair occurs in cells
5. Familiarize the Basics of tools and techniques used in biology
6. Basics of Bioinformatics as a tool in biology.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C	C	C	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C	C	C	C
	T	2	3	4	5	6	7	8	9	1	1
	1									0	1
I Core competency	X										
II Critical thinking	X										
III Analytical reasoning	X										
IV Research skills	X										
V Team work	X										

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

SEMESTER III

PART A- Molecular Biology		
	CHAPTER 1. NUCLEIC ACIDS	5 hrs
1.1	Structure and Properties of DNA and RNA: DNA as genetic material. Watson and Crick model of DNA, different forms of DNA (A, B and Z) – (self-study) , Chargaff's rule. Structure and functions of different types of RNA - mRNA, tRNA and rRNA.	
	CHAPTER 2. CENTRAL DOGMA IN MOLECULAR BIOLOGY	16 hrs
2.1	DNA replication: Mechanism of prokaryotic DNA replication, models of replications in prokaryotes. Fidelity of replication, Eukaryotic DNA polymerases and mechanism of replication Semi conservative type (Meselson and Stahl expt.)- steps involved in activation, unwinding, formation of RNA primers, Okazaki fragments.	6 hrs
2.2	Transcription: Characteristics and function of bacterial RNA polymerases, mechanism of transcription. Eukaryotic RNA polymerases- transcription factors, mechanism of transcription. Post transcriptional modifications of mRNA (5' CAP formation, polyadenylation, mechanism of splicing	6 hrs
2.3	Translation: Genetic code characteristics, Wobble hypothesis. Mechanism of translation in prokaryotes and eukaryotes. Differences between prokaryotic and eukaryotic protein synthesis, codon usage. Co and post-translational modifications of proteins.	4 hrs
	CHAPTER 3. GENE REGULATION, DNA DAMAGE AND REPAIR	7 hrs
3.1	Regulation of Gene expression: Gene regulation, Operon Model-Inducible and Repressible systems, Lac, Trp operon (self-study); (Attenuation, positive and negative regulation). Regulation of eukaryotic gene expression, transcriptional control, cis control elements, promoters, enhancers, transacting factors.	4 hrs
3.2	DNA damage and Repair: DNA damage- alkylation, deamination, oxidation, UV radiation. Repair mechanisms- excision repair and definitions of photoreactivation, mismatch repair and SOS repair.	3 hrs
PART – B TOOLS AND TECHNIQUES IN BIOLOGY		
	CHAPTER 4. MICROSCOPY	5 hrs
4.1	Working principle and components – Compound microscope (Self-study), fluorescent microscope, Phase-contrast microscope and Electron microscope.	
	CHAPTER 5. CENTRIFUGATION TECHNIQUES	3 hrs

5.1	Types of centrifuges and rotors, Density gradient differential centrifugation and ultracentrifugation	
	CHAPTER 6. PRINCIPLE AND APPLICATIONS OF POLYMERASE CHAIN REACTION	3 hrs
6.1	PCR (Polymerase Chain Reaction), RT- PCR (Reverse Transcriptase) and Q-PCR (Real-time/ Quantitative).	
	CHAPTER 7. PRINCIPLE AND APPLICATIONS OF GEL ELECTROPHORESIS	3 hrs
7.1	Agarose Gel electrophoresis, Native PAGE, SDS-PAGE	
	CHAPTER 8. DNA SEQUENCING AND ANALYZATION	4 hrs
8.1	Di-deoxy method of sequencing, Sanger's method of sequencing, DNA Fingerprinting and RFLP.	
	CHAPTER 9. PRINCIPLE AND APPLICATIONS OF BLOTTING TECHNIQUES	3 hrs
9.1	Southern blotting, Western blotting and Northern blotting (Self-study)	
	CHAPTER 10. CHROMATOGRAPHIC TECHNIQUES	4 hrs
10.1	Paper Chromatography- TLC, Column Chromatography- Ion exchange chromatography, Affinity chromatography and Gel filtration technique	
	CHAPTER 11. BIOINFORMATIC TECHNIQUES	3 hrs
11.1	Introduction NCBI, EMBL, DDBJ. Nucleotide Databases, Search tool: BLAST and FASTA, Local and Globalsequence alignment, Protein Database- PDB	

Reference books:

