KANNUR UNIVERSITY

(Abstract)

M.Sc. Zoology ((Structure, Physiology, Development and Classification of Animals) programme - Scheme, Syllabus, Model Question Paper and Pattern of Question Papers (First & Second semester only) under Choice Based Credit and Semester System (in Outcome Based Education System-OBE) in Affiliated Colleges -Implemented with effect from 2023 Admission - Approved - Orders issued.

ACADEMIC C SECTION

ACAD C/ACAD C5/22952/2023 Dated: 06.11.2023

Read:-1. U.O No. Acad C2/429/2017 Dated 08.09.2020.

2. U. O No. Acad C1/21246/2019 Dated 07.12.2020.

3. U.O. No. Acad/C1/21246/2019 Dated 16.02.2023.

4. U.O. No. Acad/C1/21246/2019 Dated 20.04.2023.

5. Minutes of the meeting of the CSMC & Conveners of Adhoc committee held on 15.06.2023

6. Orders of the Vice Chancellor in the file No. Acad C1/21246/2019 Dated 05.08.2023.

7. U.O. No. Acad/C1/21246/2019 Dated 09.08.2023.

8. The Minutes of the meeting of the Ad hoc Committee for Zoology (PG) held on 29.09.2023.

9. Syllabus of M.Sc. Zoology (Structure, Physiology, Development and Classification of animals) programme (First and Second Semester) submitted by the Convener, Ad hoc Committee for Zoology (PG) vide e-mail dated 29.10.2023

ORDER

1. A Curriculum Syllabus Monitoring Committee comprising the members of Syndicate was constituted for the Syllabus revision of UG & PG Programmes in Affiliated Colleges, vide paper read (1) above and as per the recommendation of this Committee in its meeting held on 20.11.2020, constitute a sub Committee to prepare the Regulation for PG programmes in Affiliated Colleges vide paper read (2) above.

2. As the reconstitution of Board of Studies of the University is under the consideration of the Hon'ble Chancellor, and considering the exigency of the matter, Ad hoc Committees were constituted vide paper read (3) above and it has been modified vide paper read (4) above, to revise the Curriculum and Syllabus of PG Programmes in Affiliated Colleges w.e.f 2023- 24 academic year,.

3. The combined meeting of the Curriculum Syllabus Monitoring Committee & Conveners of Ad hoc committee held on 15.06.2023 at syndicate room discussed in detail the draft Regulation, prepared by the Curriculum Syllabus Monitoring Committee, for the PG programmes under Choice Based Credit and Semester System to be implemented in Affiliated Colleges w.e.f 2023 admission and proposed the different phases of Syllabus revision process such as subject wise workshop, vide the paper read (5) above.

4. The revised Regulations for Post Graduate Programmes under Choice Based Credit and Semester System (In OBE- Out Come Based Education System) was approved by the Vice Chancellor on 05.08.2023 and implemented w.e.f 2023 Admission vide Paper read (7) above.

5. Subsequently, as per the paper read (8) above, the Ad hoc Committee for Zoology (PG) finalized the Scheme, Syllabus, Model Question Paper and Pattern of Question Papers of New generation programme, M.Sc. Zoology (Structure, Physiology, Development and Classification of Animals) programme (First and Second Semester) to be implemented with effect from 2023 Admission .

6. As per the paper read (9) above, the Convener, Ad hoc Committee for Zoology (PG) submitted the finalized copy of Scheme, Syllabus, Model Question Paper and Pattern of Question Papers of M.Sc. Zoology (Structure, Physiology, Development and Classification of Animals) programme (First and Second Semester) for implementation with effect from 2023 Admission.

7. The Vice Chancellor after considering the matter in detail and in exercise of the powers of the Academic Council conferred under section 11(1) Chapter III of Kannur University Act, 1996 and all other enabling provisions read together with ***accorded sanction to implement the Scheme, Syllabus, Model Question Paper and Pattern of Question Papers of*** **M.Sc.** ***Zoology (Structure, Physiology, Development and Classification of Animals) programme*** **(First and Second Semester)** ***under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) in Affiliated Colleges under the University with effect from 2023 Admission, subject to report to the Academic Council.***

8. The Scheme, Syllabus, Model Question Papers and Pattern of Question Papers of M.Sc. Zoology (Structure, Physiology, Development and Classification of Animals) programme (First and Second Semester) under Choice Based Credit and Semester System (in OBE- Outcome Based Education System) in Affiliated Colleges under the University with effect from 2023 Admission is uploaded in the University website.

9. Orders are issued accordingly.

Sd/-

Narayanadas K

DEPUTY REGISTRAR (ACAD)

For REGISTRAR

To:
1. Principals of Affiliated Colleges offering M.Sc. Zoology (Structure, Physiology, Development and Classification of animals) programme.
2. Convener, Curriculum Syllabus Monitoring Committee.
3. Convener, Ad hoc Committee for Zoology (PG).

Copy To:
1. The Examination Branch (Through PA to CE)
2. PS to VC / PA to PVC / PA to R/PA to FO
3. DR / AR 1 (Acad) /Computer Programme
4. Web Manager (for uploading on the website).
5. EG 1/EX C1 (Exam), EP V
6. SF/DF/FC

Forwarded / By Order

SECTION OFFICER

KV

KANNUR UNIVERSITY
കണ്ണൂർ സർവകലാശാല
Re-accredited by NAAC with 'B++' Grade

SYLLABUS for Affiliated Colleges

M Sc. ZOOLOGY (Structure, Physiology, Development and Classification of animals)

CBCSS - OBE (Outcome Based Education) System

(KU CBCSS OBE -PG-2023)

2023 admission onwards

PART-1

(I & II Semester)

Kannur University

Thavakkara, Civil Station P.O. Kannur District.

Kerala 670 002, India.

INDEX

PREFACE

Outcome Based Education is a learner centered approach that stresses defining clear and measurable learning outcomes and line up teaching and assessment methods to achieve those outcomes. The purpose of an OBE syllabus is to provide a structured frame work for designing and delivering instructions that focuses on desired learning outcomes. While clearly articulating the expected knowledge, skills, and competencies that students should acquire, the syllabus guides teachers in developing meaningful learning experiences that lead to assessable results. It confirms that education is determined, relevant, and student centric. OBE integrates clear and assessable norms for assessing student learning outcomes. This permits for more precise and consistent evaluation of students' achievements. While focusing on the outcomes, teachers can better identify areas of strengths and weaknesses, provide targeted feedback, and implement necessary involvements to improve learning outcomes. OBE confirms that the knowledge and skills acquired by students line up with the demands and expectations of the job market or specific industries. This syllabus encompasses a wide range of topics that will expand students' knowledge and appreciation for the Animal life. Throughout the study of Zoology, they will have the opportunity to engage in hands-on laboratory work, field observations, and research projects. These practical experiences will enhance the understanding of theoretical concepts and develop essential scientific skills. Zoology offers an exceptional perspective on the living world and provides a foundation for various careers, including Animal research, Environmental conservation, Agriculture, Veterinary science, Education, Public health and Pharmaceuticals, among others. Through studying Zoology, students will not only develop a deeper understanding of animal life but also gain insights into the intricate mechanisms that sustain life on our planet. As per the regulations of Kannur University Credit Based Semester System (KUCBSS-PG-2023) the committee has revised the M Sc. ZOOLOGY (Structure, Physiology, Development and Classification of animals) curriculum for affiliated colleges focusing on the outcome based education approach. We acknowledge that the collective efforts and expertise of professionals were instrumental in shaping the syllabus and making it comprehensive, relevant, and impactful. We are sincerely grateful for their valuable inputs, which will undoubtedly enrich the educational experience for our students.

Dr. Jiji joseph V.

Convener (Ad hoc Committee)

Members:

Dr. Maheshkumar Madathil

Dr. Jayakrishnan T. V.

Dr. Venugopalan Nambiar M.

Dr. Prasad B. O.

Dr. Siby Philip

Mr. Raghunathan P. P.

Ms. Manjula K. T.

SCHEME AND CREDIT DISTRIBUTION CHART OF COURSES IN THE M Sc. ZOOLOGY (Structure, Physiology, Development and Classification of animals) PROGRAMME

Semester	Course Code	Title of Course	Marks			Credits	Hrs/Wk
			Internal	External	Total		
1	MSZNG01C01	Biochemistry	15	60	75	4	4
	MSZNG01C02	Biophysics & Biostatistics	15	60	75	4	4
	MSZNG01C03	Cell Biology & Genetics	15	60	75	4	4
	MSZNG01C04	Systematics, Evolutionary Biology & Behavioural Science	15	60	75	4	4
	MSZNG01C05	Biochemistry, Physiology, Endocrinology and Immunology - Practical					3
	MSZNG01C06	Cell Biology, Genetics, Molecular Biology, Bioinformatics and Biophysics - Practical					3
	MSZNG01C07	Systematics, Evolutionary Biology, Environmental Biology Biostatistics and Behavioural Science - Practical					3
	Total Credits For semester I		**60**	**240**	**300**	**16**	**25**
2	MSZNG02C08	Animal Physiology & Endocrinology	15	60	75	4	4
	MSZNG02C09	Molecular Biology and Bioinformatics	15	60	75	4	4
	MSZNG02C10	Environmental Biology	15	60	75	4	4
	MSZNG02C11	Immunology	15	60	75	4	4
	MSZNG01&02C05	Biochemistry, Physiology, Endocrinology and Immunology - Practical	15	60	75	3	3
	MSZNG01&02C06	Cell Biology, Genetics, Molecular Biology, Bioinformatics and Biophysics - Practical	15	60	75	3	3
	MSZNG01&02C07	Systematics, Evolutionary Biology, Environmental Biology Biostatistics and Behavioural Science - Practical	15	60	75	3	3
	MSZNG02C12	Viva Voce	5	20	25	2	
	Total Credits For Semester II		**110**	**440**	**550**	**27**	**25**
3	MSZNG03C13	Developmental Biology & Animal Ethics	15	60	75	4	4
	MSZNG03 O01	Open Elective (Multi-Disciplinary)	15	60	75	3	4
	MSZNG03 E01	Elective I	15	60	75	3	**4**

	MSZNG03 C14	Microbiology and Biotechnology - Practical					3
	MSZNG03 C15	Histology and Developmental Biology- Practical					3
	MSZNG03 E04	Elective - Practical					3
	MSZNG03 C16	Project (with presentation)					4
	Total Credits For Semester III		**45**	**180**	**225**	**10**	**25**
4	MSZNG04C17	Microbiology & Biotechnology	15	60	75	4	4
	MSZNG04 E02	Elective II	15	60	75	3	3
	MSZNG04 E03	Elective III	15	60	75	4	4
	MSZNG03&04 C14	Microbiology and Biotechnology- Practical	15	60	75	**3**	**3**
	MSZNG03&04 C15	Histology and Developmental Biology- Practical	15	60	75	**3**	**3**
	MSZNG03&04 E04	Elective - Practical	15	60	75	**3**	**3**
	MSZNG03&04C16	Project (with presentation)	15	60	75	**3**	**4**
	MSZNG04C18	Viva Voce	5	20	25	2	
	MSZNG04C19	Personal Collection and field study report	5	20	25	2	**1**
	Total Credits For semester IV		**115**	**460**	**575**	**27**	**25**
Total Marks & Credits for Semesters I, II, III and IV			**330**	**1320**	**1650**	**80**	

Master of Science in ZOOLOGY (Structure, Physiology, Development and Classification of animals)

The aim of the MSc Zoology course is to provide students with a comprehensive understanding of Zoology, develop their research and practical skills, and prepare them for professional careers in the field of zoology or further academic pursuits.

