

TAMIL NADU OPEN UNIVERSITY

Regulations and Syllabi for M.Sc. ZOOLOGY (Non Semester)

(Academic Year 2021-22 onwards)



Department of Zoology

School of Science

Chennai - 600 015

Tamil Nadu, INDIA

TAMIL NADU OPEN UNIVERSITY
Department of Zoology
School of Science

Members of Board of Studies

Chairperson

DR. S. JANARTHANAN

Professor & Head,
Dept. of Zoology
University of Madras
Guindy Campus, Chennai-600025
Mobile No.9486362887
Office: +91044 22202840
Email: janas_09@yahoo.co.in

Internal Faculty Members

DR. T. RAVIMANICKAM

Associate Professor of Zoology,
School of Sciences
Tamil Nadu Open University
Saidapet, Chennai – 15
Mobile. 9786506522
Email : ravimanick2003@gmail.com

DR. S. VINOD KANNA

Assistant Professor of Botany
School of Sciences
Tamil Nadu Open University
Saidapet, Chennai – 15
Mobile:9894800807
Email: winskan@gmail.com

Member Subject Experts

DR. R. THIRUMURUGAN

Professor
Dept. of Animal Science
School of Life Sciences
Bharathidasan University
Tiruchirappalli–620024
Mobile No. 9443094199
Office:+91 4312407040

Email: ramthiru72@gmail.com

DR. V. BALACHANDAR

Assistant Professor

Dept. of Human Genetics and Molecular Biology

Bharathiar University

Coimbatore – 641 046.

Mobile No:+91 9994999924

Office: +91-422-2428514

Email(s): geneticbala@buc.edu.in & geneticbala@yahoo.co.in

DR.G. SINGARAVELU

Associate Professor

Dept. of Zoology

Thiruvalluvar University

Vellore-632 11, Tamil Nadu, INDIA.

Mobile No: 09952395363

Office: 0416-2274900

Email:gsvelu@gmail.com

DR. RITA JAYARAJ

Assistant Professor and Head

Dept. of Zoology

Stella Maris College,

Cathedral Road,

Chennai –

Tamil Nadu INDIA

Mobile No:9840500791

Email; ritajayaraj@gmail.com

Industrialist

MR. A. PARTHASARATHI

Technical Director,

B-Sustain Energy Projects Private Limited

No.38/1, Vinayapuram Ist Main Road,

Arumbakkam, Chennai-600 106.

Mobile No: 9176650001

Office:+91 4423630788

Email: bsustain@gmail.com

DR. M. KAILASAM

Principal Scientist

ICAR-Central Institute of Brackish water Aquaculture (CIBA)

#75, Santhome High Road,
MRC Nagar ,
Chennai, Tamil Nadu. 600028.
Office +91- 044 – 24618817 Ext:405
Email: kailu66@hotmail.com

Student on Roll

P. CHARULATHA (I M.Sc Zoology)
No. 15/17, Narayana street
Periyamet
Chennai – 600 003
Tamil Nadu INDIA
Mobile No: 8695988881
Email: charusruthi@yahoo.com

Master of Science in Zoology

Regulations (Non-Semester)

1. Objective of the Course:

The science that explains the world of animals, their evolutionary development to the present forms over time, their ecological habitats, habits and their co-existence with each other is called 'Zoology'. It is legitimate to raise question the meaning of zoology for starters.

However, imagine how bewildering it would be to observe all these different live forms of our surroundings, some of them with features common to human beings. Moreover, humans appreciate life, nature and animals form highly integral form of our natural surroundings. Thus, knowledge of zoology is an indispensable to explore the wonders of nature in the fullest.

The major objectives of M.Sc. Zoology course are:

- PO-1 To give a thorough understanding in the morphology, comparative anatomy, phylogenic relationships, mode of life of invertebrates and vertebrate animals.
- PO-2 To understand the various physiological mechanisms in animal kingdom.
- PO-3 To acquire knowledge about the cell, molecular biology, developmental biology and concepts of genetics.
- PO-4 To understand the biochemical and biostatistical parameters.
- PO-5 To make the students aware of the basic principles of immunology and immune-technology.

2. Programme Learning Outcomes:

PLO-1 This programme is offered to meet current needs of aspiring youths and adult population and understand the depth of knowledge of animal diversity and physiological mechanisms of animal kingdom.

PLO-2 Analyze the relationships among animals with their ecosystems.

PLO-3 Explain the applications of Zoology in daily life.

PLO-4 Contributes the knowledge for nation building.

PLO-5 Learners gain knowledge and develop skill over animal sciences, understands the interactions among various living organisms.

PLO-6 Learners are able to correlate the physiological and biochemical processes of animals.

PLO-7 Explain the ecological factors, environmental conservation processes and its importance, pollution control, biodiversity and protection of threatened species.

PLO-8 Gain the concepts of genetics and its importance in human health.

PLO-9 Develops empathy and love towards the animals.

3. Programme Specific Outcomes:

PSO-1 Enrich the nature and basic concepts of Cell Biology, Genetics, Animal Physiology, Ecology and Applied Zoology.

PSO-2 Analyse the relationships among animals with their ecosystems.

PSO-3 Perform procedures as per laboratory standards in the areas of Animal Physiology, Ecology, Cell Biology, Genetics, Applied Zoology, Biochemistry and Techniques of Zoology, Sericulture, Biochemistry, Fish Biology, Animal Biotechnology, and Immunology.

PSO-4 Explain farming of animals like Fish Culture, Apiculture, Sericulture etc.

PSO-5 Gains knowledge about animal breeding and its care and contributes the knowledge for Nation building.

PSO-6 Apply the knowledge and understanding of Zoology to one's own life and work.

4. Eligibility:

A candidate who has passed U.G. degree in Zoology/Animal Science/Biotechnology/Microbiology/Biochemistry as a main subject in Part - III of any affiliated Institution/University accepted by syndicate shall be permitted to admission for M.Sc. Zoology programme of this University.

5. Medium: English

6. Duration of the Course:

The course for the degree of Master of Science in Zoology shall consist of two years.

7. Admission

The candidate's admission for the degree of Master of Science in Zoology will be taken in academic year only.

8. Course of Study

The course of study shall comprise the instruction in the following subjects according to the syllabus.

FIRST YEAR	SEMESTER - I	<ol style="list-style-type: none"> 1. Major – I - Structure and Function of Invertebrates 2. Major – II - Comparative Anatomy of Chordata and Vertebrata 3. Major – III – Genetics 4. Practical - Practical I - Covering the major courses I, II and III
	SEMESTER - II	<ol style="list-style-type: none"> 5. Major - IV Animal Physiology 6. Major - V Biochemistry 7. Major - VI Cell & Molecular Biology 8. Elective -Economic Zoology 9. Major VII - Practical I - Covering the major courses I, II and III
SECOND YEAR	SEMESTER – III	<ol style="list-style-type: none"> 10. Major - VIII Developmental Biology 11. Major - IX Biophysics and Biostatistics and Computer Applications 12. Major - XI Biotechnology 13. Major Practical – II - Covering the major courses VIII, IX to X
	SEMESTER IV	<ol style="list-style-type: none"> 14. Major - XIV Environmental Biology 15. Major - XIII Evolution 16. Major - XII Immunology & Microbiology 17. Elective - Aquaculture 18. Major Practical – II - Covering the major courses VIII, IX, X, XI, XII & XIII

9. Examinations:

Theory Examinations: The theory examinations shall be three hours duration to each paper at the end of each year. The candidates who failing in any subject(s) will be permitted to appear for each failed subject(s) in the subsequent examination.

Practical Examinations: The practical examinations shall be three hours duration and the examinations should be conducted at the end of year. Compulsory record should be submitted at the time of practical examination.

10. Scheme of Examinations The scheme of examinations for two years shall be as follows:

Course	Course Code	Course Title	Evaluation			Credits
			CIA	TEE	Total	
I Year - Semester I						
Core I	MZON-11	Structure and Function of Invertebrates	30	70	100	4
Core II	MZON-12	Comparative Anatomy of Chordata and Vertebrata	30	70	100	4
Core III	MZON-13	Genetics	30	70	100	4
Core IV	MZON-14	Cell & Molecular Biology	30	70	100	4
Core V	MZON-15	Animal Physiology	30	70	100	4
Core VI	MZON-16	Biochemistry	30	70	100	4
Core VII	MZON-P1	Practical I - Covering the major course I, II, III, IV, V & VI	30	70	100	8
Elective-1	MZONE-11	Economic Zoology	30	70	100	4
II Year						
Core IX	MZON-21	Developmental Biology	30	70	100	4
Core X	MZON-22	Biophysics, Biostatistics and Computer Application	30	70	100	4
Core XI	MZON-23	Biotechnology	30	70	100	4
Core XII	MZON-24	Immunology & Microbiology	30	70	100	4
Core XIII	MZON-25	Environmental Biology	30	70	100	4
Core XIV	MZON-26	Evolution	30	70	100	4
Core XVI	MZON-P2	Practical II- Covering the major course VIII, IX, X, XI, XII & XIII	30	70	100	8
Elective-2	MZONE-27	Aquaculture	30	70	100	4
Total			540	1260	1800	72

11. Question Pattern for Theory Examinations:

Blue Print of the question paper

Max. Marks: 70

Time: 3 hours

PART - A (5× 2 = 10 marks)

Answer ALL the questions

1. From Unit - I
2. From Unit - II
3. From Unit - III
4. From Unit - IV
5. From Unit - V

PART - B ($4 \times 5 = 20$ marks)

Answer any FOUR questions in about 150 words

All questions carry equal marks

6. From Unit - I
7. From Unit - II
8. From Unit - III
9. From Unit - IV
10. From Unit - V
11. From any unit
12. From any unit

PART - C ($4 \times 10 = 40$ marks)

Answer any FOUR questions in about 500 words.