- Bruce alberts, julianlewis, alexander johnson, j. Lewis, m. Raff (1994), molecular biology of the cell, garland publisher inc., new York
- Cell biology, genetics, molecular biology evolution & ecology, agarwal v. K. And vermap.s , s. Chand & company pvt ltd
- Dhananjaya (2002). Introduction to bioinformatics, www.sd-bio.com series
- Genes and Genomes by Watson.
- Gerald karp (2006). Cell and molecular biology – concepts and experiments. John wiley and sons, inc., new york.
- Harvey lodish, arnold berk, paulmatsudaira, chris a. Kaiser, montykrieger, matthew p. Scott, s. Lawrence zipursky and jamesdarnell. (2003). Molecular cell biology, w.h. freeman and company, new york.
- Higgins & taylor (2000). Bioinformatics.
- Watson, J.D., Baker,a.t. and bell, p.s. (2008). Molecular biology of gene. 5th edition. Pearson education inc.

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

Question Paper Pattern:

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (4 questions)	30
TOTAL		60

ZOOLOGY SEMESTER-III

PRACTICAL III

ZO 3P1: MOLECULAR BIOLOGY, TOOLS AND TECHNIQUES IN BIOLOGY

Zoology Core Lab Course Content

Course Title: Molecular Biology, Tools and Techniques in Biology	Course Credits: 2
Course Code: ZO3P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs):

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

- Extract DNA and Protein from Animal samples.
- Able to Estimate the concentration of Nucleic acids and Proteins in the given samples using colorimeter
- To be familiar with the Tools used in Biology
- Develop the skills to understand the techniques used in biology
- Aware of using Bioinformatic Databases
- To perform Phylogenetic analysis using bioinformatics

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C	C	C	C	C	C	C	C	C	C	C	C
	P	2	3	4	5	6	7	8	9	1	1	1
	1									0		1
I Core competency	X											
II Critical thinking	X											
III Analytical reasoning	X											
IV Research skills	X											
V Team work	X											

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome

List of labs to be conducted	44 hrs.
1. Extraction of Genomic DNA from liver tissue	1 unit
2. Estimation of DNA by Diphenylamine method	1 unit
3. Estimation of RNA by Orcinol method	1 unit
4. Extraction of Protein from animal tissue.	1 unit
5. Estimation of Protein by Lowry's method.	1 unit
6. DNA amplification through PCR [thermocycler]	1 unit
7. Agarose Gel Electrophoresis.	1 unit
8. Types of centrifuges and rotors -Working of Centrifuge.	1 unit
9. Online Databases- NCBI, EMBL and DDBJ, Search tool- BLAST and FASTA.	1 unit
10. Pair wise comparison of sequences, multiple alignments of sequences for Evolutionary studies / Phylogenetic analysis.	1 unit
11. Revision	1 unit
<ul style="list-style-type: none"> • Virtual Labs (Suggestive sites) <ul style="list-style-type: none"> https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu 	

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	35
Practical Internal Assessment	15
Total	50

Course Outcomes and Course Content

Under New Education Policy – Year 2021-22 for

IV Semester B.Sc., Zoology

Core Course Content

Course Title: Immunology, Gene Technology and Histology	CourseCredits: 4
Course Code: ZO421	L-T-P per week: 4-0-0
Total Contact Hours: 56 (52 hours teaching + 4 hrs. self-study)	Duration of ESA: 2 Hours
Formative Assessment Marks: 40	SummativeAssessmentMarks: 60

Course outcomes:

The student at the completion of the course will learn:

- To develop an understanding of the basics in Immunology.
- To learn the basics of the Antigen-Antibody reactions.
- To understand the different immunological reactions.
- To understand the various functional components of Histology.
- To explore the complex network of the various functional components of different tissues.
- To comprehend the various tools and types involved in Gene Technology.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C	C	C	C	C	C	C	C	C	C	C
	P 1	P 2	3	4	5	6	7	8	9	1 0	1 1
I Core competency		X									
II Critical thinking		X									
III Analytical reasoning		X									
IV Research skills		X									
V Teamwork		X									