Objectives:

1. **Advanced Knowledge in Zoology:** To provide students with in-depth knowledge and understanding of various basic aspects Zoology. This includes Animal physiology, taxonomy,

ecology, genetics, biochemistry, Biotechnology, Immunology, Developmental biology and other specialized areas within Zoology.

2. **Research Skills:** To equip students with the skills required to conduct independent research in the field of Zoology. Students are trained in research methodologies, experimental design, data analysis, scientific instruments, and scientific writing.

3. **Specialization:** To gain expertise in their chosen area of specialization. This may include studying specific animal groups/ interactions (e.g., parasites and insects).

4. **Practical Skills:** To develop practical skills in collection, preservation, microscopic techniques, tissue culture, molecular biology techniques, and other essential laboratory and field skills. Students are engaged in laboratory work, fieldwork, and animal identification exercises.

5. **Critical Thinking and Problem Solving:** To foster scientific mindset, critical thinking and problem-solving abilities among students. This involves analyzing and interpreting scientific data, evaluating research findings, and developing innovative solutions to zoological problems.

6. **Communication and Presentation Skills:** To develop the ability to communicate scientific information clearly and effectively to both scientific and non-scientific audiences. Students are encouraged to present their research findings through scientific presentations, seminars, and scientific writing.

7. **Professional Development:** To prepare students for careers in research, academia, industry, conservation organizations, or other related fields. This may involve workshops on scientific ethics, career guidance, and opportunities for networking with professionals in the field.

Ist Semester

MSZNG01C01: BIOCHEMISTRY (72 hours, 4 Credits)

CO1: To *understand* and *apply* the role of bio-molecules in living systems and chemistry of biomolecules (Carbohydrates, proteins, lipid and nucleic acids). To *understand* the mechanism and pathways of synthesis and degradation of bio-molecules.

CO2: Students will be able to *explain* the role of enzymes in biological system and understand the mechanism of enzyme action

CO3: Students will be able to *explain* the thermodynamic principles and appreciate their role in life processes

CO3: *Understand* and *apply* the knowledge gained about nutrition and metabolism in daily life.

Module 1

Part 1 (8 hours)

1. **Water and polarity**
   1.1. Solvent properties of water.
2. **Chemical bonds:**
   2.1. Covalent bonds, ionic bonds, salt bridges, ion-dipole interactions, Van der Waals interactions (dipole-dipole, dipole-induced dipole, induced dipole-induced dipole), hydrophobic interactions, hydrogen bonds.
3. **Acids, bases and pH**
   3.1. Titration curves; Buffers (*note: application level problems to be covered*).
4. **Life and thermodynamics**
   4.1. Energy changes in living cells, spontaneity in biochemical reactions, concept of free energy, enthalpy and entropy.
5. **Colligative properties**.

Part 2: (10 hours)

6. **Structure of Biomolecules**
   6.1. Composition, structure and function of carbohydrates and lipids in detail.
   6.2. Composition, structure and function of Proteins

6.3. Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds).

6.4. Composition, structure and function of nucleic acids

6.5. Conformation of nucleic acids (helix (A, B, Z), t-RNA, micro-RNA).

6.6. Stability of proteins and nucleic acids.

6.7. Protein folding and molecular chaperones.

Module 2

Part 1 (10 hours)

7. **Enzymes and Catalysis**

7.1. Principles of catalysis, activation energy and reaction equilibrium, macromolecular crowding effects, specificity

7.2. Classification of enzymes,

7.3. Enzyme kinetics – Michaelis-Menten Kinetics, Lineweaver - Burk Plots, multisubstrate reactions, enzyme inhibition.

7.4. Enzyme catalysis – organic reactions and transition state, transition state stabilization, catalytic mechanisms (proximity, acid-base catalysis, covalent catalysis, electrostatic effects),

7.5. Detailed mechanisms of enzyme catalysis of chymotrypsin and alcohol dehydrogenase, roles of amino-acids and cofactors in catalysis,

7.6. Effect of temperature and pH on catalysis.

7.7. Enzyme regulation – genetic control, covalent modification, allosteric regulations, compartmentalization.

7.8. Enzyme Inhibition

7.9. Isozymes.

8. **Coenzymes and vitamins**

8.1. Co-enzyme classification

8.2. ATP and other nucleotide co-substrates

8.3. NAD, NADP, FAD, FMN

8.4. Coenzyme A, Acyl Carrier Protein

8.5. Thiamine diphosphate

8.6. Pyridoxal Phosphate

8.7. Vitamin C

8.8. Biotin

8.9. Tetrahydrofolate

8.10. Cobalamin

8.11. Lipoamide

8.12. Lipid vitamins

8.13. Ubiquinone

8.14. Cytochromes.

Part 2 (8 hours)

9. **Metabolism**

9.1. Introduction to metabolism

9.2. Major pathways in cells

9.3. Compartmentation and interorgan metabolism

9.4. Free energy change and metabolism

9.5. Role of ATP in metabolism

9.6. Role of co-enzymes in conserving energy from biologic oxidations

9.7. Mention experimental methods to study metabolism.

10. **Metabolism of Carbohydrates**

10.1. Glycolysis

10.2. Gluconeogenesis

10.3. Glycogenesis

10.4. Glycogenolysis

10.5. Pentose-phosphate pathway

10.6. Metabolism of fructose

10.7. Storage and regulation of carbohydrate metabolism

Module 3

Part 1 (8 hours)

11. **Metabolism of Lipids**

11.1. Lipid transport and storage

11.2. Role of chylomicrons, VLDL, LDL, HDL

11.3. Catabolism of lipids: oxidation of saturated (even number chained) fatty acids, energy yield from oxidation of fatty acids

11.4. Oxidation of unsaturated fatty acids and odd-carbon fatty acids, ketone bodies

11.5. Biosynthesis of fatty acids

11.6. Synthesis of acylglycerols – synthesis of triacyl glycerol, phosphatidyl ethanolamine (in bacteria and eukaryotes), interconversion of phosphatidylethanolamine and phosphatidylserine

11.7. Biosynthesis of sphingosine

11.8. Cholesterol biosynthesis, Transport and excretion

12. **Amino-acid metabolism**:

12.1. Role of glutamine synthase in ammonia fixation

12.2. Essential and non-essential amino acids.

12.3. Biosynthesis of non-essential amino acids:

12.3.1. Transamination (with structural details of pathways) - transamination of glutamate, aspartate and alanine, role of Pyridoxal phosphate

12.3.2. Biosynthesis of serine and conversion of serine to glycine (with structural details), role of tetrahydrofolate.

12.3.3. Role of essential amino-acids in synthesis of tyrosine and cysteine, biosynthesis of proline from glutamate.

13. Catabolism of amino acids and the relationship between amino acid metabolism and the citric acid cycle – glucogenic and ketogenic amino acids.

13.1. Role of glutamate dehydrogenase and transdeamination,

13.2. Role of amino-acid oxidases (eg: oxidative deamination of glutamate) and catalases,

13.3. Role of glutaminase and asparaginase.

13.4. Urea cycle.

13.5. Protein turnover and the ubiquitin-proteasome system.

Part 2: (10 hours)

14. **Metabolism of nucleotides**

14.1. Purine biosynthesis and catabolism.

14.2. Salvage reactions

14.3. Pyrimidine biosynthesis and catabolism

14.4. Conversion of ribonucleic acid to deoxyribonucleic acid, conversion of UTP to dTTP.

15. **Krebs cycle**

15.1. Fate of pyruvic acid

15.2. The citric acid cycle and its regulation

15.3. Energetics of citric acid cycle

15.4. Role of vitamins in citric acid cycle

15.5. Relation with gluconeogenesis, transamination and deamination

15.6. Role in fatty acid synthesis

15.7. Glyoxylate cycle

15.8. Routes of entry of metabolites into citric acid cycle

15.9. Metabolism of volatile fatty acids in ruminants

Module 4

Part 1 (10 hours)

16. **Energy changes in metabolism**

16.1. Standard states of free energy changes

16.2. Modified standard state for biochemical applications

16.3. Nature of metabolism, role of oxidation and reduction in metabolism

16.4. Coenzymes in biologically important oxidation-reduction reactions

16.4.1. Coupling of use and production of energy

16.5. Coenzyme A in activation of metabolic pathways

17. **Electron transport chain**

17.1. Entry of electrons into the cycle via complex I and complex II

17.2. Q-cycle

17.3. Electron transport inhibitors

17.4. Oxidative phosphorylation, Chemiosmotic theory, ATP synthesis

17.5. Control of oxidative phosphorylation, Coupled reaction, uncoupled electron transport

17.6. Reactive oxygen species and oxygen toxicity, antioxidants, group transfer

17.7. Biological energy transducers.

18. **Photosynthesis**

18.1. Chlorophyll and chloroplast

18.2. Light reactions:

18.2.1. Photosystem II and water oxidation

18.2.2. Photosystem I and NADPH synthesis

18.2.3. Photophosphorylation

18.3. Light independent reactions:

18.3.1. Calvin cycle,

18.3.2. Photorespiration,

18.4. Alternatives to C3 metabolism,

18.5. Regulation of photosynthesis.

Part 2 (8 hours)

19. **Biochemistry and nutrition**

19.1. Dietary fuels – macronutrients (Carbohydrates, Proteins and Lipids)

19.2. Amount of energy absorbed from metabolism of a gram of each type of macronutrient, ethanol in context of diet.

19.3. Fuel stores – average amount of stored macronutrients

19.4. Type of storage molecules

19.5. Daily energy expenditure (DEE),

19.6. BMR and RMR

19.7. Factors affecting BMR

19.8. Estimation of BMR (rough estimate and Mifflin-St. Jeor methods)

19.9. Role of BMR, RMR

19.10. Physical activity and diet-induced thermogenesis (DIT) in DEE

19.11. Fuel requirements, calculation of energy requirements

19.12. Fat-free mass

19.13. Indirect calorimetry and respiratory quotient

19.14. Weight gain and weight loss

19.15. Recommended dietary allowances of carbohydrates, essential fatty acids, essential amino acids, vitamins and minerals, mention dietary guidelines, xenobiotics in diet and recommendations.