All questions carry equal marks.

13. From Unit - I
14. From Unit - II
15. From Unit - III
16. From Unit - IV
17. From Unit - V
18. From any unit
19. From any unit

Practical: (External only)

Time: 3 hours

Max.marks:100

1. Major question – system/experiment - 35 marks
2. Minor question – analysis/mounting/experiment - 15 marks
3. Spotters (5 only) (5 x 6) - 30 marks
4. Record note book - 10 marks
5. *viva voce* - 10 marks

12. Passing Minimum:

For theory examination: The candidate shall be declared to have passed the examination if the candidate secures not less than 32 marks in the Term End Examinations (TEE) in each theory paper and secures not less than 13 marks in the Continuous Internal Assessment (CIA) and overall aggregated marks is 50 in both the external and internal taken together.

Continuous Internal Assessment (CIA)		Term End Examination (TEE)		Overall Aggregated Marks	Maximum Marks
Minimum Pass Mark	Maximum Mark	Minimum Pass Mark	Maximum Mark	CIA + TEE	
13	30	32	70	50	100

For practical examination: The candidate shall be declared to have passed the examination if the candidate secures not less than 50 marks in the University practical examination and the mark distributions on results, record note book, procedure writing and *viva voce* taken together is required to pass the examinations.

14. Classification of Successful Candidates:

Candidates who pass all the courses prescribed and who secure 60% and above in the aggregate of marks in Core courses will be placed in the First Class. Those securing 50% and above but below 60% in the aggregated will be placed in the Second Class.

15. Conduct Hours:

Counselling Sessions is fixed as per UGC Deb - 2017 norm (10% of total study hours).



Tamil Nadu Open University
School of Science
Chennai – 600 015

M. Sc. ZOOLOGY SYLLABI - I YEAR (DISTANCE MODE)

COURSE TITLE : STRUCTURE AND FUNCTION OF INVERTEBRATES
COURSE CODE : MZON-11
COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Structure and Function of Invertebrates course, the student shall be able to:

- CO-1** Define and explain organization, symmetry, coelom and metamerism.
- CO-2** Describe the locomotion and nutrition in various phylum of invertebrates.
- CO-3** Compare and explain the respiration and excretion in the species of invertebrates.
- CO-4** Discuss the nervous system of invertebrates.
- CO-5** Explain the various larval forms of invertebrates and their significance.

Block – I Organization – Symmetry, Coelom and Metamerism

Unit -1. Organization: Symmetry in animal organization - symmetry, radial, biradial and bilateral symmetry – significance

Unit - 2. Coelom - Evolution of coelom. Acoelomate, pseudocoelomate, coelomate groups (Schizocoel, Enterocoel, mesenchyme) - Significance

Unit – 3. Metamerism - Evolution of metamerism - Pseudometamerism, cyclo metamerism, corn theory, embryological theory - Significance

Block –II Locomotion and Nutrition

Unit - 4. Locomotion: Flagella and ciliary movement in protozoa

Unit – 5. Hydrostatic movement in Coelenterata, Annelida and Echinodermata

Unit - 6. Nutrition: Patterns of feeding and digestion in lower metazoan

Unit – 7. Filter feeding in Polychaetes, Molluscs and Echinodermata.

Block – III Respiration and Excretion

Unit - 8. Respiration: Organs of respiration: gills, lungs and trachea

Unit – 9. Respiratory pigments

Unit – 10. Mechanism of respiration

Unit – 11. Excretion: Organs of excretion, coelom, coelomoducts, nephridia and Malphigian tubules

Unit – 12. Mechanisms of excretion

Unit – 13. Excretion and osmoregulation

Block – IV Nervous system

Unit – 14. Nervous system

Unit - 15. Primitive nervous system: Coelenterata and Echinodermata

Unit – 16. Advanced nervous system: Annelida, Arthropoda (crustacean and insecta) and Mollusca (cephalopoda)

Block – V Invertebrate larvae

Unit – 17. Invertebrate larvae, Larval forms of free living invertebrates

Unit – 18. Larval forms of parasites

Unit – 19. Strategies and evolutionary significance of larval forms

Unit – 20. Minor Phyla: Concept and significance

COURSE LEARNING OUTCOMES

After completion of the Structure and Function of Invertebrates, the student will be able to:

CLO-1 Describe the organization of symmetry, coelom and evolution of metamerism.

CLO-2 Examine locomotion nutrition, respiration and circulation of invertebrates.

CLO-3 Analysis the development of excretion, respiration, reproduction of animals.

CLO-4 Examine the structure and functions of Nervous System of invertebrates.

CLO-5 Discuss the various larval forms of invertebrates and their significance.

REFERENCES

1. **BARNES, R.D.** (1982), Invertebrate Zoology, IV Ed, Holt Saunders International Edition.
2. **BARRINGTON, E.J.W.** (1979), Invertebrate Structure and Functions, II Ed., ELBS and Nelson.
3. **MOORE, R.C., LOLICKER** and **FISCHER, A.G.** (1952), Invertebrate Paleontology, McGraw Hill Book Co., Inc., New York.
4. **HIGHNAM, K.C.** and **HILL, L.** (1979). The Comparative Endocrinology of Invertebrates, ELBS & Edward Arnold (Publishers) Ltd., London.

5. **HYMAN, G.H** (1967) The invertebrates, Vol. I to VII, McGraw Hill Book Co., Inc., New York.
6. **VASANTIKA KASHYAP** (1997). Life of Invertebrates, Vikas Publishing House Pvt. Ltd., New Delhi.
7. **KOTPAL, R.L** (2002) Minor Phyla, Rastogi Publication, Meerut New Delhi.
8. **JORDAN, E.L., and VERMA, P.S.,** (1993). Invertebrate Zoology, 12th Edition. S. Chand and Co. Ltd., New Delhi.

Weblink

1. <https://encrypted-vtbn0.gstatic.com/video?q=tbn:ANd9GcQuokVYRvhGTWYrJtv0913QAr0MZuB34IfwjA>
2. <https://youtu.be/5b8f3vQqy5c>
3. <https://youtu.be/TFz5xJMd8Ns>
4. <https://youtu.be/2JeS9vkgq64>
5. <https://youtu.be/bak25PZhW28>
6. <https://youtu.be/GWIk4FyPRrk>

COURSE TITLE : COMPARATIVE ANATOMY OF CHORDATA AND VERTEBRATA

COURSE CODE : MZON-12

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Comparative Anatomy of Chordata and Vertebrata course, the student shall be able to:

CO-1 Define and describe the origin of chordates and concepts of origin of chordates.

CO-2 Categorize and explain the classification of vertebrates.

CO-3 Differentiate the general plan of circulation in various groups of vertebrates.

CO-4 Compare the skeletal system of vertebrates.

CO-5 Discuss the sense organs present in the vertebrates.

Block – I Origin of Chordata

Unit: 1. Origin of Chordata

Unit: 2. Concept of protochordata and the nature of vertebrate morphology

Unit: 3. Definition, scope and relation to other disciplines. Importance of the study of vertebrate morphology

Block – II Origin and classification of vertebrates

Unit: 4. Origin and classification of vertebrates

Unit: 5. Vertebrate integument and its derivatives

Unit: 6. Development, general structure and functions of skin and its derivatives

Unit: 7. Glands, scales, horns, claws, nail, hoofs, feathers and hairs

Block – III General plan of circulation in various groups

Unit: 8. General plan of circulation in various groups

Unit: 9. Blood

Unit: 10. Evolution of heart

Unit: 11. Evolution of aortic arches and portal systems

Unit: 12. Respiratory system

Unit: 13. Characters of respiratory tissue

Unit: 14. Internal and external respiration

Unit: 15. Comparative account of respiratory organs

Block – IV Skeletal system

Unit: 16. Skeletal system, Form, function, body size and skeletal elements of the body

Unit: 17. Comparative account of jaw suspensorium, vertebral column

Unit: 18. Limbs and girdles, Evolution of urinogenital system in vertebrate series

Block – V Sense organs

Unit – 19. Sense organs: Simple receptors, Organs of olfaction and taste

Unit – 20. Lateral line system and Electroreception

Unit – 21. Nervous system: Comparative anatomy of the brain in relation to its functions.

Unit –22. Comparative anatomy of spinal cord and Nerves-Cranial, Peripheral and Autonomous nervous system

COURSE LEARNING OUTCOMES

After completion of Comparative Anatomy of Chordata and Vertebrata, the student will be able to:

- CLO-1** Explain the relationships of structure, functions and origin of vertebrates and Chordates.
- CLO-2** Classify the vertebrates based on their structural and functional features.
- CLO-3** Describe the organization of General plan of circulation in various groups, excretion, nervous system, reproduction of animals.
- CLO-4** Explain the structural organization of skeletal structure.
- CLO-5** Comparative analysis organization of sense organs in animals

REFERENCES

1. **WATERMAN, A.J** (1971), Chordate Structure and Function, The Macmillan Company.
2. **COLBERT, H. EDWIN** (1989), Evolution of the Vertebrates, II Ed., Wiley Eastern Limited, New Delhi.
3. **HARREY POUGH, JOHN B. HEISHER, WILLIAM N. McFARLAND** (1990), Vertebrate Life, Macmillan Publishing Co., New York.
4. **JOLLIE, M** (1962), Chordate Morphology, Reinholt Publishing Corporation, NewYork.
5. **KENT, G.C** (1976), Comparitive anatomy of the Vertebrates, McGraw Hill Book Co., Inc., New York.
6. **ROMER, A.S** (1974), The Vertebrate Body, W.B. Saunders, London.