Note: Course Articulation Matrix relates course outcomes of course with the corresponding programs whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Unit I		
	Chapter 1. INTRODUCTION TO THE IMMUNE SYSTEM	5 hrs
1.1	General concepts of the immune system- Structure, properties and functions of the immune cells & Organs of the Immune System – Thymus, bone marrow, spleen, lymph Node, small Intestine (Peyer’s patches) and liver (Kupffer cells).	
1.2	Hematopoiesis, T and B-lymphocytes, NK cells; Monocytes and macrophages; Neutrophils, eosinophils, and basophils - Mast cells and dendritic cells.	
	Chapter 2. ANTIGENS AND ANTIBODIES	9hrs
2.1	Antigens and Haptens: properties (foreignness, molecular size, heterogeneity).	
2.2	Antibodies: Structure, function and properties of the antibodies; Different classes and biological activities of antibodies; Antibody as B cell receptor, antigenic determinants on antibodies (isotype, allotype and idiotype). Interactions between Antigen-Epitope, Antibody-paratope, Epitope-paratope	
2.3	Major histocompatibility gene complex: Organization of MHC I & II, APC’s. Structure and cellular distribution of HLA antigens.	
2.4	Genesis of antibody variability- VDJ Model	
2.5	Hybridoma technology - monoclonal antibodies (Self-study) and abzymes.	
2.6	Introduction to antibody engineering.	
	Chapter 3. IMMUNITY	7hrs
3.1	Innate and adaptive immunity; Inflammation - general properties Humoral Mediated: Plasma B cells (B - lymphocytes) – Antibody mediated (IgG,IgM, IgA, IgD and IgE) with examples.	
3.2	Cell Mediated: Cell types (CTLs, NK cells, macrophages and T _C T _H cells), effector mechanisms and effector molecules of cell mediated reactions.	
3.3	Assessment of cell-mediated cytotoxicity.	

3.4	Cytokines - properties and functions of interleukins (IL).	
3.5	Hypersensitivity: Types and mechanism of hyper-sensitive reactions.	
3.6	Regulation and modulation of immune response: A general account - Adjuvants, tolerance, immunopotential and immunosuppression.	
	Chapter 4. AUTOIMMUNITY	5hrs
4.1	Mechanisms of induction of organ specific (Hashimoto's thyroiditis, autoimmune anemia, Goodpasture's syndrome, IDDM), Autoimmune Encephalitis and systemic autoimmune diseases (Self-study).	
4.2	Transplantation immunology: Types of grafts, immunologic basis of graft rejection, immunosuppressive therapy and transplants to immunologically privileged sites.	
4.3	Immunity and tumors: tumor antigens (TSTA and TAA), immune response to tumors. Tumor evasion of the immune system and Immunotherapy for tumors.	
	CLINICAL IMMUNOLOGY:	2hrs
4.4	Immunity against viral, bacterial and parasitic infections.	
4.5	Vaccines: Types and uses - Immunization schedule for children (Self-study).	
4.6	Prevention of postnatal diseases: tetanus, diphtheria, whooping cough, cholera, yellow fever, measles and AIDS.	
	Unit 2	
	Chapter 5. GENE TECHNOLOGY	13hrs
5.1	Introduction to genetic engineering - Tools in genetic engineering: DNA manipulative enzymes: Restriction endonucleases types and applications, DNA Ligation.	2hrs
5.2	Cloning vectors and Host: Plasmid (pBR322) Bacteriophage (λ phage), <i>E. coli</i> and its role in genetic engineering	3hrs
5.3	Basic principles of gene cloning strategies - Transformation techniques: CaCl ₂ mediated Transformation, Microinjections, Electroporation and Liposome mediated transfer.	4hrs

5.4	Introduction to Crispr-Cas 9, Production of human Insulin	2hrs
5.5	Application and Ethics - Applications of gene cloning and Ethics in Genetic Engineering (Self-study). Applications of gene cloning in Medicine (Gene therapy).	2hrs
	Unit 3	
	Chapter 6. HISTOLOGY	15hrs
6.1	Histological Structures of Mammalian Organs - Tongue, Stomach, Small Intestine, Liver, Pancreas, Thyroid (self-study), Spleen, Kidney, Pituitary (self-study), Adrenals, Testes and Ovary	

Suggested Readings:

- Abul K Abbas, Andrew K. Litchman and Jordan S. Pober, 2003.
- Brown, T.A. 2000, Gene Cloning, fourth edition, Chapman and Hall Publication, USA.
- C.VRao, 2005. Immunology, 2nd edition, Narosa Publishing House, New Delhi.
- Cellular and Molecular Immunology, 3rd Edition, W.B. Saunders, Philadelphia