19.16. Metabolic diseases

19.16.1. Ketosis

19.16.2. Acidosis

19.16.3. Alkalosis

19.16.4. Protein and vitamin deficiency diseases

19.16.5. Mineral deficiency and diseases

Textbooks:

Module I, Energy changes in metabolism:

1. Campbell, M. K., Farrell, S. O., & McDougal, O. M. (2016). *Biochemistry*. Cengage Learning.

Metabolism and pathways:

2. Murray, K., Rodwell, V., Bender, D., Botham, K. M., Weil, P. A., & Kennelly, P. J. (2009). Harper's illustrated biochemistry. 28. *Citeseer, New York, United States*.

Enzyme and catalysis, Photosynthesis:

3. McKee, T., & McKee, J. (2011). *Biochemistry: The molecular basis of life. 5th*. New York: Oxford University Press.

Biochemistry and Nutrition:

4. Lieberman, M., & Marks, A. D. (2009). *Marks' basic medical biochemistry: a clinical approach*. Lippincott Williams & Wilkins.

Co-enzymes and vitamins:

5. Horton, H. R., Moran, L. A., Scrimgeour, K. G., Perry, M. D., & Rawn, J. D. (2006). Principles of biochemistry. In *Principles of biochemistry* (pp. 852-852).

References:

1. Voet, J. G., Voet, D., Pratt, C. W. (2018). Voet's Principles of Biochemistry. Singapore: Wiley.
2. Cox, M., Nelson, D. L. (2017). *Lehninger Principles of Biochemistry*: International Edition. United Kingdom: Macmillan Learning.
3. Pratt, C. W., Cornely, K. (2015). *Essential Biochemistry*. United States: Wiley.
4. Berg, J. M., Gatto, G. J., Stryer, L., Tymoczko, J. L. (2015). *Biochemistry*. United States: W. H. Freeman.

MSZNG01C02: Biophysics and Biostatistics
(Theory -72 hrs, Credits -4)

Biophysics (36 hrs)

CO 1 Understand the principle of microscopy and the types of microscopy

CO 2 Deals with the knowledge of different types of chromatographic techniques.

CO 3 Explore the principle and applications of various spectroscopic techniques such as UV- Vis, Fluorescence, ESR, NMR and mass spectrometry.

CO 4 Understands the principles and applications of electrophoresis

CO 5 Acquire the concepts of radioactivity, properties of isotopes used in biology, biological effects of radiations and use of different types of detection counters

CO 6 Acquaint the instrumental principle and concepts of electrophysiological techniques.

MODULE 1

1.Microscopy:(6 hours)

Principle and Biological Applications only

1.1 Confocal microscopy

1.2 Dark field electron Microscopy

1.3 High voltage Electron Microscopy

1.4 NMR Microscopy

1.5 Flow cytometry

2. Electrophoresis: **(4 hrs)**

2.1 Electrophoretic mobility

2.2Factors affecting electrophoretic mobility

2.3 Disc electrophoresis

2.4 PAGE

2.5 Two dimensional PAGE

2.6 Highvoltage Electrophoresis

2.7 Pulsed field electrophoresis

3. Chromatography (4 Hrs)

3.1 Adsorption Chromatography

3.2 Partition and Ion exchange

3.3 Column chromatography

3.4 Thin- layer chromatography

3.5 Gel-filtration

3.6 HPLC

4. Centrifugation (4 Hrs)

4.1 Definition of centrifugation

4.2 Application of centrifugation

4.3 Basic principles of sedimentation

4.4 Density Gradient centrifugation

4.5 Differential centrifugation

4.6 Ultra centrifugation

MODULE 2

4. Spectroscopy (6hours)

Principle and Biological Applications only

4.1 Electromagnetic radiations

4.2 Infrared spectroscopy

4.3 Ultraviolet-Visible spectroscopy

4.4 Mass spectroscopy

4.5 Raman spectroscopy

4.6 Fluorescence spectroscopy

4.7 ORD and CD

4.8 NMR

4.9 ESR

4.10 Surface plasma resonance

5. Radiation Biology: (4 hours)

5.1 Radioactivity

5.2 Different types ionizing radiations and their sources

5.3 Radiation Detectors

5.4 GM Counter

5.5 Solid and Liquid Scintillation Counter

5.6 Gama counter

5.7 X ray – Biological applications

5.8 X ray crystallography

6. Biophysics of vision: (4 hrs)

6.1 Optical properties of Eye

6.5 Light perception in retina

7. Bioacoustics: (4 hrs)

7.1 Physical aspects of sound transmission in the ear

7.2 Physical Basis of Hearing

7.3 Echocardiography

7.4 Doppler ultra sonography

7.5 Lithotripsy

7.6 Echolocation

8 Electrophysiological methods (4hrs)

8.1 Single neuron recording

8.2 Patch-clamp recording

8.3 ECG

8.4 Brain activity recording

8.5 Lesion and stimulation of brain

8.6 Pharmacological testing

8.7 PET, MRI, fMRI, CAT

Self Study

1. Image formation in a microscope
2. Magnification
3. Resolving power
4. Paper chromatography
5. Gas chromatography
6. Paper electrophoresis
7. Phase contrast Microscopy
8. Fluorescence Microscopy
9. Scanning Electron microscopy
10. Transmission Electron Microscopy

BIOSTATISTICS (36 Hours, 4 Credits)

CO 1 Acquire knowledge to collect, organize and classify the data for relevant analyses and interpretation

CO 2 Develop skills in tabulation and graphical representation of data

CO 3 Understand the fundamental concepts with regard to descriptive and inferential biostatistics

CO 4 Select any inferential statistics for conducting hypothesis testing

CO 5 Make reliable decisions based on data, and formulate predictions

MODULE 3

1. Introduction (2 hrs)

1.1 Biostatistics: Definition,

1.2 Applications of biostatistics

1.3 Limitations of Statistics

2. Data (6 hrs)

2.1 Types of data

2.2 Methods of collection of data

2.2.1. Census method, sampling method

2.2.2. Advantages and disadvantages of census and sampling method

2.3. Sampling techniques

2.3.1 Random sampling - Simple Random Sampling, Stratified Random Sampling, Systematic Random Sampling, Cluster Sampling, Multistage Sampling

2.3.2 Non Random sampling - Convenience sampling, Purposive sampling, Quota sampling

2.4 Classification of data

2.4.1. Class intervals- exclusive and inclusive method

2.4.2. Frequency distribution

2.5. Representation of data

2.5.1. Graphic representation

2.5.2. Diagrammatic representation

2.6. Skewness and Kurtosis

3. Statistical Methods: Measures of central tendency and dispersion (problems to be discussed) (6 hrs)

3.1. Arithmetic Mean, Median and Mode

3.2 Range, Inter Quartile range, Mean deviation, Standard deviation, Variance

4. Probability distributions (4 hours)

4.1. Basic concepts and definition:

4.2. Laws of probability

4.3. Probability distribution: -Binomial, Poisson and Normal

MODULE 4

5. Statistical inference (problems to be discussed) (8 Hours)

5.1. Difference between parametric and non-parametric statistics

5.2. Testing of statistical hypothesis

5.3. Errors in hypothesis testing

5.4. Confidence interval; levels of significance, Critical region, Two tailed and one tailed tests

5.5. Standard error

5.6. Student's t-test

5.7. Chi-square test - Goodness of fit

5.8. ANOVA- One –way, Two- way classification

7. Correlation and Regression (problems to be discussed) (6 Hrs)

7.1. Types of correlation

7.2. Methods to measure correlation, Scatter diagram

7.2.1. Karl Pearson's coefficient of correlation

7.2.2. Spearman's correlation

7.3. Types of regression analysis

7.4. Regression equations

7.5. Difference between regression and correlation analysis

8. Statistical Software (4 Hrs)

8.1 Biostatistics platforms and software

8.2 What is R?

8.3 How R Differs from other Statistical software

8.4 Statistical applications of R

8.5 Language of R

8.6 Requirements for installation of R

Reference books

Biophysics

1. Ackerman, E. (1962). *Biophysical Sciences*, Prentice-Hall, Inc.
2. Ackerman, E.; Ellis, L. B. & Williams, L. E. (1979). *Biophysical Science*. Prentice hall of India, New Jersey, USA.
3. Arora, M. P. (2004). *Biophysics*. Himalaya Publishing House, Mumbai.
4. Casey, E. J. (1962). *Biophysics- Concepts and Mechanisms*, East West Press Pvt. Ltd., Delhi.
5. Daniel, M. (1989). *Basis biophysics for biologists*. Agro – Botanical publishers, India.
6. Das, D. (1991). *Biophysics and Biophysical Chemistry*, Academic Publishers, Calcutta.
7. Kane, J. W. & Steinhein, M. M. (1978). *Life Science Physics*, John Wiley & Sons.
8. Narayanan, P. (1999). *Introductory Biophysics,* New Age Publishing Co., Mumbai, India.
9. Pattabhi, V. & Gautham, N. (2003). *Biophysics*. Narosa publishing House, New Delhi.
10. Roy, K. N. (1996). *A text book of Biophysics*, New Central Book Agency, Pvt. Ltd., Calcutta.