7. **ROMER, A.S** (1979), Hyman's Comparative Vertebrate Anatomy, III Ed., The University of Chicago Press, London.
8. **WEICHERT, C.K** (1965), Anatomy of the Chordates, McGraw Hill Book Co., New York.
9. **NEWMAN, N.H** (1961), Phylum Chordate, The University of Chicago Press, Chicago.

Weblink

1. <https://youtu.be/yT5iR32Sq90>
2. <https://youtu.be/X-EocX4zo8M>
3. https://youtu.be/529mXVmvQ_E
4. <https://youtu.be/y7d1Jj-KpWc>
5. <https://youtu.be/yz7El5jTfsU>
6. <https://youtu.be/44O4ZRNtu-8>
7. <https://youtu.be/WLswe4albqU>

COURSE TITLE : GENETICS
COURSE CODE : MZON-13
COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Genetics course, the student shall be able to:

- CO-1** Discuss the concept DNA as genetic material.
- CO-2** Explain the principles of Mendel's law.
- CO-3** Illustrate the human chromosome and explain the chromosomal conditions in syndromes.
- CO-4** Explain in detail the bacterial genetics.
- CO-5** Define and describe the genetics of human metabolic disorders and diseases.

BLOCK – I DNA as genetic material

- Unit -1. DNA as genetic material - Experimental evidences
- Unit -2. Semi conservative application of DNA
- Unit -3. DNA damage and repair mechanism
- Unit -4. Molecular basis of spontaneous and induced mutations

BLOCK – II Principles of Mendel's law

- Unit -5. Mendel's law – Principles of segregation and independent assortment – deviation from Mendel's findings
- Unit -6. Linkage and crossing over
- Unit -7. Genetic mapping
- Unit -8. Polygenic inheritance – Polygene concept
- Unit -9. Multiple alleles – ABO blood groups in man – Mn blood group – Rh blood group – erythroblastosis foetalis

BLOCK – III Human Chromosomes

- Unit -10. Chromosomal aberration – ploidy – Euploidy & Polyploidy – Aneuploidy
- Unit -11. Syndromes – Turner's, Klinefelter's, Down's syndromes
- Unit -12. Inherited disorders – Sickle cell anemia, Thalassaemia
- Unit -13. Genetic counselling

BLOCK - IV Bacterial genetics

Unit -14. Bacterial genetics – Conjugation, Transformation – Transduction,

Unit -15. Sexduction

Unit -16. Mapping of Bacterial chromosome

BLOCK - V Genetics of human metabolic disorders & diseases

Unit -17. Genetics of human metabolic disorders & diseases

Unit -18. Defects in amino acid, lipid and sugar metabolism

Unit -19. One gene – one enzyme theory; one gene – one polypeptide theory

Unit -20. Oncogenes & cancer

Unit -21. Karyotype study and identification of diseases

Unit -22. Transposons, IS elements

COURSE LEARNING OUTCOMES

After completion of the Genetics, the student will be able to:

CLO-1 Explain the concept of DNA as genetic material.

CLO-2 Describe the principles of Mendel's law.

CLO-3 Define chromosomal aberration and syndromes.

CLO-4 Explain the human metabolic disorders.

CLO-5 Define the bacterial genetics.

REFERENCES:

1. **GARDNER, EJ SIMMONS, MJ. SNUSTAD, DP** (1991) Principles of Genetics, 8th edition, John Wiley & Sons, UK.
2. **BENJAMIN LEVIN** (2005) Genes VIII, Oxford University Press, New York.
3. **STRICKBERGER**, (2002), Genetics, 3rd edition, Prentice Hall of India.
4. **BENJAMIN LEWIN** (2000), Genes VII, Oxford University Press. UK.
5. **BROOKER** (1999) Genetics: Analysis and Principles , Addison-Wesley the University of Wisconsin – Madison
6. **DANIEL L. HARTL** (1996) Genetics, III Ed., Jones Bartlett Publishers. UK
7. **URSULA GOODENOUGH** (1984) Genetics, Saunders College Publishing Co., London.
8. **DANIEL L. HARTL** (1996) Genetics, III Ed., Jones Bartlett Publishers. UK.

9. **URSULA GOODENOUGH** (1984) Genetics, Saunders College Publishing Co.,
London.

Weblink

1. <https://youtu.be/JI6gsjPB1RU>
2. <https://youtu.be/jWcqZiGuoAM>
3. <https://youtu.be/z481uPMkfZI>
4. <https://youtu.be/tnqO-mqfg8w>
5. https://youtu.be/7_p14l8gPhk
6. <https://youtu.be/mg6tXQaiBaI>
7. https://youtu.be/n7Z5-mRB_gI
8. <https://youtu.be/ydYv45ARMSY>

Semester II

COURSE TITLE : CELL AND MOLECULAR BIOLOGY
COURSE CODE : MZON-14
COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Cell and Molecular Biology course, the student shall be able to:

- CO-1** Give detailed explanation of the structure of cell.
- CO-2** Illustrate the various organelles of cells along with their functions.
- CO-3** Describe the structure of nucleus and internal structure of nucleus.
- CO-4** Elaborately explain the step-by-step process of cell cycle.
- CO-5** Explain the DNA structure and their functions.

BLOCK - I Cell Structure

- Unit -1. Cell Structure: Cellular and structural organization
- Unit -2. Prokaryotes and Eukaryotes
- Unit -3. Cytoskeleton – Microfilaments – Microtubules – Cilia and flagella
- Unit -4. Plasma membrane – Ultra structure and functions
- Unit -5. Membrane associated receptors
- Unit -6. Extra cellular space – Cell adhesion – Inter cellular junctions

BLOCK – II Cell Organelles

- Unit -7. Cell Organelles: Structure and function of cell organelles
- Unit -8. Endoplasmic reticulum – Golgi apparatus – Lysosome – Ribosome – Centrosome
- Unit -9. Mitochondria Structure and function – Glycolysis, Krebs cycle, Respiratory chain, Oxidative phosphorylation

BLOCK – III Nucleus

- Unit -10. Nucleus – Nuclear envelope
- Unit -11. Structure and function of chromatin – Organization of nucleosome
- Unit -12. Euchromatin and Heterochromatin – Unusual chromosomes – Polytene and Lampbrush chromosomes
- Unit -13. Mechanism of chromosome formation and Nucleolus

BLOCK – IV Cell Cycle

Unit -14. Cell Cycle: Cell cycle and its components – Spindle organization – Chromosome movements

Unit -15. Synchronisation of cell division – Mitosis and Meiosis

Unit -16. Differences between normal and cancer cells – Membrane, biochemical, nuclear and chromosomal changes in cancer cells

BLOCK – V DNA structure and Function

Unit -17. DNA structure and Function – Watson & Crick Model

Unit -18. Types of DNA & RNA

Unit -19. DNA Replication – DNA Transcription – Genetic Code

Unit -20. Protein synthesis

COURSE LEARNING OUTCOMES

After completion of the Cell and Molecular Biology, the student will be able to:

- CLO-1** Explain the structure and functions of cell and give a comparative analysis of Prokaryotic and Eukaryotic cells.
- CLO-2** Comparative analysis of cellular and inter cellular organelles.
- CLO-3** Describe the structure and function of nucleus.
- CLO-4** Explain the importance of cell cycle and divisions.
- CLO-5** Elucidate the structure and function of DNA.

REFERENCES:

1. **DEROBERTIS, E.D.P & DEROBERTIS, E.M.F.** (1981), Essentials of Cell and Molecular Biology. Saunders International Edition, New York.
2. **KARP. G** (1985) Cell Biology, 2nd edition, McGraw Hill, New York.
3. **ALBERTS, B. BRAY, D. LEWIS, J. RAFF, M. ROBERTS, K AND J WATSON, J.D** (1994) Molecular Biology of the Cell, 3rd Edition, Garland Publishing, New York.
4. **KORNBERG, A.** (1974), DNA Replication, W.H. Freeman and Company, New York.
5. **HOWLAND, J.L** (1973), Cell Physiology, Macmillan Publishing Co. London.

Weblink

1. <https://youtu.be/t5DvF5OVr1Y>

2. <https://youtu.be/ZyWYID2cTK0>
3. https://youtu.be/DSfkBzOy_YE
4. <https://youtu.be/IJ-9K8o6FrE>
5. <https://youtu.be/PQhQ80UGwBo>
6. <https://youtu.be/yRLQKZzFb68>
7. <https://youtu.be/RA9n0Enu5Gw>
8. <https://youtu.be/6rv5Z8EBXwY>
9. <https://youtu.be/NDIJexTT9j0>

COURSE TITLE : ANIMAL PHYSIOLOGY

COURSE CODE : MZON-15

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Animal Physiology course, the student shall be able to:

CO-1 Define blood and explain the composition of blood.

CO-2 Describe the cardiovascular system.

CO-3 Illustrate the respiratory system and nervous system anatomically and functionally.

CO-4 Recognize and explain the sense organs and their functions in various animals.

CO-5 Explain the thermoregulation and endocrinology in different animals.