- Clark. John Wiley and Sons, W. The Experimental Foundations of Modern Immunology, New York.
- David, Brostoff and Roitt, 2006. Immunology, 7th Ed., Mosby & Elsevier Publishing, Canada, USA.
- Lewin B., 2000, Genes VII, Oxford University Press, Oxford, U.K.
- Lichtman, A. and Pober, W.B. Cellular and Molecular Immunology by Saunders Company, Philadelphia.
- Old R.W. and Primrose S.B., 1996, Principles of Gene Manipulations, Blackwell Science Publications, London.
- Prescott, Harley and Klein's, 2008. Microbiology, 7th edition, Tata McGraw Hill international edition, Page 1-1086.
- Raj Khanna, 2011. Immunology, Oxford University press, New Delhi.
- Richard A. Goldsby, Thomas J. Kindt, Barbara A. Osborne, Janis Kuby, 2003. Immunology, W.H. Freeman, NY.
- Roitt, M and Peter J. Delves, 2005. Essential immunology, 10th Edition, Blackwell, USA.
- SandhyaMitra, 1996, Genetic Engineering, Mac Millan India Ltd., New Delhi.
- Symonds N., A. Toussaint, P. Van De Putte, M.M. Howe, 1987, Phage Mu. Cold Spring harbor Laboratory. 47
- Watson, J.D., N.H.Hopkins, J.W. Roberts, J.A. Steitz and A.M. Weiner, 1998, Molecular Biology of the Gene, fourth edition, The Benjamin/Cummings Publishing Company Inc., Tokyo.
- Winnaker E.L., 1987, From Gene to Clone: Introduction to Gene Technology, VCH Publications, Weinheim Federal Republic German

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
House Examination/Test – Mid semester test	20
Written Assignment/Presentation/Project /Seminar – I-CA-1	10
Written Assignment/Presentation/Project /Seminar – II-CA-II	10
Total	40

End Semester Examination Question Paper Pattern:

Questions	With choices	Total mark
1 mark	10 x 1	10
5 marks	4 x 5 (6 questions)	20
10 marks	3 x 10 (4 questions)	30
TOTAL		60

PAPER CODE ZO4P1
ZOOLOGY SEMESTER-VI
PRACTICAL VI
ZO 4P1: IMMUNOLOGY, GENE TECHNOLOGY AND HISTOLOGY

Zoology Core Lab Course Content

Course Title/Code: Immunology, Gene Technology and Histology	CourseCredits: 2
Course Code: ZO4P1	L-T-P per week: 0-0-4
Total Contact Hours: 44	Duration of ESA: 3 Hours
Formative Assessment Marks: 15	Summative Assessment Marks: 35

Course Outcomes (COs):

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

- Basics of antigen-antibody reactions.
- Develop the skills to identify different types of blood cells.
- Enhance basic laboratory skill like keen observation, analysis and discussion.
- Learn the functional attributes of vaccination and fluorescent staining techniques.
- Know the uniqueness of ELISA Technique.

Course Articulation Matrix: Mapping of Course Outcomes (COs) with Program Outcomes (POs)

Course Outcomes (COs) / Program Outcomes (POs)	C	C	C	C	C	C	C	C	C	C	C
	C	C	C	C	C	C	C	C	C	C	C
	P	P	3	4	5	6	7	8	9	1	1
	1	2								0	1
I Core competency		X									
II Critical thinking		X									
III Analytical reasoning		X									
IV Research skills		X									
V Teamwork		X									

Note: Course Articulation Matrix relates course outcomes of course with the corresponding program outcomes whose attainment is attempted in this course. Mark 'X' in the intersection cell if a course outcome addresses a particular program outcome.

Lab Course Content:

List of labs to be conducted	44hrs
1. Antigen-Antibody reactions – agglutination - Blood grouping: (A, B, O and AB)	1 unit
2. Precipitation – Gel diffusion and Double Diffusion (ODD).	1 unit
3. Virtual Dissection to locate primary and secondary lymphoid organs (any vertebrate)	1 unit
4. Observation of permanent slides of lymphoid organs / tissues.	1 unit
5. ELISA-demo.	
6. Visit to different Institutes and departments related to immunology and vaccine producing laboratories, Diagnostic centers.	1 unit 1 unit
7. Histological Structures of Mammalian Organs - Tongue, stomach, small intestine, liver, pancreas, thyroid, kidney, pituitary, adrenals, testes and ovary.	3 units
8. Restriction and Digestion of Plasmid DNA	1 unit
9. Revision	1 unit
Virtual Labs (Suggestive sites) https://www.vlab.co.in https://zoologysan.blogspot.com www.vlab.iitb.ac.in/vlab www.onlinelabs.in www.powershow.com https://vlab.amrita.edu https://sites.dartmouth.edu	

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

Formative Assessment	
Assessment Occasion	Weightage in Marks
End Semester Examination	35
Practical Internal Assessment	15
Total	50