Biostatistics

1. Agarwal, B. L. (2006). *Basic Statistics*. 4 rd Edition, New Age International (P) Ltd. Publishers, New Delhi.
2. Banerjee, P. K. (2011). *Introduction to Biostatistics*. S. Chand & Company Ltd.
3. Campell, R. C. (1989). *Statistics for Biologists*. 3 rd edition, Blackie and Son Publishers, Bombay.
4. Crawley, M. J. (2012). *The R Book*. Wiley Publishers
5. Gupta, C. B. & Gupta V. (2002). *Statistical Methods*. Vikas Publishing House, New Delhi.
6. Gupta, S. P. (1996). *Statistical Methods*. S. Chand & Sons Publishers, New Delhi.
7. Gurumani, N. (2015). *An introduction to Biostatistics*. MJP Publishers, Chennai.
8. Kamath, A.; Sreelatha, M. & Nalini, S. (2012). *R Manual for Health Science Researchers*. Manipal University Press.

MSZNG01C03: CELL BIOLOGY AND GENETICS

(72Hrs and 4 Credits)

CO1. Understand cell communication between and within the cells, and various pathways involved in signal transduction

CO2. Develop theoretical understanding of laws of inheritance, location of genes on chromosomes and linkage mapping

CO3. Acquire knowledge on proteins and understanding their folding and apply the knowledge on pathways to diseases.

CO4. Understanding membrane modifications and various cell changes in ageing

CO5. Acquiring knowledge on cancer pathways, cell cycle, stem cells and their use.

PART A - CELL BIOLOGY

(36 Hrs. and 4 credits)

Module – I

Introduction to Cell Biology; briefly mention recent trends in cell biology (2hrs)

1.The Plasma Membrane (6hrs)

1.1 Structure and Functions and modifications.

1.2 Protein Sorting and Vesicular Transport overview

1.2.1 Nuclear transport,

1.2.2 Transport into the ER

1.2.3 Vesicular transport

1.2.4 Transport between the ER and Golgi

1.2.5 Sorting by the Golgi

1.2.6 Endocytosis

2. Ageing. (6hrs)

2.1 Overall view of ageing and mechanisms.

2.1.1 Exogenous and endogenous stressors.

2.1.2 Genomic instability

2.1.3 Telomere attrition

2.1.4 Epigenetic alterations

2.1.5 Loss of Proteostasis

2.1.6 Deregulated nutrient sensing

2.1.7 Mitochondrial dysfunctions

2.2 Cellular senescence

2.3 Stem cell exhaustion and altered inter cellular communication

2.4 Lysosome's role in diseases and ageing

Module - II

3. ECM and Cell Adhesion. (10hrs)

3.1 ECM and its molecules-collagens, elastin fibronectins and laminin, other microfibrillar proteins

3.2 Cell adhesion molecules-integrins, selectins, immunoglobulin superfamily, cadherins and CD44

3.3 Cell signalling

3.3.1 G-protein coupled receptor signalling

3.3.2 Enzyme linked receptors pathway

3.3.3 Ras signalling pathway

4. Cell Cycle and Types of Cell death. (12hrs)

4.1 Cell cycle and its regulations

4.2 Cancer and its pathways-Hippo, Myc, Notch Nrf2, PI3k

4.3 Stem cells-types, significance

4.4 Apoptosis (type I) and its regulations

4.5 Autophagy (type II) and its importance in development

4.6 Necrosis (type III) and its regulation

4.7 Entosis definition and significance

4.8 Mention other types of cell degradation - necroptosis, pyroptosis ferroptosis, Netotic cell death and Parthanatos

PART B – GENETICS

(36Hrs)

CO1. Acquire knowledge on the historical review and basics on mendelian and post mendelian works.

CO2. Develop understanding on different aspects of microbial and Eukaryotic genetics, genetics of development, evolutionary genetics, and biochemical genetics.

Module: 3

1. History and Trends in Genetics. (1Hrs)

1.1 Important branches of genetics

2. Classical genetics (4Hrs)

2.1 Mendelian and post mendelian genetics

2.2 Linkage and chromosome mapping

3. **Quantitative genetics (6Hrs)**

3.1 Polygenic inheritance heritability and its measurements

3.2 QTL mapping

4. **Mutations (Self study)**

4.1 Types of mutations, causes

4.1.1 Deletions lethal conditional, biochemical, loss of function, gain of function, germinal and somatic mutants, insertional mutagenesis and mutagens.

4.1.2 Ploidy changes and structural changes in chromosomes

5. **Microbial and human genetics (10Hrs)**

5.1.1 Recombination- General

5.1.2 Nonhomologous recombination

5.1.3 Site-specific recombination

5.1.4 Replicative recombination

5.2 Genetics of Prokaryotes

5.2.1 Transformation

5.2.2 Transduction

5.2.3 Conjugation

5.2.4 Sexduction

5.2.5 Mapping of genes by interrupted mating method

5.2.6 Genetics of viruses-structure, replication and genetic changes of PhiX174 and M13

5.3 Transposable elements in Prokaryotes and Eukaryotes

5.3.1 Human-Alu &LINEs.

5.3.2 Transposones-Yeast-Ty

5.3.3 Drosophila Transposons

5.3.4 Controlling elements in Maize

5.3.5 Prokaryotes-IS elements

5.4 Methods of Analysis

5.4.1 Pedigree Analysis

5.4.2 Lod score for linkage testing

5.4.3 Karyotyping and genetic diseases

Module:4

6 Cancer Genetics (7Hrs)

6.1 Oncogenes genetics of HER 2 and Ras family

6.2 Tumour Suppressor genes- RB and P53

6.3 Pathways to cancer-Erb Family

6.4 P53-mediated pathway

6.5 GSK signalling pathways

6.6 Inheritance of cancer- cause and examples-inherited RB, familial adenomatous polyposis

7 **Epigenetics (6Hrs)**

7.1 Epigenome-external modifications on DNA

7.1.1 Methylation

7.1.2 Histone modification and ncRNA related gene silencing

7.1.3 Briefly discuss Histone code

7.1.4 Briefly discuss the roles of Behaviour and environment on gene interactions

8 **Evolutionary genetics (2Hrs)**

8.1 Role of Genetic variations in evolution.

8.2 Palaeogenetics – contribution of Svante pääbo in reconstruction of genetic information of extinct Neanderthal DNA and Denisova DNA. (Self Study)

Text Books:

Klug, W. S.; Cummings, M. R., Spencer, C. A.; Palladino, M. A. & Killian, D. (2019). *Concepts of Genetics*, 12th edition. Pearson Publishers.

Benjamin, P. (2016). *Genetics: A conceptual approach* 6th edition. W. H. Freeman & Co, NY.

Krebs, J. E.; Lewin, B.; Goldstein, E. S. & Kilpatrick, S. T. (2014). *Lewin's Genes XI*. Jones & Bartlett Learning.

Lodish, F. (2013). *Molecular Cell Biology 7th edition*. W.H. Freeman and Co., NY.

Reference books.

Klug, W. S.; Cummings, M. R., Spencer, C. A.; Palladino, M. A. & Killian, D. (2019). *Concepts of Genetics*, 11th edition. Pearson Publishers.

Hartwell, L.; Hood, L.; Goldberg, M.; Reynolds, A. E. & Silver, L. (2010). Genetics: From Genes to Genomes 4th Edition. McGraw-Hill Education.

Carlberg, C. & Molnar, F. (2019). *Human Epigenetics*: *How Science Works*. Springer.

Snustad, D. P. & Simmons, M. J. (2011). *Principles of Genetics*. 6th edition. Wiley.

Karp, G. (2009). *Cell and Molecular Biology: Concepts and experiments*. 6th edition. John Wiley & Sons Inc.

Alberts, B.; Johnson, A.; Lewis, J.; Raff, M.; Roberts, K. & Walter, P. (2002). *Molecular Biology of the Cell*. 4th edition. Garland Science.

Krebs, J. E.; Goldstein, E. S. & Kilpatrick, S. T. (2018). *Lewin's Genes XII*. Jones & Bartlett Learning.

Wood, C. (2010). *Molecular Conformations*. Christopher Wood & Ventus Publishing ApS.

Barresi, M. J. F. & Gilbert, S. F. (2019). *Developmental Biology 9th edition*. Oxford University Press.

Online source

www. ncbi.nih.gov

MSZNG01C04: SYSTEMATICS, EVOLUTIONARY BIOLOGY AND BEHAVIOURAL SCIENCE

(72 Hours, 4 Credits)

A – SYSTEMATICS

(36 Hours)

CO 1 Understand the procedures of taxonomic collection, identification and description.

CO 2 Provide a thorough knowledge on rules and regulations to be followed in classification of animals

CO 3 Deliver information on newer trends in Systematics

CO 4 Understand the main ethics to be followed in taxonomic studies and publication

CO 5 Develop a comprehensive understanding of the practical methods of analyzing morphological and molecular characters

CO 6 Develop a theoretical and practical understanding of the principles of Taxonomy and Zoological Systematics

CO 7 Put to use the ICZN nomenclatural practices in Taxonomy

MODULE 1

1. **Introduction 2 hrs**

1.1. Definition and basic concepts

1.2. Systematics and Taxonomy

1.3. Levels of Taxonomy- alpha, beta and gamma Taxonomy

1.4. Importance and applications of Taxonomy

2. **Classification 3 hrs**

2.1 History of classification

2.2 Principles and Rules of classification

2.3. Functions of Classification

2.4. Kinds of Classification- Phenetic, Cladistic, Evolutionary and Hierarchical.

3. **Species Concepts 4 hrs**

3.1. Species concepts

3.1.1. Typological concept

3.1.2. Nominalistic concept

3.1.3. Biological concept

3.1.4. Evolutionary concept

3.2. Intraspecific Categories - Variety, Race, Cline, Subspecies.

4. Taxonomic characters 5 hrs

4.1 Different kinds of taxonomic characters Morphological, Anatomical, Embryological, Ecological, Ethological, Cytological, Biochemical, Geographical and Molecular.