BLOCK – I Blood

Unit - 1. Blood and circulation - Blood corpuscles, haemopoiesis and formed element

Unit – 2. Plasma function, blood volume and blood volume regulation

Unit – 3. Blood groups, haemoglobin, immunity and haemostasis

Unit – 4. Digestive system - Digestion, absorption, energy balance, BMR

BLOCK – II Cardiovascular System

Unit – 5. Cardiovascular System: Comparative anatomy of heart structure

Unit – 6. Myogenic heart, specialized tissue and ECG – its principle and significance

Unit – 7. Cardiac cycle, heart as a pump, blood pressure, neural and chemical regulation of all above

BLOCK –III Respiratory system

Unit – 8. Respiratory system - Comparison of respiration in different species, anatomical considerations

Unit – 9. Transport of gases, exchange of gases, waste elimination, neural and chemical regulation of respiration

Unit – 10. Nervous system – Neurons and Action potential

Unit – 11. Gross neuroanatomy of the brain and spinal cord

Unit – 12. Central and peripheral nervous system, neural control of muscle tone and posture

BLOCK – IV Sense organs

Unit – 13. Sense organs - vision, hearing and tactile response

Unit – 14. Excretory system - comparative physiology of excretion, kidney, urine formation, urine concentration, waste elimination

Urine – 15. Regulation of water balance, blood volume, blood pressure, electrolyte balance, acid-base balance

BLOCK – V Thermoregulation and Endocrinology

Urine - 16. Thermoregulation - comfort zone, body temperature

Unit – 17. Physical, chemical, neural regulation, acclimatization

Unit – 18. Endocrinology and reproduction - Endocrine glands, basic mechanism of hormone action

COURSE LEARNING OUTCOMES

After completion of the Animal Physiology, the student will be able to:

- CLO-1** Explain the composition of blood and digestion in animals.
- CLO-2** Describe the detailed concepts of cardiovascular system of animals.
- CLO-3** Discuss the respiratory system and nervous system of animals.
- CLO-4** Import the knowledge about the sensory organs and their functions.
- CLO-5** Differentiate about the Physiological response to body exercise and explain the concept of thermoregulation and endocrine glands.

REFERENCES:

1. **HOAR, W.S** (1968), General and Comparative Physiology, Prentice Hall, New Jersey
2. **PROSSER, C.L** (1973), Comparative Animal Physiology, 3rd edn. W.B. Saunders & Co., Philadelphia.
3. **WOOD, D.W** (1968), Principles and Animal Physiology. 3rd edn. Edward Arnold, London.
4. **BENTLEY** (1971), Endocrine and osmoregulation, Springer Verlag, New York.
5. **PALMEN, J.D. BROWN, J.R. AND HASTINGS, J.W** (1970), Biological clocks, Academic Press, London.
6. **SCHIEMDT NIELSEN** (1997) Animal Physiology: Adaptation and Environment. Cambridge.
7. **STRAND, F.L** (1978) Physiology: A regulation System Approach. Macmillan Publishing Co., New York.

Weblink

1. <https://youtu.be/yj7bfZKlIp8>
2. <https://youtu.be/Vr72mSL5GSo>
3. <https://youtu.be/ZkqJDsQR2kk>
4. <https://youtu.be/xIZQRjkwV9Q>
5. <https://youtu.be/9j6BpanhpKY>
6. <https://youtu.be/pDr6DDRHvUY>
7. https://youtu.be/C_LiAEjuIc
8. <https://youtu.be/qYDiL2PNOoc>

COURSE TITLE : BIOCHEMISTRY

COURSE CODE : MZOS-16

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Biochemistry course, the student shall be able to:

CO-1 Define biomolecules and identify different types of biomolecules.

CO-2 Illustrate the structure and functions of nucleic acids and enzymes.

CO-3 Classify and describe the vitamins and hormones.

CO-4 Explain the process of cell respiration and carbohydrate metabolism.

CO-5 Describe the steps and process involved in the metabolism of protein.

BLOCK – I Biomolecules

Unit -1. Study of Biomolecules: Structure, Properties, Analytical tests and Functional Significance of Carbohydrates (mono,di and poly saccharides)

Unit – 2. Lipids (fatty acids, triglycerids and steroids)

Unit – 3. Proteins (amino acid classification)

BLOCK – II Nucleic Acid and Enzymes

Unit – 4. Nucleic Acid and Enzymes: Molecular structure, Types and Properties of DNA and RNA

Unit – 5. Biosynthesis of Purines and Pyrimidine

Unit – 6. Enzymes: Types, Kinetics and Mechanism of Action

Unit – 7. Enzyme inhibition, Coenzymes (NAD,FAD) and Cofactors

BLOCK – III Vitamins and Hormones

Unit – 8. Vitamins and Hormones: Vitamins: Types and Occurrence

Unit – 9. Classification, Structure, Properties, Functions and Deficiency symptoms

Unit – 10. Animal hormones: Classification and Salient features

Unit – 11. Biochemical Properties and Functions: Pituitary, Thyroid, Parathyroid, Adrenal, Reproductive, Placental, Thymus, Pineal and Gastrointestinal glands

Unit – 12. Prostaglandins

BLOCK – IV Cell Respiration and Carbohydrate Metabolism

Unit – 13. Cell Respiration and Carbohydrate Metabolism: Cell Respiration and Biological Oxidations

Unit – 14. Bioenergetics – High energy compounds – Biological oxidation – Electron Transport chain – Oxidative Phosphorelation

Unit – 15. Enzymes involved in Biological oxidation

Unit – 16. Free radicals and Antioxidants

Unit – 17. Carbohydrate Metabolism: Glycolysis - Kreb's cycle – Gluconeogenesis – Glycogenesis – Glycogenolysis - HMP Shunt – Electron Transport System

BLOCK –V Protein Metabolism

Unit – 18. Protein Metabolism: Metabolism of Amino acid

Unit – 19. Ammonia and Urea cycle

Unit - 20 Disorders of Amino acid metabolism – Phenylketoneuria and Albinism

Unit – 21. Lipid Metabolism: Metabolism of Triglycerols, Fatty acid oxidation

COURSE LEARNING OUTCOMES

After completion of the Biochemistry, the student will be able to:

- CLO-1** Explain the basic concepts of Biomolecules.
- CLO-2** Describe the detailed structure and functions of nucleic acids and enzymes.
- CLO-3** Differentiate the vitamins and their biological role.
- CLO-4** Discuss the process and steps involved in cell respiration and carbohydrate metabolism.
- CLO-5** Explain the metabolism of protein.

REFERENCES:

1. **STRYER, L** (1988), Biochemistry, W.H. Freeman and Company, New York.
2. **COOPER, T.G** (1977), The Tools of Biochemistry, Wiley Interscience Publication, John Wiley and Sons, New York.
3. **SMITH** (1983), Principles of Biochemistry, 7th edn. McGraw Hill (Mammalian Biochemistry). New York.
4. **VOET, D. & VOET, J** (1995), Biochemistry, John Wiley and Sons, New York.
5. **LEHNINGER, L.** (2012) Biochemistry 6th Edn. W.H. Freeman Co. London.

Weblink

1. <https://youtu.be/H8WJ2KENIK0>
2. <https://youtu.be/9dMsDgWMq1w>

3. <https://youtu.be/KjqLFs4YKHo>
4. <https://youtu.be/4AzHoPe48Yg>
5. <https://youtu.be/z2JEDeGkfCc>
6. <https://youtu.be/0lZRAShqt0>
7. <https://youtu.be/5m4fUrocEdg>
8. <https://youtu.be/2f7YwCtHcgk?list=PLbKSbFnKYVY3iv3oH0dFv14x1QrpYropw>
9. https://youtu.be/15Fezs8uG_c
10. https://youtu.be/-fy8-owt6sk?list=PLRpz4J5dUMCf0Jk8oojz_5TuaXtPNLmX

COURSE TITLE : ECONOMIC ZOOLOGY
COURSE CODE : MZONE-11
COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Applied Zoology course, the student shall be able to:

- CO-1** Explain the beneficiary and harmful insects along with their economic importance.
- CO-2** Define aquaculture and describe the principles, scopes, merits and demerits of aquaculture.
- CO-3** Explain the methods and techniques of apiculture.
- CO-4** Discuss the culturing techniques involved in sericulture.
- CO-5** Describe poultry farming disease management in poultry birds.

BLOCK – I Beneficial and harmful insects

Unit -1. Beneficial and harmful insects, including insect vectors of human diseases (Mosquito and Lice)

Unit -2. Pests of sugar cane (*Pyrrilla perpusilla*)

Unit -3. Pests of oil seed (*Achaea janata*)

Unit -4. Pests of rice (*Sitophilus oryzae*)

BLOCK – II Aquaculture

Unit -5. Aquaculture: Principles, definition and scope

Unit -6. Exotic fishes-their merits and demerits

Unit -7. Basic principles of different aquaculture system (Polyculture and integrated farming)

Unit -8. Culture of prawn

Unit -9. Pearl culture

BLOCK – III Apiculture

Unit -10. Apiculture: Development of Apiary in India

Unit -11. Types of honey bees

Unit -12. Modern methods of apiary management

Unit -13. Products and its uses

Unit -14. Problems and prospects

BLOCK – IV Sericulture

Unit -15. Sericulture: Life history and rearing of *Bombyx mori*, harvesting & processing of cocoon, reeling and extraction of silk

Unit -16. Diseases of worms of *Bombyx mori* and control measures

BLOCK – V Poultry Farming

Unit -17. Poultry: Fowl -Types of breeds

Unit -18. Rearing of Fowl

Unit -19. Disease management

COURSE LEARNING OUTCOMES

After completion of the Applied Zoology, the student will be able to:

- CLO-1** Explain the basic concepts of insect vectors and comment on beneficial and harmful insects.
- CLO-2** Describe fish culture, prawn culture, apiculture etc.
- CLO-3** Discuss about rearing techniques and disease management of apiculture.
- CLO-4** Discuss about rearing techniques and disease management of sericulture.
- CLO-5** Elucidate the concepts and importance of poultry farming.

REFERENCES:

1. **AYYAR, E. K. & T. N. ANANTHAKRISHNAN** (2000), Manual of Zoology Vol. I & II (Non – Chordata and Chordata), S. Viswanathan (Printers and Publishers) Pvt. Ltd., Madras.
2. **SHUKLA & UPADHYAY** (2014) Economic Zoology, 5th edn. Rastogi Publication, Meerut New Delhi.
3. **KOTPAL, R. L.** (2000), Modern Textbook of Zoology, Rastogi Publications (2000) Meerut New Delhi.
4. **H. R. SINGH AND N. S. LAKRA** (2000) Coldwater Aquaculture and Fisheries, Narendra Publishing House, New Delhi.
5. **SANTOSH KUMAR AND MANJU TEMBHARE** (2010) Fish and Fisheries, New Central book Agency (P) LTD, London.
6. **PITCHER, T. J. & P. J. E. HART** (1992) Fisheries Ecology, Room Helm, London.

Weblink

1. https://youtu.be/FjB_4qwqnWA
2. https://youtu.be/DQxwoK_mvBg
3. <https://youtu.be/IKzkUBu1KIk>

4. <https://youtu.be/bz57wCVGJO0>
5. <https://youtu.be/hgrq4zmSUOw>
6. <https://youtu.be/1EhRqb2mylI>

COURSE TITLE : **PRACTICAL – I (Covering the major course IV, V & VI)**
COURSE CODE : **MZON-P1**
COURSE CREDIT : **8**

COURSE OBJECTIVES

While studying the Practical - I course, the student shall be able to:

- CO-1** First-hand on training about identification of non-chordate and chordate specimens (fresh and preserved) along with larval forms and study of endoskeleton of vertebrates.
- CO-2** Examine the invertebrate and vertebrate fossils.
- CO-3** Learners are examining the cell division by Onion root.
- CO-4** Comparative analysis of cell types
- CO-5** Learners are able to conduct quantitative analysis of salivary amylase and Quantitative analysis of haemoglobin.

Structure and Functions of Invertebrata

Major Practicals:

Earthworm - Nervous system

II. Minor Practicals: Earthworm -

Body setae - Mouth parts – Honey Bee, Housefly, Mosquito and Cockroach

I. Spotters:

- a) Classify giving reasons: *Entamoeba*, Hydra, *Ascaris*, Earthworm, *Penaeus*, Crab, Rhinoceros beetle, Freshwater mussel, Starfish, and Sea cucumber
- b) Draw Labeled Sketch: T.S. of *Taenia*, T.S. of *Fasciola*, Nauplius larva, Zoea larva
- c) Biological Significance: *Physalia*, Peripatus
- d) Relate structure and function: *Taenia – Scolex* , Nereis – Parapodium, Star fish –Tube feet

Spotters

Beneficial (Silkworm and Honey bee) and harmful insects (Mosquito and Lice)

Carps – Catla, Mirgal, rohu

Prawn - *Penaeus*

Comparative Anatomy of Chordata and Vertebrata

Major Practicals: Virtual laboratory technique: Video clippings of Arterial system, Venous system, Digestive system and Reproductive system of Frog / (Fish, Birds). Demonstration Dissection: digestive system, nervous system and reproductive system of Fish, Brain of Frog.

Minor Practicals: Mounting: Placoid Scale of Shark, Teleost Fish (Ctenoid, Cycloid types), Gills and Fins of fish, Feathers (Ultra structure)

Museum specimens and slides

Classify giving reasons:

- a) Amphioxus, Balanoglossus, Tilapia, Cat fish, Duck, Eagle, Viper, Cobra
- b) Draw Labelled Sketch: T.S of Amphioxus, Pectoral girdle, Pigeon - Pelvic girdle
- c) Biological Significance: Ascidian tadpole larva, Chameleon
- d) Give adaptive significance: Exocetus. Ambystoma, Sphenodon, Bird, Bat

Genetics

Mendelian traits, Pedigree chart - Explanation, Human Karyotype, Human Syndromes
Down's syndrome, Turner's syndrome and Klinefelter's syndrome

Cell Biology & Molecular Biology

1. Squash preparation – Onion root tip
2. Squamous epithelial cells

Spotters

1. Cell types – Epithelium, Muscle, Nerve cell, Bone cell

Animal Physiology and Biochemistry

1. Quantitative estimation of salivary amylase
2. Quantitative estimation of haemoglobin (Sahli's Method)
3. Enumeration of RBC & WBC
4. Qualitative test for Ammonia, Urea and Uric acid
5. Qualitative test for Protein, Carbohydrate and Lipid

COURSE LEARNING OUTCOMES

After completion of the Practical - I, the student will be able to:

- CLO-1** Learners are first-hand on training about identification of non-chordate and chordate specimens (fresh and preserved) along with larval forms and study of endoskeleton of vertebrates.
- CLO-2** Explain the invertebrate and vertebrate fossils and their evolutionary importance.
- CLO-3** Comparative analysis of various stages of cell division in onion root and Analysis of cell structure, functions and their types.
- CLO-4** Describe the quantitative analysis of salivary amylase and quantitative analysis of haemoglobin, ammonia, urea and uric acid.

CLO-5 Learners are taught about various parameters of haematology

WEBLINK

1. <https://youtu.be/I6xrTOYnhG0>
2. <https://youtu.be/rQDsAI9uDyI>
3. <https://youtu.be/Hx8mXeRtOlo>
4. <https://youtu.be/vA26UI htIU>
5. <https://youtu.be/Wovq3rds8eM>
6. <https://youtu.be/QOK-uHCr0HE>
7. <https://youtu.be/SUtejgI6vUs>
8. <https://youtu.be/rGrHDmwI-2Q>
9. <https://youtu.be/8p-GAX4Xb2A>
10. <https://youtu.be/wylff4jVhJ0>
11. <https://youtu.be/-7zeezjNxzE>
12. <https://youtu.be/QPcFOlb6Ly0>
13. https://youtu.be/Iy_KYSBcZF0
14. <https://youtu.be/s53Wn5O0J0M>
15. <https://youtu.be/GbBcqQKfhFI>
16. <https://youtu.be/D8zMM98YR6s>
17. <https://youtu.be/wOakTEMqyk4>

M. Sc. ZOOLOGY - II YEAR SYLLABUS

COURSE TITLE : DEVELOPMENTAL BIOLOGY

COURSE CODE : MZON-21

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Developmental Biology course, the student shall be able to:

CO-1 Describe the structural development and fertilization of gametes.

CO-2 Elucidate the process of patterns in the embryonic cleavage.

CO-3 Explain the organogenesis in vertebrates and influence of hormones in the growth and metamorphosis in amphibians.

CO-4 Summarize the advanced techniques in developmental biology.

CO-5 Discuss the assisted reproductive technology, birth control and its needs.

BLOCK -I: Structure of gametes

Unit - 1. Structure of gametes – the egg and sperm

Unit - 2. Fertilization

Unit -3. Cellular differentiation, morphological, physiological, chemo-differentiation and cyto-differentiation

BLOCK -II: Cleavage

Unit -4. Cleavage, blastulation, pattern of embryonic cleavage, mechanism and control of cleavage

Unit -5. Amphibian Gastrulation

Unit -6. Totipotency and pluripotency

Unit -7. Morphogenic movements

Unit -8. Formation of extra embryonic membranes

BLOCK -III: Organogenesis

Unit -9. Organogenesis - Development of eye

Unit -10. Influence of hormones on growth and metamorphosis of insects and amphibians

Unit -11. Regenerative ability in various invertebrates and vertebrates

Unit -12. Mechanism of regeneration in amphibians-blastema formation – Factors affecting regeneration

Unit -13. Aging and alterations in development – Gene regulation of aging

BLOCK – IV Advanced Techniques in Developmental Biology

Unit -14. Advanced Techniques in Developmental Biology: Cell differentiation and Stem cells

Unit – 15. Applications of stem cells

Unit – 16. Control of transcription involving tissue specific transcription regulators

BLOCK –V Assisted Reproductive Technology

Unit – 17. Assisted Reproductive Technology (ART)

Unit – 18. Super ovulation, ICSI, GIFT- Artificial insemination – *In vitro* fertilization – Human development – Placentation

Unit -19. Birth control and its need

COURSE LEARNING OUTCOMES

After completion of the Developmental Biology, the student will be able to:

- CLO-1** Elucidate the structural organization of gametes.
- CLO-2** Illustrate the cleavage, blastulation and gastrulation.
- CLO-3** Elaborately explain the Organogenesis of animals.
- CLO-4** Describe the assisted reproductive technology.
- CLO-5** Discuss about the hormones and endocrine mechanisms and relation with Developmental Biology.

REFERENCES:

1. **BALINSKY, B.L** (1981) An Introduction to Embryology, 5th Edn. Saunders Co., Philadelphia.
2. **BERRIL & CORP** (1983) Developmental Biology. Mc Graw Hill Book Company, New York.
3. **BERRILL, N. J** (1986) Developmental Biology, Tata McGraw Hill, New York.
4. **MAJUMDAR, N. N** (1990) Text book of Vertebrate embryology. Tata McGraw-Hill publishing company Ltd., New Delhi.
5. **GILBERT, S.F.** (1995) Developmental Biology, II Edn. Sinamer Associates Inc. Publishers Sanderland, Massachusetts, USA.