4.2 Functions of taxonomic characters.

4.3 Taxonomic characters and classification

4.4 Taxonomic characters and evolution

5. **Taxonomic Procedure 6 hrs**

5.1. Taxonomic collections- types of collections, value of collections

5.2. Curation- preservation of collection in field and laboratory

5.3. Recording of field data, storage of collection, labelling and cataloguing of collections 5.4. Identification- methods of identification

5.4.1. Use of keys- kinds of keys, their merits and demerits

5.5. Taxonomic descriptions: presentation of findings

5.6. Kinds of taxonomic publications.

MODULE 2

6. **Zoological Nomenclature 5 Hrs**

6.1. History of Zoological Nomenclature

6.2. International Code of Zoological Nomenclature

6.3. Nature of Scientific names

6.4. Species and infraspecific names; Genus group taxa

6.5. Synonyms and Homonyms

6.6. Law of Priority

6.7 Type Method and kinds of Types.

7. Ethics in taxonomy 5 Hrs

7.1 Ethics related to collections

7.1.1 Credit

7.1.2 Lending and borrowing of specimens

7.1.3 Loan of material

7.1.4 Exchange of materials

7.1.5 Collaboration and co-operation with co-workers

7.1.6 Use of language

7.2. Ethics related to taxonomic publications

7.2.1 Authorship of taxonomic papers

7.2.2 Correspondence

7.2.3 Suppression of data

7.2.4 Undesirable features of taxonomic papers

7.3 Taxonomists and user communities

8. Newer trends in systematics 8 Hrs

8.1 Chemo and Sero Taxonomy

8.2 Cytotaxonomy

8.3 Numerical Taxonomy

8.4 Cladistics

8.5. Molecular Systematics

8.6 DNA bar coding Vs traditional Taxonomy

B - EVOLUTIONARY BIOLOGY

(18 hours)

Module 3

CO1 Understand the fundamentals and mechanism of Evolution

CO2 Analyse different scenarios in populations/species and conclude upon the mechanism of evolution involved in shaping it.

Part 1 (10 Hours)

1. **Introduction (2 Hours)**

   1.1.Definition of evolution

   1.2.Charles Darwin's Theory of Evolution

   1.3.Evolutionary Synthesis

   1.4.Evolution as a fact and theory.

2. **Geological fundamentals (2 Hours)**

2.1. Fossil Records

2.2.Hominin Fossil Records

2.3.Evolutionary Trends

2.4.Punctuated Equilibrium

2.5.Rates of Evolution

3. **Biogeography (2 Hours)**

3.1.Biogeographic evidence for evolution

3.2.Factors affecting geographic distribution

3.3.Phylogeography

3.4.Evolution of geographical patterns of diversity

4. **Speciation (2 Hours)**

4.1.Modes of speciation

4.2.Allopatric, sympatric, parapatric and recombinational speciation.

5. **Co-evolution (1 Hours)**

5.1.Nature of co-evolution

5.2.Coevolution of enemies and victims

6. **Special topics in evolutionary biology (1 Hours)**

6.1.Gradualism

6.2.Saltation

6.3.Evolution of novelty

6.4.Phylogenetic conservation and Change

Part 2 (8 Hours)

7. **Origin of genetic variation (2 Hours)**

7.1.Mutations and its central role

7.2.Variation

7.2.1. Sources of phenotypic variation

7.3.Hardy-Weinberg principle,

7.4.Factors in evolution,

7.5.Inbreeding depression,

7.6.Variation among populations,

7.7.Gene flow.

8. **Genetic Drift (2 Hours)**

8.1.Definition and nature of genetic drift

8.2.Evolution by genetic drift

8.3.Effective population size

8.4.Founder effect

8.5.Neutral theory

8.6.Geneflow and Genetic Drift.

9. **Natural Selection (2 Hours)**

9.1.Role of selection in adaptations

9.2.Models of selection

9.3.Fitness.

10. **Genome and Evolution (2 Hours)**

10.1. Origin of new genes

10.2. Evolution of multigene families

10.3. Gene and Genome duplication and its fate.

11. **Self Study Topics:**

11.1. History of Life on Earth: Emergence of life, Pre-cambrian, Paleozoic, Mesozoic and Cenozoic eras

11.2. Ancient genome duplications in animal evolution

11.3. Pseudogenes

11.4. Homologous and analogous characters and its importance in evolutionary (phylogenetic inference)

11.5. Parts of a phylogenetic tree

C – BEHAVIOURAL SCIENCE

(18 Hrs)

CO 1 Understand the knowledge of ethology and other schools of studies on animal behaviour

CO 2 Develop theoretical understanding of neural basis of behaviour

CO 3 Develop conceptual understanding on the communication systems in animals

CO 4 Demonstrate the role of genes and environment in developing behaviour

Module 4

1. **Introduction (1 Hour)**

   1.1. Definition and concepts

   1.2. Approaches and Methods in the study of behaviour.

2. **Instinctive Behaviour (2 hours)**

   2.1.Instinctive behaviour
   2.2. Fixed Action Pattern
   2.3. Sign Stimuli and Releasers
   2.4. Supernormal Stimuli.

3. **Neural basis of behaviour (3 Hours)**

   3.1.Memory, cognition, sleep and arousal
   3.2. Reflex and Complex Behaviour:
      3.2.1 Latency; After discharge; Summation; Warm up; Fatigue; Inhibition; Feedback regulation
   3.3.Biological clock
   3.4.Orientation and Navigation in birds
   3.5. Displacement Activities.

4. **Biological Communication (3 Hours)**

   4.1.Nature and Functions
   4.2. Forms of signals
   4.3. Costs and benefits of signalling
   4.4. Types of Communications- Chemical, Visual, Auditory, Tactile and Electrical.

5. **Reproductive Behaviour (3 Hours)**

   5.1.Evolution of sex and reproductive strategies

5.2. Mating system
5.3.Courtship
5.4.Sperm competition
5.5. Sexual selection
5.6. Parental investment and Reproductive success
5.7. Parental care.

6. Genetics of Behaviour (3 Hours)

6.1.Relationship between genes and behaviour
6.2. Experimental methods demonstrating genetic basis of behaviour
6.3. Relationship between genes and environment in the control of behaviour.

7. Evolution of Behaviour (3 Hours)

7.1.Adaptiveness of behaviour
7.2.Cultural transmission of behaviour
7.3. Kin selection and inclusive fitness
7.4.Altruism

Reference Books

Systematics

1. Kapoor, V. C. (2008). *Theory and Practice of Animal Taxonomy*. Oxford & IBH, Publ., Co., New Delhi.
2. Mayr, E. & Ashlock, P. D. (1991). *Principles of Systematic Zoology*. McGraw-Hill Inc., NY.
3. Mayr, E. (1972). *Principles of Systematic Zoology*. MC Graw Hill Inc., NY.
4. Mayr, E.; Linsley, E. G.& Usinger, R. L. (1953). *Methods and principles of Systematic Zoology*. Mc Graw Hill Book Company, Inc., New York.
5. Narendran, T. C. (2006). *An introduction to Taxonomy*, Zoological Survey of India, Kolkata.
6. Simpson, G. G. (2012). *Principles of Animal Taxonomy*, Scientific Publishers India.
7. Verma, A. (2020). *Principles of Animal Taxonomy*, Narosa Publishing House
8. Williams, D. M. (2020). *Cladistics: A Guide to Biological Classification*. Cambridge University Press.
9. Winston, J. E. (1999). *Describing species: practical taxonomic procedure for biologists*. Columbia University Press.

Behavioural science

1. Alcock, J. (2001). *Animal behaviour*- 7th Ed. Sinauer Associates Inc. US.
2. Alcock, J. (2005). *Animal Behaviour*- 8th Ed. Sinauer Associates, Inc. US.
3. Bolhuis, J. J.; Hogan, J. A. & Bateson, P. (1998). *The development of Animal Behaviour. A Reader.* Blackwell Publishers.

4. Boulenger, E. G. (2003). *An Introduction to animal behaviour*, Discovery Publishing House, New Delhi.
5. Dugatkin, L. A. (2004) *Principles of animal behaviour*. 4th Ed., The University of Chicago Press.
6. Goodenough, J.; McGuire, B. & Jakob, E. (2009). *Perspectives on Animal behaviour* John Wiley and Sons, London.
7. Lehner, N. P. (1998) *Handbook of Ethological methods*. Cambridge Univ. Press.
8. Manning, A. (1972). *An Introduction to Animal Behaviour*. 2nd Ed., Edward Arnold Publ., London.
9. Manning, A. & Dawkins, M. S. (2012). *An Introduction to Animal Behaviour*. 6th Ed. Cambridge University Press.
10. Postlethwait, J. H. & Hopson , J. L. (1995). *The Nature of life*. McGraw Hill.
11. Sarkar, A. (2003). *Development of Animal Behaviour*, Discovery Publishing House.
12. Slater, P. J. B. (1985). *An Introduction to Ethology*. Cambridge Univ. Press. Lond.
13. Slater, P. J. B. (1999). *Essentials of Animal Behaviour*. Cambridge Univ. Press.
14. Slater, P. J. B. & Halliday, T. (1994). *Behaviour and Evolution* . Cambridge Univ. Press

Evolutionary Biology

Textbook

1. Futuyma, D. J. (2013). *Evolution.* 3rd Ed. Sunderland, Massachusetts U.S.A, Sinauer Associates, Inc. Publishers.

Reference books.

1. Barton, N. H.; Briggs, D. E. G.; Eisen, J. A.; Goldstein, D. B. &Patel, N. H. (2007). *Evolution.* Cold spring Harbor press, NY.
2. Freeman, S. & Herron, J. C. (2003). *Evolutionary Analysis* 3rd Ed. Prentice Hall.
3. Hall, B. K. & Hallgrímsson, B. (2000). Strikberger's *Evolution*. Jones and Bartlett Learning, London.
4. Losos, J. B. (2017). *The Princeton guide to evolution*. Princeton University Press.
5. Smith, J. M. (1988). *Evolutionary Genetics*. 2nd Ed. Oxford University Press.

IInd Semester

MSZNG02C08: Animal Physiology and Endocrinology

(72 Hours, 4 Credits)

CO 1 Value the different physiological systems in animals and apply physiological concepts and principles at the basic and applied levels.

CO 2 Develop a comprehensive knowledge of physiological activities in invertebrates and vertebrates and the role of evolutionary processes in driving the organisation of physiological systems.

CO 3 Develop an understanding of cellular physiology at different internal cell environment.