Weblink

1. <https://youtu.be/Yy5E13LWgBg>

2. <https://youtu.be/H5hqwZRnBBw>
3. <https://youtu.be/W8xx975RtP4>
4. <https://youtu.be/yP8zWLruBDA>
5. <https://youtu.be/t-86dB3JkBw>
6. <https://youtu.be/Kdhqc8MVfNI>
7. <https://youtu.be/E0PeAsNdKug>

COURSE TITLE : BIOPHYSICS AND BIOSTATISTICS AND COMPUTER APPLICATIONS

COURSE CODE : MZON-22

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Biophysics and Biostatistics course, the student shall be able to:

CO-1 Define and explain the structure and properties of atoms and molecules.

CO-2 Explain the working principles and applications of bioinstruments.

CO-3 Access the biostatistics tool for data analysis, sampling and presentation.

CO-4 Describe the measures of central tendency and correlation.

CO-5 Elucidate the computation of biology.

BLOCK – I Structure and properties of atoms and molecules

Unit -1. Structure and properties of atoms and molecules

Unit -2. Energy sources – Principle and application of thermodynamic laws

Unit -3. Natural radiations – Properties of natural light

Unit -4. Photoelectric effect – Photodynamic sensitization

Unit -5. LASER – Concept of spectroscopy - Visible, NMR spectroscopy, Atomic absorption and plasma emission spectroscopy

Unit -6. Measurement of radio activity – Geiger Muller counter – Isotopes as tracers

BLOCK – II Principles and application of chromatography and Electrophoresis

Unit -7. Principles and application of chromatography – Paper – Thin layer – Column – Ion – exchange

Unit -8. Gel filtration – Gas liquid – HPLC and Affinity chromatography

Unit -9. Principles and applications of electrophoresis – Paper electrophoresis – Agarose gel electrophoresis – PAGE – SDS-PAGE

Unit -10. Immunoelectrophoresis – Isoelectric focussing

BLOCK – III Introduction to Biostatistics

Unit -11. Primary and Secondary data – methods of data collection – processing of data – classification and tabulation organization of data

Unit -12. Individual, discrete and continuous series

Unit -13. Sampling designs - Diagrammatic and graphic presentation of data – Bar diagram – Pie diagram

Unit -14. Frequency polygon – frequency curve – histogram

BLOCK –IV Measures of central tendency and Correlation

Unit -15. Measures of central tendency – mean, median, and mode

Unit -16. Measures of dispersion – range, standard deviation and variance – standard error

Unit -17. Correlation – rank correlation, coefficient of correlation – simple linear regression

BLOCK –V Computation of Biology

Unit -18. Definition of computer –types – basic components of computer

Unit -19. Input and output devices

Unit -20. CPU – memory and its types – number system in brief – brief account of software and hardware

Unit -21. Introduction to MS Excel – MS Power Point – Internet, website, browser (explorer and Mozilla) and Email

Unit -22. Computer application in biology

COURSE LEARNING OUTCOMES

After completion of the Biophysics and Biostatistics, the student will be able to:

- CLO-1** Describe the structural properties of atoms and molecules.
- CLO-2** Explain the principles, procedure and applications of bioinstruments.
- CLO-3** Explain the bio- statistical tools for data analysis and its important.
- CLO-4** Describe the principles, concepts of thermodynamic laws
- CLO-5** Explore the fundamentals of computer and application in biology.

REFERENCES

1. **DANIEL, M.** (1989), Basic Biophysics for Biologists, Agro-Botanical Publishers, Bikaner, India.
2. **DE ROBERTIS, E.D.P. AND DE ROBERTIS E.M.F.** (1987), Cell and Molecular Biology, VIII Edition, Lea and Febiger, Philadelphia.
3. **DOG, A. DOUGLAS and JAMES J. LEARY** (1992), Principles of Instrumental Analysis, Under Golden Sunberst Series.

4. **DAS.H.K** (2005). Text Book of Biotechnology. Wiley Dreamtech, India, Pvt Ltd, New Delhi.
5. **BAILEY, N.Y.J** (1997), Statistical Methods in Biology, III Ed, Cam University Press, N.Y.
6. **SOKAL, R & JAMES, F** (1973), Introduction to Biostatistics, W.H.Freeman And Company LTd, Tokyo, Japan.

Weblink

1. <https://youtu.be/vlSOESXQI7o>
2. <https://youtu.be/8N1BxHgsoOw>
3. <https://youtu.be/oYnp0WZDhYQ>
4. <https://youtu.be/SnbXQTTHGs4>
5. <https://youtu.be/mN5IvS96wNk>
6. https://youtu.be/mhJzr_C2V6M
7. https://youtu.be/_e4mwlqCQrc
8. <https://youtu.be/LAIufwyOFSY>
9. <https://youtu.be/eyFGZjiqLGg>

COURSE TITLE : BIOTECHNOLOGY

COURSE CODE : MZON-23

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Biotechnology course, the student shall be able to:

CO-1 Define and sketch the tools and techniques involved in the genetic engineering.

CO-2 Describe the molecular techniques involved in the biotechnology.

CO-3 Elucidate the process, technique and applications of fermentation.

CO-4 Explain the animal and medical biotechnology.

CO-5 Discuss the industrial biotechnology and their applications in various field.

BLOCK –I Genetic engineering

Unit -1. Basic principles of genetic engineering

Unit -2. Gene cloning

Unit -3. Tools – Enzymes and Vectors

Unit -4. Gene cloning strategies

BLOCK -II Molecular techniques in Biotechnology

Unit -5. Molecular techniques in Biotechnology, Southern, Northern and Western blotting

Unit -6. PCR- Principles, types and applications

Unit -7. DNA sequencing and DNA finger printing

Unit -8. Gene transfer methods

BLOCK -III Fermentation

Unit -9. Fermentation- Process and types

Unit -10. Applications of biotechnology in the field of medicine

Unit - 11. Applications of biotechnology in the field of agriculture

Unit – 12. Applications of biotechnology in the field of industry and in pollution control

BLOCK- IV Animal and Medical Biotechnology

Unit – 13. Animal and Medical Biotechnology: Animal cell culture technology: Organ culture - whole embryo culture

Unit – 14. Embryo transfer in human and transgenic animal

Unit – 15. Methods involved and applications– Stem cell culture and preservation. DNA in disease diagnosis– DNA Probes, chip & Microarray

Unit – 16. Gene Therapy– *Ex vivo* and *in vivo* therapy

Unit – 17. Vectors used for gene therapy and Recombinant vaccines

BLOCK – V Industrial Biotechnology

Unit – 18. Industrial Biotechnology: Fermentation– Types– Fermenter designs

Unit 19. Scale up microbial process Upstream and Downstream processing

Unit 20. Product recovery and purification – Production of alcohol, enzymes, vitamins, single cell proteins

COURSE LEARNING OUTCOMES

After completion of the Biotechnology, the student will be able to:

- CLO-1** Explain about different techniques used in Genetic engineering, gene cloning in animals.
- CLO-2** Describe the molecular experimental techniques of biotechnology.
- CLO-3** Analysis the applications of fermentation in biotechnology.
- CLO-4** Explain the fields of animal and medical biotechnology.
- CLO-5** Discuss about industrial biotechnology.

REFERENCES:

1. **BROWN, C.M. CAMPBELL, I. & PRIEST, F.G.** (1988), Introduction to Biotechnology, Blackwell Scientific Publications, UK.
2. **PRIMROSE, S.B.** (2000), Modern Biotechnology, Blackwell Scientific Publications, Oxford, London.
3. **KESHAV TREHAN** (1996), Biotechnology, New Age International Pvt. Ltd. Publishers, New Delhi.
4. **WATSON, J. MYERS, R.M. CAUDY, A. A. WITKOWSKI, J.A.** (2007) Recombinant DNA: Genes and Genomes. W.H. Freeman and Company, New York.
5. **BABIUK, L.A., JOHN, P. PHILLIPS AND MURRAY** (1989) Animal Biotechnology, Pergamon Press, Oxford, London.
6. **HIGGINS, I.J., BEST, D.J. AND JONES, J.** (1988) Biotechnology – Principles and Applications. Blackwell Scientific Publications, Oxford, London, Edinburgh.

7. **OLD, R. W. AND PRIMROSE, S. B.** (1989) Principles of Gene Manipulation, An Introduction to Genetic Engineering, Oxford Blackwell Scientific Publications. London.

Weblink

1. <https://youtu.be/5ffl-0OYVQU>
2. <https://youtu.be/igPbNeIvJNo>
3. <https://youtu.be/8rAgLPb85N0?list=PLnOqvBJZU3IZw17z58fWVTBzmd9OLURp9>
4. <https://youtu.be/FtDqQINtKuE>
5. <https://youtu.be/CG6Qba1wYX8>
6. <https://youtu.be/fY1XXKE-tr8>
7. <https://youtu.be/fLa2sC9fO5U>
8. <https://youtu.be/2CqifuTu4K0>

COURSE TITLE : ENVIRONMENTAL BIOLOGY

COURSE CODE : MZON-25

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Environmental Biology course, the student shall be able to:

CO-1 Define environment and distinguish between biotic and abiotic interactions.

CO-2 Discuss population ecology and concepts of population ecology.

CO-3 Describe the concept of ecosystem and adaptations in the aquatic environment.

CO-4 Explain various communities present in the ecology and their adaptation with respect to their environment.

CO-5 Elucidate natural resources, problems in urbanization and social forestry.

BLOCK – I Environment

Unit – 1. The Environment: Physical environment; biotic environment

Unit – 2. Biotic and abiotic interactions

Unit – 3. Habitat and Niche: Concept of habitat and niche; niche width and overlap; fundamental and realized niche

Unit -4. Resource partitioning; character displacement

BLOCK – II Population Ecology

Unit – 5. Population Ecology: Characteristics of a population

Unit – 6. Population growth curves; population regulation; life history strategies (r and K selection)

Unit – 7. Concept of metapopulation – demes and dispersal, interdemec extinctions

Unit – 8. Age structured populations

BLOCK – III Concept of ecosystem

Unit -9. Concept of ecosystem - Energy flow – Tropic structure and levels

Unit -10. Pyramids, food chain and food web ecological efficiencies and productivity and its measurement

Unit -11. Dark and light reaction

Unit -12. Adaptations of Pelagic, Benthic - Sandy and Muddy Shore with reference to physicochemical features of environment of coastal ecosystems

BLOCK – IV Community Ecology

Unit -13. Community: Definition, nature and flux of energy through communities

Unit -14. Influence of competition, predation and disturbances

Unit -15. Community succession

Unit -16. Homeostasis

Unit -17. Biogeochemical cycles - Cycling of non-essential elements and organic nutrients

BLOCK – V Natural Resources

Unit -18. Natural Resources: Renewable and non-renewable resources

Unit -19. Animal resources

Unit -20. Conventional and non conventional energy sources

Unit -21. Environmental pollution and its biological effects

Unit -22. Air, water, soil and noise pollution

Unit -23. Biological indicators and their role in environmental monitoring

Unit -24. Problems of urbanization - Sewage, solid waste and industrial waste disposal and management

Unit -25. Social forestry

COURSE LEARNING OUTCOMES

After completion of the Environmental Biology, the student will be able to:

- CLO-1** Explain the various concepts of ecology and ecosystem
- CLO-2** Elaborate types of ecosystem, population and community characteristics and dynamics.
- CLO-3** Explore the fundamental knowledge of concepts of ecosystem.
- CLO-4** Describe the various communities of ecology.
- CLO-5** Define the concepts regarding natural resources and pollution.

REFERENCES:

1. **ODUM, E.P** (1983). Basic Ecology. Saunder's College Publishing, New York.
2. **MOODY, P.A** (1978). Introduction to Evolution. Harper International, New York.
3. **DODSON, E.O** (1990). Evolution. Reinhold, New York.
4. **BENDALL (ED), E.S** (1983). Evolution from Molecules to Men. Cambridge University Press. London.

5. **GRENE (ED), M** (1983). Dimensions of Darwinism. Cambridge University Press. London.
6. **MINKOFF, E.C** (1984). Evolutionary Biology. Addison – Wesley. London.
7. **MONTAGU (ED)** (1980). Sociobiology examined. Oxford University Press. London

Weblink

1. <https://youtu.be/qEsPI3pcDMA>
2. <https://youtu.be/k6sJtdLxurs>
3. <https://youtu.be/dc7h-5sIqDU>
4. <https://youtu.be/1wVqplezc8s>
5. <https://youtu.be/VkTcxtcKKZA>
6. <https://youtu.be/Bn411XKyVWQ>
7. <https://youtu.be/Zgp86PVXXuQ>

COURSE TITLE : EVOLUTION

COURSE CODE : MZON-25

COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Evolution course, the student shall be able to:

CO-1 Define the concept of molecular evolution.

CO-2 Explain the origin of higher categories like phylogenetic gradualism and punctuated equilibrium, and micro and macro-evolution.

CO-3 Illustrate the molecular phylogenetics and construction of phylogenetic tree.

CO-4 Describe the evolution of economically important microbes and animals.

CO-5 Discuss population genetics and ecology for metapopulations, monitoring natural population and loss of genetic variations.

BLOCK – I Molecular Evolution

Unit - 1. Molecular Evolution - Gene Evolution

Unit – 2. Evolution of gene families

Unit – 3. Molecular drive

Unit – 4. Assessment of molecular variation

BLOCK – II Origin of higher categories

Unit – 5. Origin of higher categories; Phylogenetic gradualism and punctuated equilibrium

Unit – 6. Major trends in the origin of higher categories

Unit – 7. Micro- and Macro-evolution

BLOCK – III Molecular phylogenetics

Unit – 8. Molecular phylogenetics; How to construct phylogenetic tree?

Unit – 9. Phylogenetic inference – Distance methods, parsimony methods, maximum likelihood method

Unit – 10. Immunological techniques

Unit – 11. Amino acid sequences and phylogeny

Unit – 12. Nucleic acid phylogeny - DNA-DNA hybridizations

Unit – 13. Restriction enzyme sites

Unit – 14. Nucleotide sequence comparisons and homologies

Unit – 15. Molecular clocks

BLOCK – IV Evolution of economically important microbes and animals

Unit – 16. Origin and evolution of economically important microbes and animals

BLOCK – V Population genetics and ecology

Unit – 17. Population genetics and ecology; Metapopulations

Unit – 18. Monitoring natural populations

Unit – 19. Why small populations become extinct?

Unit – 20. Loss of genetic variations

Unit – 21. Conservation of genetic resources in diverse taxa

COURSE LEARNING OUTCOMES

After completion of the Evolution, the student will be able to:

- CLO-1** Explain the various concepts and structure of molecular evolution
- CLO-2** Elaborate the origin of higher categories animals.
- CLO-3** Explore the fundamental knowledge of micro and macro-evolution.
- CLO-4** Describe the molecular phylogenetics.
- CLO-5** Define the concepts regarding population genetics.

REFERNCES:

1. **DOBZHANSKY, Th** (1951) Genetic and Origin of Species. Columbia University Press.
2. **FUTUYAMA, D. J.** (1986) Evolution Biology, Suinaer Associates, INC Publishers, Dunderland.
3. **HARTL, D.L.** (2001) A Primer of Population Genetics. Sinauer Associates. Inc, Massachusetts.
4. **KING, M** (1995) Species Evolution –The role of chromosomal change. The Cambridge University Press, Cambridge.
5. **SMITH, J.M.** (1989) Evolutionary Genetics. Oxford University Press, New York.
6. **STRIKBERGER, M.W.** (2007) Evolution. Jones and Bartett Publishers, Boston London.

Weblink

1. https://youtu.be/HnEvze4o_Bw

2. <https://youtu.be/yM014ZQP3Iw>
3. <https://youtu.be/ho7Gal2rCwI>
4. <https://youtu.be/OJoJ7Xdd2aE>
5. https://youtu.be/CALCg_Tjafw
6. <https://youtu.be/CHJrV92kkXE>
7. <https://youtu.be/jDFZnWXXK07I>

COURSE TITLE : IMMUNOLOGY AND MICROBIOLOGY
COURSE CODE : MZON-24
COURSE CREDIT : 4

COURSE OBJECTIVES

While studying the Immunology and Microbiology course, the student shall be able to:

- CO-1** Explain the conceptual understanding of functional organization of immune system and its responsiveness in health and disease.
- CO-2** Describe the antigen-antibody reaction and various class of antibodies and their preparation and efficacies.
- CO-3** Illustrate the various concepts of immune responses shown by the cells and their major active pathways.
- CO-4** Classify the microbes based on the morphology and function and explain the bacterial culture techniques.
- CO-5** Discuss the causative agents, mode of transmission, prevention and treatments for various human diseases.

BLOCK – I Introduction to immune system

- Unit – 1. Introduction to immune system - An overview and scope of immunology
- Unit – 2. Concept of external and internal defence system
- Unit – 3. First line (innate) and second line (acquired) of defences
- Unit - 4. Immune organs – Types, anatomical location, structure and function
- Unit – 5. Role of cells in immune response

BLOCK – II Antigen and Antibody

- Unit – 6. Antigen - Definition, Types - Characteristic features and classification
- Unit -7. Adjuvants – Definition types and applications
- Unit – 8. Antibodies: primary structure – classification – variants – functional characteristics of various antibody classes – generation of diversity
- Unit – 9. Antibody engineering and its applications
- Unit – 10. Vaccines- types preparations and efficacies

BLOCK – III Immune response

Unit – 11. Complement and Effector Mechanism: Complement – definition – salient features – major activation pathways

Unit – 12. Immune response: Humoral immune response and Cell mediated immune response. Unit –13. Cytokines: Properties – General structure and functions – Interleukins – types (Lymphokines and monokines) and functions

Unit – 14. Interferon – origin – types and functions

BLOCK –IV Classification of microbes

Unit – 15. Classification of microbes

Unit – 16. Morphology and ultra structure of bacteria, fungi and viruses

Unit – 17. Bacterial culture techniques

Unit – 18. Bacterial growth curves and nutritional requirements

BLOCK V: Human Diseases

Unit – 19. Causative agents, mode of transmission, control, prevention and treatment of Polio and Rabbits

Unit –20. Causative agents, mode of transmission, control, prevention and treatment of AIDS and Leprosy

Unit -21. Causative agents, mode of transmission, control, prevention and treatment of Tuberculosis

Unit -22. Causative agents, mode of transmission, control, prevention and treatment Cholera

COURSE LEARNING OUTCOMES

After completion of the Immunology and Microbiology, the student will be able to:

- CLO-1** Explain the functional organization of immune system.
- CLO-2** Explain the mechanism of antigen- antibody interaction.
- CLO-3** Describe the mechanism of immune system.
- CLO-4** Classify the microorganisms.
- CLO-5** Define the culture media and culture techniques of microbes.