Section A. Animal Physiology

MODULE.1 (16 hour)

UNIT I: Introduction to physiology (4 hour)

1.1. Homeostasis

1.2. Cellular and Organ level of body functioning

1.3. Functional systems of the body

UNIT II: Physiology of Impulse transmission (6 hour)

2.1. Role of ions in Membrane potential; Resting membrane potential and Action potential

2.2. Propagation of action potential

2.3. Neuromuscular junction

2.4. Synaptic transmission

2.5. Chemical transmitters

2.6 Molecular mechanism of Acetylcholine formation and its release

UNIT III: Muscle physiology (6 hour)

3.1 Muscle contraction

3.1.1. Molecular mechanism of muscle contraction and Contractile proteins in muscle.

3.2. Cardiac muscle and Cardiac cycle

MODULE.2 (20 hour)

UNIT IV: Respiration and Fluid circulation (8 hour)

4.1. Physical principles of gas exchange

4.2. Transport of respiratory gases

4.3. Regulation of respiration by Neural mechanism.

4.4. Circulating fluids in Animals

4.5. Blood clotting

4.5.1 Coagulants and Anticoagulants in animals

4.5.2 Blood clotting mechanism

4.6. Types of heart in Invertebrates

UNIT V: Osmoregulation and Kidney. (8 hour)

5.1. Body fluid Compartments: ICF, ECF and its constituents

5.2. Urine formation

5.2.1. Glomerular filtration and Determinants of GFR

5.2.2. Juxta Glomerular Apparatus (JGA)

5.2.3. Tubular reabsorption and Tubular Secretion

5.2.4. Urine concentration and dilution mechanisms.

5.3. Osmoreceptors: ADH feed back system

5.4. Diuretics and their mechanism of action.

UNIT VI: Thermoregulation (4 hour)

6.1. Heat production and Heat loss.

6.2. Regulation of body temperature: Role of Hypothalamus and Neuronal-Effector mechanisms.

Section B. Endocrinology (36 hours)

MODULE.3 (18 hours)

UNIT I: Structure of hormones and its synthesis (6 hours)

1.1. Steroid hormones
1.2. Peptide hormones
1.3. Amino acid derivatives

UNIT II: Hormone Receptors (5 hours)

2.1. Membrane bound receptors

2.1. Cytoplasmic receptors

2.3. Nuclear receptors

UNIT III: Mechanism of Hormone action (7 hours)

3.1. Receptor mediated action

3.2. Second messenger mediated action

3.3. Hormones and gene expression

MODULE.4 (18 hours)

UNIT V: Hormone secreting glands (7 hours)

5.1. Hormone secreting glands in Invertebrates: Prothoracic gland, Corpora allata, Corpora cardiaca, X-organ sinus gland complex and Y-organ.

5.2. Hormone secreting glands in Vertebrates: Hypothalamus, Pituitary, Pineal, Adrenal, Thyroid, Parathyroid and Pancreas

Unit VI: Hormones and body functions (11 hours)

6.1. Neuro-endocrine regulation of digestion in Vertebrates.

6.2. Endocrine control on Renal excretion in Mammals.

6.2. Hormonal control on Reproduction and Development in Animals.

6.2.1. Hormonal control on Reproduction in Invertebrates; Insects and Crustacea

6.2.2. Hormonal control on Reproduction in Mammals.

Reference books

1. Barrett, K. E.; Barman, S. M.; Brooks, H. L.& Yuan, J. X. J. (2019). *Ganong's Review of Medical Physiology* 26th Ed. Mc Graw Hill Eucation.
2. Hall, J. E. & Hall, M. E. (2020). *Guyton and Hall Text book of Medical Physiology*, 14th Ed. Elsevier.
3. Hoar, W. S. (1983). *General and Comparative Physiology*. 3rd Ed. Prentice Hall.
4. Kay, I. (1998). *Introduction to Animal Physiology;* Garland Science.
5. Melmed, S.; Koenig, R.; Rosen, C. J.; Auchus, R. J. & Goldfine, A. B. (2019). Williams *Textbook of Endocrinology*, 14th Ed. Elsevier.

6. Norris, D. & Carr, J. A. (2020). *Vertebrate Endocrinology*. 6th Ed. Elsevier.
7. Schreiber, A. M. (2023). *General and Comparative Endocrinology- An Integrative Approach*. CRC Press.
8. Sembulingam, K. & Sembulingam, P. (2019). *Essentials of Medical Physiology*. 8th Ed. Jaypee Brothers.
9. Tembhare, D. B. (2012). *Invertebrate Endocrinology* . Himalaya Publishing House.
10. Tortora, G. J. & Derrickson, B. H. (2020). *Principles of Anatomy and Physiology*. 16th Ed. Wiley.

MSZNG02C09: Molecular Biology and Bioinformatics

(72 hours and 4 credits)

CO1: *Understand* the mechanism of DNA replication, transcription, translation, post transcriptional and translational modifications and its significance.

CO2: *Analyze* DNA, RNA and protein data using various bioinformatic methods

CO3: *Explain* the general features of genetic code and variations in genetic code

CO4: Students will be able to *explain* various applied molecular biology techniques and *apply* them in their research related activities.

CO5: Gain *knowledge* regarding the regulation of gene expression in Phages, Bacteria, and in Eukaryotes; recent research findings like antisense RNA strategies and role of siRNA and miRNA in the regulation of eukaryotic gene expression and their *applications*

Module 1

Part 1 (8 hours)

1. **Introduction**
   1.1. Introduction to Molecular Biology: Goals of Molecular Biology. Early Years of Molecular biology research.
2. **Techniques in Molecular Biology**
   2.1. Gel electrophoresis
   2.2. Restriction endonucleases and its uses,
   2.3. DNA Cloning, Vectors, DNA libraries, use of hybridization to identify a specific clone
   2.4. Polymerase chain reaction
   2.5. Chemical synthesis of DNA
   2.6. Shotgun sequencing, paired-end sequencing strategy
   2.7. Genome-wide identification of protein-coding genes
   2.8. Identification of regulatory regions
   2.9. Sequencing of protein molecules
3. **Genome structure**
   3.1. Organization of the genome in *E. coli* and in eukaryotes
   3.2. Chromosomes, centromere, telomere, nucleosomes, histones, higher order chromatin structure, regulation of chromatin structure
   3.3. Histone modification, nucleosome assembly

3.4. Repetitive DNA

3.5. C-value paradox

Self Study:

1.1. Early experiments confirming that DNA is the genetic material

1.2. Central Dogma, Adaptor Hypothesis, Messenger hypothesis

1.3. Direction of protein synthesis

1.4. Nucleic Acids: Physical and chemical structure of DNA and RNA, Circular and superhelical DNA, Double Helical DNA, major groove and minor groove, Alternate DNA structures-peculiarity of A, B and Z DNA. DNA topology, linking number, supercoiling, topoisomerases (types and classification).

1.5. RNAs as enzymes.

1.6. Denaturation of DNA, Renaturation, Hybridization, Hydrolysis of Nucleic Acids Sequencing of Nucleic Acids]

Part 2: (10 hours)

4. **Replication of DNA**

4.1. Chemistry of DNA synthesis, Mechanism of DNA polymerase, structure of DNA polymerase (different domains), mechanism of DNA polymerase (proof-reading, how rNTP and dNTP is differentiated by DNA polymerase, primer-template junction, role of Mg^{2+} and Zn^{2+})

4.2. Processivity of DNA polymerase

4.3. Replication fork – simultaneous synthesis of both strands, primers, helicases (different proteins interacting at the fork), single-stranded DNA binding proteins, topoisomerases in replication, RNase H, Ligase, leading and lagging strands, Specilization of DNA polymerases, Sliding clamps, clamp loaders, processivity of DNA polymerases.

4.4. Replication at the replication-fork and the "trombone model" of DNA replication. Initiation of replication (in *E. coli*), Replicon model, OriC

4.5. Replication of eukaryotic chromosomes and relation to cell cycle, multiple origins, ORC, helicase loading proteins (Cdc6 and Cdt1), Mcm2-7 helicases, G1 to S phase

4.6. Activation of helicases by CDK, and DDK, the CMG (Cdc45-Mcm2-7-GINS) complex, different types of DNA polymerases and their specific roles.

4.7. Copying of extreme ends of lagging strands, Telomerase, Telomere-binding proteins

4.8. Similarities between eukaryotic and prokryotic replication

Part 1 (8 hours)

5. **D-loop replication**
   - 5.1. Replication of DNA in mitochondria
   - 5.2. mtDNA replication proteins involved, TWINKLE, POLRMT, O_H and O_L, mtSSB, D-Loop, TAS, 7S DNA
   - 5.3. Termination, topoisomerases, catenanes and separation of circular genomes
   - 5.4. The mitochondrial nucleoid
6. **Rolling circle replication**
   - 6.1. ΦX174 and pT181 replication
   - 6.2. Nick site, bind site, double strand origin and leading strand synthesis, single strand origin and lagging strand synthesis
   - 6.3. Difference between phage and plasmid replication

(PS: only brief explanation expected about D-loop and Rolling circle replication and essay type questions on these topics may be avoided)

7. **DNA repair**
   - 7.1. Replication errors and their repair: Proofreading, Mismatch repair (in prokaryotes and eukaryotes)
   - 7.2. DNA damage – mutagens, depurination, alkylation, oxidation, radiation damage base analogs, intercalating agents, tautomeric shifts of bases.
   - 7.3. DNA Damage repair:
     - 7.3.1. Direct reversal (photo reactivation , suicide enzymes)
     - 7.3.2. Base Excision repair (both prokaryotes and eukaryotes)
     - 7.3.3. Nucleotide Excision repair (both prokaryotes and eukaryotes)
     - 7.3.4. Direct joining of Broken Ends
     - 7.3.5. Non-homologous end joining (NHEJ)
     - 7.3.6. Recombination repair
     - 7.3.7. Translesion DNA synthesis (TLS) and SOS response

Part 2 (10 hours)

8. **Mechanism of Transcription**
   - 8.1. RNA Polymerase, types in bacteria, holoenzyme, role of sigma factor, C-terminal domain
   - 8.2. Steps involved in transcription of bacteria (initiation elongation and termination)
   - 8.3. Consensus sequences/promoters, elements and discriminators
   - 8.4. Initial transcribing complex, closed complex, escape from promoter and transition to open complex

8.5. Various channels in RNA polymerase and their roles, abortive synthesis

8.6. Transient excursion, inchworming and scrunching models of translocation of template or promoter escape;

8.7. Elongation and processivity of RNA polymerase

8.8. Rho-dependent and Rho-independent termination

8.9. Proofreading by RNA polymerase and factors involved

8.10. Transcription arrest and damage recognition in DNA

8.11. **Transcription in eukaryotes**

1. Different promoters (differentiate from bacteria)
2. Role of transcription factors and formation of complexes
3. Mediator complex
4. mRNA capping, polyadenylation
5. Termination of transcription and RNase

Module 3

Part 1 (8 hours)

9. **RNA Splicing**

9.1. The chemistry of RNA splicing

9.2. Alternative splicing, splice sites, branch points, trans-esterification reactions and lariat formation, spliceosome machinery