REFERENCES:

1. **SELLS, S** (1987). Basic Immunology, Elsevier Science Publishing Co., New York.
TIZARD, I. R (1995). Immunology – An Introduction, 4th Edn. Saunders College Publications, Philadelphia.
2. **KUBY, J** (1994). Immunology, W.H. Freeman and Co., New York.

3. **RICHARD, A. GOLDS, THOMAS I, KINDT & BARBARA. A. OSBORNE, KUBY** (2000). Immunology, Freeman and Co. New York.
4. **RICHARD, H.M.** (1992), Immunology(2nd Edition), Williams and Wilkins, Baltimore Maryland.
5. **PELCZER, M.J. REID, R.D. and CHAN, E.C.S** (1996), Microbiology, 5 Edn., Tata McGraw Hill Publishing Company Ltd., New Delhi.

Weblink

1. <https://youtu.be/xM0bozu8Q6Q>
2. <https://youtu.be/r8r1yNeQcp0>
3. <https://youtu.be/zg61a3BoR8Y>
4. <https://youtu.be/YIKLpQEWILg>
5. <https://youtu.be/13an3uhiHAw>
6. https://youtu.be/3A9w_PUGd8Q
7. <https://youtu.be/AorQ3rSsWwY>

COURSE TITLE : AQUACULTURE

COURSE CODE : MZONE - 21

COURSE CREDIT : 3

COURSE OBJECTIVES

While studying the Aquaculture course, the student shall be able to:

CO-1 Define aquaculture and explain the scopes and designing the aquaculture ponds.

CO-2 Explain the various forms of culture system and integrated farming.

CO-3 Elucidate the culture of carps, pearl oyster and prawns.

CO-4 Discuss factors involved in fish disease management and formulating fish feeds.

CO-5 Explain fish harvesting and marketing.

BLOCK – I Importance of aquaculture

Unit -1. Importance of aquaculture – Over exploitation of wild fish stocks – advantages of aquaculture

Unit -2. Aquaculture production trends in the world and in India

Unit -3. Scope for aquaculture in India

Unit -4. Basic Fish farm design: selection of site, grow - out and nursery ponds

BLOCK – II Cultivable species

Unit -5. Cultivable species of fish, crustaceans, molluscs and algae

Unit -6. Culture systems: Extensive, intensive and semi-intensive culture, composite fish culture

Unit -7. Integrated farming

Unit -8. Advantages of polyculture, monoculture and monosex

BLOCK – III Culture of carp, Pearl oyster and Prawn

Unit -9. Culture of carp species –oyster culture: pearl oyster

Unit -10. Prawn culture: the problems in penaeid prawn (shrimp) culture due to socio-economic and environmental problems

Unit -11. Freshwater prawn culture

Unit -12. Potential for ornamental fish culture

Unit -13. Common species for ornamental fish culture

BLOCK – IV Fish disease management

Unit -14. Fish disease management: Common bacterial, viral, fungal, protozoan and crustacean diseases, their symptoms and treatment

Unit -15. Water quality maintenance

Unit -16. Importance and composition of feeds; types of feed: wet and dry feeds

BLOCK – V Marketing

Unit -17. Marketing the products: Marketing the fish to local markets and for export

Unit -18. Harvesting and transport

Unit -19. Quality control and norms of MPEDA for export of fishes

Unit -20. Canning and freezing

COURSE LERANING OUTCOMES

After completion of the Aquaculture, the student will be able to:

- CLO-1** Explain the concepts and importance of fisheries.
- CLO-2** Discuss about freshwater fish culture and marine aquaculture like Oyster, Shrimp, etc.,
- CLO-3** Comparative analysis of aquaculture.
- CLO-4** Describe the techniques of fish culture and disease managements.
- CLO-5** Explain the fish marketing and quality control norms.

REFERENCES:

1. **RATH, R.K.** (2000) Freshwater Aquaculture. Scientific Publishers (India), Jodhpur.
2. **JHINGRAN, A.V.G.** (1991) Fish and Fisheries of India. Hindustan Publishing Co. New Delhi.
3. **BARADACH, J.E. J.H., RYTHER & WO, M.C. LARNEY** (1972) Aquaculture. The farming and Husbandry of Freshwater and Marine Organisms. Wiley Inter Science, New York.

Weblink

1. <https://youtu.be/W6lDgj5YwZg?list=RDQMdmfTkfmmGJE>
2. <https://youtu.be/zat-USX5Sf4>
3. <https://youtu.be/dFQYLBd1bU4>
4. <https://youtu.be/GkUgYCWruc8>
5. https://youtu.be/cqh_mEJbkU8
6. <https://youtu.be/h0HdUPRj-sQ>
7. https://youtu.be/mYqV0_1_T2s

COURSE TITLE : **PRACTICAL –II (Covering the major course VIII, IX, X, XI, XII & XIII)**
COURSE CODE : **MZON-P2**
COURSE CREDIT : **8**

COURSE OBJECTIVES

While studying the Practical -II course, the student shall be able to:

- CO-1** Gain skill about quantification of various ecological parameters.
- CO-2** Learners gain skill in operating of different statistical tools.
- CO-3** Learners will gain skill about slide preparation, staining and mounting.
- CO-4** Explain the principle, working mechanisms of Electrophoresis.
- CO-5** Classify Indian major Carps.

Developmental Biology

1. Structure of spermatozoa and egg
2. Vital staining and mounting of chick blastoderm
3. Spotters: Frog – Egg, blastula and Yolk plug; Chick – 24 and 72 hours stage

Biostatistics

1. Calculation of Mean, Median and Mode.
2. **Spotters:**
Haemoglobinometer, Haemocytometer, Histogram, Pie diagram Input and Output devices

Biotechnology

Vector: Plasmid, Phages (diagram), PCR, Transgenic animal – Sheep, Mice, Cow, Fish (diagram), Petriplate, Inoculation loop

Immunology and Microbiology

- Blood grouping (ABO & Rh)
- Staining - Simple and Gram's staining

Spotters:

- Lymphoid organs- Thymus, bone marrow and spleen
- Immuno-electrophoresis

Equipments in Microbiology - Inoculation loop - Autoclave -

Laminar flow hood - Spotters related to theory

Aquaculture

Spotters:

Indian Major Carps and Prawn

Environmental Biology & Evolution

1. Estimation of dissolved O₂
2. Estimation of dissolved CO₂

Spotters

Rocky, sandy and muddy shore fauna

Animal association – Mutualism and parasitism

Spotters: Peripatus, Limulus, Sphenodon, Endangered animals (any two)

Sphygmomanometer, Stethoscope

P^H meter, Spectrophotometer

Vertebrate and Invertebrate Fossils

COURSE LEARNING OUTCOMES

After completion of the Practical -II, the student will be able to:

- CLO-1** Explain about the quantification of various ecological parameters.
- CLO-2** Explore statistical data manipulation using different statistical methods.
- CLO-3** Gain the techniques about slide preparation of staining and mounting.
- CLO-4** Identify the developmental stages of chick embryo.
- CLO-5** Define the electrophoresis techniques.

WEBLINK

1. https://youtu.be/-KcV_JP6iNA
2. <https://youtu.be/mIE80svYsBQ>
3. https://youtu.be/_vqtMHCHIA0
4. <https://youtu.be/g9ld8XkQJhA>
5. <https://youtu.be/6HIJhp2RkD8>

6. https://youtu.be/_7wxUPUSpbM
7. <https://youtu.be/6bSJ9NE-2Pg>
8. <https://youtu.be/GWm-viFOQtQ>
9. <https://youtu.be/dflOQ8hXUbA>
10. https://youtu.be/nUjK4n3_1C8
11. <https://youtu.be/iaqxTaXit9M>
12. <https://youtu.be/KSs0SMfERuA>
13. <https://youtu.be/frtln5ZoeNQ>
14. <https://youtu.be/mDsTyRIH-Ec>

MAPPING

Core Courses (CC)

Programme Outcomes	MZ ON -11	MZ ON -12	MZ ON -13	MZ ON-14	MZ ON-15	MZ ON -16	MZ ON -P1	MZ ON -21	MZ ON -22	MZ ON -23	MZ ON -P2	MZ ON -24	MZ ON -25	MZ ON -26
Core competency	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Critical thinking	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Analytical reasoning	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Research-skills	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Teamwork	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Discipline Specific Elective Courses (DSE)

Programme Outcomes	MZONE-11	MZONE-21
Additional Academic Knowledge	✓	✓
Problem-solving	✓	✓
Additional analytical skills	✓	✓
Additional Research-skills	✓	✓

Skill Enhancement Course (SEC)

Programme Outcomes	MZOSE- 11	MZOSE- 21
Additional Knowledge enhancement	✓	✓
Exposure beyond discipline	✓	✓
Analytical reasoning	✓	✓
Digital Literacy	✓	✓
Moral and ethical awareness	✓	✓

Ability Enhancement Course (AEC)

Programme Outcomes	MZ OS- 15	MZ OS - 16	MZ OS - 17	MZ OS - P1	MZ OS - 21	MZ OS - 22	MZ OS - 23	MZ OS - P2	MZ OS - 24	MZ OS - 25	MZ OS - 26	MZ OS - E- 11	MZ OS - E- 21
Additional Academic Knowledge	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Psychological skills	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Problem-solving	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