9.3. snRNAs, snurps

9.4. Pathways of splicing

9.5. Peculiarity of Group I introns.

10. **Genetic code**

10.1. Degeneracy, synonyms, order in makeup of genetic code

10.2. Wobble concept

10.3. Experiments to crack the genetic code (use of poly-A, poly-G, poly-C, poly-U and copolymers)

10.4. Rules governing genetic code – the direction of reading a codon, the non-overlap of codons, fixed reading frame set by the initiation codon

10.5. Missense and nonsense mutations

10.6. Experiment to prove that the genetic code is read in units of three

10.7. Other features of genetic code

Part 2: (10 hours)

11. **Translation**

11.1. Structure of mRNA and ORF

11.2. Kozak sequence

11.3. tRNAs – structure, attachment of Amino Acids to tRNAs

11.4. Ribosome structure (differences in prokaryotes and eukaryotes), peptidyl transferase center, peptidyl transferase reaction, initiation, elongation and termination of translation, A, P and E sites, 70S

11.5. Initiation complex in prokaryotes

11.6. Ternary complex and 43S/48S preinitiation complex in eukaryotes,

11.7. Initiation factors and elongation factors (in prokaryotes and eukaryotes)

11.8. Ribosome as a ribozyme,

11.9. Release factors

11.10. Ribosome recycling

11.11. Regulation of translation

Module 4

Part 1 (10 hours)

12. **Bioinformatics**

12.1. Definition of bioinformatics, scope of bioinformatics, history of bioinformatics

12.2. Genomics and its branches, techniques in genomics

12.3. Sequence alignment, dynamic programming methods for pairwise alignment, heuristic methods (BLAST), multiple sequence alignment

12.4. Basics of phylogenetic tree construction, brief description of different methods

12.5. Proteomics: methods used for studying the proteome

12.6. protein 3D structure visualisation,

12.7. Introduction to PyMoL

12.8. Homology modelling of protein structures

12.9. Metabolomics

12.10. Transcriptome and its uses in studying organism's biology

12.11. Biological databases

Part 2 (8 hours)

13. **Genome editing**

13.1. RNA editing

13.1.1. Role of guide RNA

13.1.2. Transport of mRNA from nucleus to cytoplasm

13.2. Adaptive immunity in bacteria and archea

13.3. CRISPR/Cas9 technology

14. **Real Time PCR**

14.1. Concept and technique of real-time PCR or qPCR

15. **Microarrays**

15.1. Spotted vs in situ synthesised arrays, one colour and two colour microarrays

16. **Next Generation Sequencing:**

16.1. Illumina, Roche 454 and Ion Torrent sequencing methods to be introduced

16.2. Metagenomics

17. **Software**

17.1. Introduction to popular open-source software packages in bioinformatics – ExPASy, BioPython, BioPERL, APE and R (only introductory knowledge is expected about software in bioinformatics)

Assignment topics

Prepare a multiple sequence alignment and calculate its alignment score.

Use online resources to prepare a pairwise sequence alignment and conduct BLAST analysis.

Use online resources to build a phylogenetic tree.

Textbooks:

1. Falkenberg, M. (2018). Mitochondrial DNA replication in mammalian cells: overview of the pathway. *Essays in Biochemistry*, 62(3): 287-296. (*For D-loop replication*)
2. Malacinsky, G. M. (2015). *Freifelder's Essentials of Molecular Biology*. 4th Ed. Jones & Bartlett.
3. Thurtle- Schmidt, D. M., & Lo, T. W. (2018). Molecular biology at the cutting edge: A review on CRISPR/CAS9 gene editing for undergraduates. *Biochemistry and Molecular Biology Education*, *46*(2): 195-205. (For CRISPR/CAS9 technology)
4. Watson, J. D.; Baker, T. A.; Bell, S. P.; Gann, A.; Levine, M. & Losick, R. M. (2004). *Molecular biology of the gene.* Pearson/Benjamin Cummings, San Francisco.
5. Wawrzyniak, P.; Płucienniczak, G.; & Bartosik, D. (2017). The different faces of rolling-circle replication and its multifunctional initiator proteins. *Frontiers in Microbiology*, 8: 2353. (*For rolling-circle replication*)

References:

1. Alberts, B. (2017). *Molecular biology of the cell*. Garland science.
2. Alberts, B.; Bray, D.; Hopkin, K.; Johnson, A. D.; Lewis, J.; Raff, M.; Roberts, K. & Walter, P. (2015). *Essential cell biology*. Garland Science.
3. Cooper, G., & Adams, K. (2023). *The cell: a molecular approach*. Oxford University Press. Harbor Laboratory Press.

4. Hardin, J.; Bertoni, G.; Kleinsmith, L. J. &Becker, W. M. (2012). *Becker's world of the cell.* Benjamin Cummings, Boston.
5. Karp, G. (2008). *Cell and molecular biology: concepts and experiments* (5th Ed.). John Wiley & Sons, Inc.
6. Karp, G.; Iwasa, J. & Marshall, W. (2019*). Karp's Cell and Molecular Biology*. 9th Ed. John Wiley & Sons, Inc.
7. Krebs, J. E.; Goldstein, E. S.; Kilpatrick, S. T. (2011). *Lewin's Genes X.* Jones and Bartlett.
8. Lodish, H.; Berk, A.; Kaiser, C. A.; Krieger, M.; Bretscher, A.; Ploegh, H. L.; & Amon, A. (2021).*Molecular cell biology*. New York: WH Freeman.
9. Mount, D. W. (2004). *Bioinformatics - sequence and genome analysis* (2. ed.). Cold Spring
10. Ramakrishnan, V. (2018). *Gene Machine: The Race to Decipher the Secrets of the Ribosome.* Harper Collins India.
11. Snustad, D.P. & Simmons, M. J. (2015) *Principles of Genetics*. 7th Ed. Wiley.
12. Weinberg, R. A. (2013). Cytoplasmic Signalling Circuitry Programs Many of the Traits of Cancer. *The Biology of Cancer.*Taylor and Francis.

MSZNG02C10: ENVIRONMENTAL BIOLOGY

(72 HOURS; CREDITS: 4)

Course Outcomes: At the end of the course, the student will be able to:

CO 1: Understand the basic principles of ecology and to relate these principles to the global ecological challenges

CO 2: Learn about the ecosystem, biotic communities and patterns of energy flow

CO 2: Create an understanding about dynamics of population structure

CO 3: Study the fundamentals of climatic conditions and its impact on environment

CO 4: Comprehend the nature of pollution and the ways for its control and reduction

CO 5: Impart the scope of various ecological tools in research and ecosystem management

Module I

Part 1 (8 hours)

1. **Habitat and Niche**
   - 1.1.Concept of Habitat and Niche
   - 1.2.Niche width and overlap; fundamental and realized niche; Gause's theory of niche
   - 1.3.Resource partitioning
   - 1.4.Character displacement
2. **Population Ecology**
   - 2.1.Population patterns, demes and dispersal, interdemic extinctions, aggregations- Allee's principle
   - 2.2.Metapopulation- Concept and Structure, Levin's model of metapopulation
   - 2.3.Age structure, life tables and survivorship curves
   - 2.4.Population Growth- exponential and logistic models and their variants, time lags, carrying capacity, density; Density dependent and density independent factors
   - 2.5.Life history strategies (r and k selection)

Part 2 (10 hours)

3. **Species Interactions**
   - 3.1.Types of interactions
   - 3.2.Interspecific competition, predation, herbivory, carnivory, pollination, symbiosis, parasitism
   - 3.3.Lotka-Volterra model

3.4.Co-evolution of prey-predator interactions – Red Queen hypothesis

Module II

Part 1 (8 hours)

4. Community Ecology

4.1.Nature of communities

4.2.Community structure and attributes

4.3.Edges and ecotones

4.4.Levels of species diversity and its measurements-

Alpha diversity: Simpson's Diversity Index; Shannon Index; Fisher's Alpha; Rarefaction

Beta diversity: Sorensen's Similarity Index; Whittaker's measure

Gamma diversity

4.5. Latitudinal gradients in diversity

Part 2 (10 hours)

5. Ecosystem Ecology

5.1.Energy flow and mineral cycling (C, N, P); Anthropogenic influence on carbon, nitrogen and phosphorous cycles

5.2.Primary production and decomposition

5.3.Ecology of Coral reefs: Importance, threats and management

5.4.Ecology of Tropical Rainforests: Importance, threats and management

5.5.Ecology of wetlands: Importance, threats and management

Module III

Part 1 (8 hours)

6. Ecological Succession

6.1. Mechanism of succession

6.2. Changes involved in succession

6.3. Concept of climax

6.4. Theories on climax

7. Biogeography

7.1. Theory of Island biogeography

7.2. Biogeographical Zones of India -(a) Trans Himalayan zone; (b) Himalayan zone; (c) Desert zone; (d) Semiarid zone; (e) Western Ghats zone; (f) Deccan plateau zone; (g) Gangetic plain zone; (h) North East zone. (i) Coastal zone; (j) Islands present near the shore line.

Part 2 (10 hours)

8. Conservation Biology

8.1. Principles of conservation

8.2. Restoration ecology

8.3. Sustainable development

8.4. Ecological foot printing

8.5. Indian case studies on conservation & management strategy (concepts of project tiger, Biosphere reserves).

Module IV

9. **Applied Ecology**

Part 1 (8 hours)

9.1 E- waste types and management aspects

9.2 Ecological Indicators

9.3 Bioremediation

Part 2 (10 hours)

9.4 Principles and applications of Remote Sensing

9.5 Principles and applications of GPS & GIS

9.6 Environmental Impact Assessment (EIA)

9.7 Ecosystem modelling (brief account)

9.8 Biodiversity: status, monitoring and documentation; Species 2000

9.9 Biodiversity management approaches

Topics for self-study:

The Environment: Physical Environment, Biotic Environment, Biotic and abiotic interactions; Gaia hypothesis; Concept of homeostasis; Concept of limiting factors- Liebig's law, Shelford's law; Food webs; Ecological pyramids; Types of Succession; Impact of major ecosystem processes like habitat degradation, loss and fragmentation, over

exploitation, species invasion and land use changes on biodiversity; Structure and function of some Indian ecosystems: terrestrial (forest, grassland) and aquatic (fresh water, marine, eustarine); Environmental pollution and management (Air, water, soil and radioactive pollution).

Preferred Text Books

1. Stiling, P. D. (2002). *Ecology Global Insights and Investigations*. McGraw- Hill Companies.
2. Smith, M. T. & Smith, L.R. & (2006). *Elements of Ecology*. Pearson.
3. Dyke, V. F. (2003). *Conservation Biology: Foundations, Concepts, Applications*. McGraw Hill Companies.
4. Odum P. E. (2004). *Fundamentals of Ecology*. W.B. Saunders Company.
5. Molles C. M. Jr. (2018). *Ecology: Concepts and Applications*. McGraw- Hill Companies.
6. Miller, T.G. Jr. (2005). *Living in the Environment: Principles, Connections and Solutions*. Thomson Brooks Cole.
7. Haggett, J.R. (2004). *Fundamentals of Biogeography*. Routledge Taylor & Francis Group.

References:

1. Begon, M., Harper, J.L. & Townsend, C.R. (1996). *Ecology: Individuals, Populations and Communities*. Blackwell Science.
2. Bhattacharya, N. N. (2003). *Biogeography*. Rajesh Publications, New Delhi.
3. Chapman, J.L. & Reiss, M.J. (1999). *Ecology: Principles and Applications*. Cambridge University Press, UK.
4. David Quammen. (1997). *The Song of the Dodo: Island Biogeography in an Age of Extinctions*. Scribner.
5. Emery W. & Camps A. (2017). *Introduction to Satellite Remote Sensing. Atmosphere, Ocean, Land and Cryosphere Applications*. Elsevier Publications.
6. Griffin, N. (2018). *Biogeography: An Ecological Approach*. Callisto Reference.
7. Heywood, V. H. & Watson, R. T. (1995). *Global Biodiversity Assessment*, UNEP. Cambridge University Press.
8. Krebs J. C. (1994). *Ecology: The experimental analysis of distribution and abundance*. HarperCollins College Publishers.

9. Lillesand, T.M., Kiefer, R.W., & Chipman, J. (2015). *Remote sensing and image interpretation*. Wiley Publications.
10. MacArthur, R. H. &Wilson, E. O. (1967). *The Theory of Island Biogeography*. Princeton University Press.
11. Magurran, A. E. (2004). *Measuring biological diversity*. Oxford: Blackwell Publishing.
12. May, M.R & McLean. R A. (2007). *Theoretical Ecology: Principles and applications*. Oxford University Press.
13. Meffe K. G. & Carroll R. C. (1997). *Principles of Conservation Biology*. Sinauer Associates.
14. Negi, S. S. (1993). *Biodiversity and Conservation in India*. Indian Publishing Company.
15. O' Riordan, T. and Stoll-Kleemann, S. (2002). *Biodiversity, Sustainability and Human Communities*. Cambridge University Press, UK.
16. Osborne, P. L. (2000). *Tropical Ecosystems and Ecological concepts*. Cambridge University Press.
17. Rees W.G (2013). *Physical Principles of Remote sensing*. Scott polar, Research Institute, University of Cambridge, New York.
18. Russel J.P, Starr, C., Wolfe, S.L., Hertz, P.E. & Mcmillan, B. (2009). *Ecology*. Thomson Press (India) Ltd.
19. Smith, L. R & Smith M.T. (2006). *Ecology and Field Ecology*. Pearson.
20. Southwood, T. R. E. & Henderson, P. A. (2000). *Ecological Methods*. Blackwell Science.
21. Sutherland, W.J. (2000). *The Conservation handbook: Research, Management and Policy*. Blackwell Science.
22. Whittaker, R. H. (1975). *Communities and Ecosystems*. MacMillan Publishing Company.

MSZNG02C11: Immunology

(72 hrs-Credits -4)

Course outcome:

CO1. To understand the molecular and cellular components and pathways that protect an organism from infectious agents.

CO2. To explore the structure, function, and genetics of the immune system's components.

CO3. The course also emphasizes the research and development opportunities for therapeutic intervention arising from recent advances in immunology.

CO4. Upon completing the course, students have a sound understanding of the immune system's essential elements, preparing them to engage further in this rapidly evolving field.

Module 1

1. Historical background and scope of immunology (1 Hour)

2. Overview of the immune system (3 Hour)

2.1 Innate immunity

2.2 Acquired immunity

2.3 Cellular and humoral immunity

2.4 Passive and active immunity

3. Cells and organs of immune system (10 Hours)

3.1 Basophils, Eosinophils, Nutrophils, B-Cells, T-cells, Natural killer cells, Monocytes and Macrophages

3.2 Primary and secondary lymphoid organs

4. Lymphocyte activation , proliferation and differentiation (4 Hours)

B Lymphocytes and T-lymphocytes

5. Phagocytosis and inflamation (3 Hours)

Module 2

6. Antigens (Immunogens) (4 Hours)

6.1 Basis of specificity

6.2 Factors affecting antigenicity

6.3 Epitopes and haptens

6.4 Adjuvants – Role of adjuvants in enhancing immunogenicity

6.5 Superantigens

7. Antibodies (10 Hours)

7.1 Structure of a typical antibody molecule

7.2 Different classes of immunoglobulins (IgG, Ig A IgD, IgM and lgE)

7.3 Organization and expression of Immunoglobulin genes- Primary immunoglobulin gene Rearrangement.

7.4 Immunoglobulin genes: Somatic recombination of gene segments, Rearrangement of V, D and J gene segments, V (D) J recombinase

8. Major histocompatibility complex (4 Hours)

8.1 General organization: MHC class I and MHC class II

8.2 Antigen processing and presentation

Module 3

9. Complement system (4 Hours)

9.1 Classical pathway and Lectin pathway

10. Cytokines (3 Hours)

10.1 Cytokines and chemokines – General properties

10.2. Cytokines families

10.3 Role of cytokines in immune system

10.4 Cytokine antagonists

10.5 Cytokine related diseases

10.6 Therapeutic applications of cytokines

11. Hypersensitivity reactions (5 Hours)

11.1 Types I, Type II and Type III hypersensitivity

11.2 Delayed type hypersensitivity (DTH)

12. Autoimmunity and Autoimmune diseases (2 Hours)

12.1 Primary immunodeficiency diseases with examples

12.2 Secondary immunodeficiency diseases with examples

12.3 Treatment of immunodeficiency diseases

13. Immunodeficiency syndrome (2 Hours)

13.1 Primary immunodeficiency diseases with examples

13.2 Secondary immunodeficiency diseases with examples

13.3 Treatment of immunodeficiency diseases

Module 4

14. Transplantation and graft rejection (4 Hours)

14.1 Immunologic basis of graft rejection – Transplantation antigens

14.2. Clinical manifestations of graft rejection

14.3. Immunosuppressive therapies – General and specific

15.Tumor Immunology (2 Hours)

16.Antigen – Antibody interactions (4 Hours)

16.1 Agglutination reactions

16.2 Haemagglutinations

16.3 WIDAL test.

16.4 Precipitation reaction

16.5 ELISA

16.6 RIA

16.7 Immunoelectrophoresis

17. Vaccination (2 Hours)

17.1 Different types of vaccines

17.1 Live attenuated vaccine

17.2 Inactivated polypeptides as vaccines

17.3 Recombinant vaccines and DNA vaccines

17.4 Route of vaccination

References:

1. Geha, R. & Rosen, F. (2007), *Case Studies in Immunology: A Clinical Companion*. 5th Ed. Garland Science, NY.

2. Goldsby, R. A; Kindt, T. A.; Osborne, B. A. & Kuby, J. (2002). *Immunology*. 5th Ed. WH Freeman, NY.

3. Joshi, K. R. & Osamo N.O. (1994), *Immunology*, Agro Botaqnical Publishers, Bikaner

4. Khan, F. H. (2011). *The Elements of Immunology*. Pearson Education.

5. Kindt, T. A.; Osborne, B. A. & Goldsby R. A. (2007). *Kuby Immunology*. 6th Ed. WH Freeman, NY.

6. Murphy, K. M; Travers, P.; Walport, M. & Janeway, C. (2008) *Janeway's Immunobiology*. 7th Ed. Garland Science, NY.

7. Parham, P. (2021). *The Immune System*. 5th Ed. WW Norton & Co.

8. Punt, J.; Stransford, S.; Jones, P & Owen, J. (2018). *Kuby Immunology*. 8th Ed. WH Freeman, NY.

9. Shetty, N. (1993). *Immunology*. Wiley Eastern Ltd. New Delhi

MSZNG01&02C05: Biochemistry, Physiology, Endocrinology and Immunology - Practical (3 Credits)

Biochemistry

CO1 Students will gain skills in methods and techniques of biochemical assays

CO2 Students will gain skills in enzyme assays

CO3 Students will appreciate the importance of biochemical assays

1. Determination of Total carbohydrate by Furfural Colorimetric Method or with Anthrone Reagent method

2. Estimation of Glucose by GOD-POD method

3. Estimation of protein concentration using colorimetric method

4. Estimation of Total sugar of fruit juice by titration with Fehling's solution

5. Estimation of Starch by Anthrone Reagent

6. Determination of Dietary Fibre of food material (Demo)

7. Estimation of Cholesterol by Zak's method

8. Study the time course of the reaction catalysed by alkaline phosphatase (Demo)

9. Detection of reducing sugars - Osazone test

References

1. Keith, W. & John, W. (2006). *Principles and Techniques of Biochemistry and Molecular Biology*. 6th Ed. Cambridge University Press

2. Keith, W. & John, W. (2010). *Principles and Techniques of Biochemistry and Molecular Biology*. 7th Ed. Cambridge University Press

3. Oser, B. L. (1965). *Hawk's Physiological Chemistry*. McGraw Hill Book Co.

4. Plummer, D. T. (2017*). An Introduction to Practical Biochemistry*. 3rd Ed. Tata Mc Graw-Hill, New Delhi.

5. Sawhney, S. K. & Singh, R. (2014). Introductory Practical biochemistryNarosa Publishing House, New Delhi.

6. Thimmaiah, S. K. (2016). *Standard Methods of Biochemical Analysis*. Kalyani Publishers

7. Varley, H. (2022). *Practical Clinical Biochemistry*. CBS Publishers and Distributors, New Delhi.

8. Wilson, K. & Walker, J. (2000). *Principles and Techniques of Practical Biochemistry*. Cambridge University Press.

Physiology, Endocrinology and Immunology

CO1 To support to do experiments on advance animal physiology
CO2 Hands on experience in various instruments and handing of human and animal samples

CO3 Acquire knowledge regarding experiment designing and data collection and processing

1. Determination of effect of PH, substrate concentration, Temperature on salivary amylase activity

2. Detection of digestive enzymes in the hepatopancreas of crabs

3. Determination of vertebrate hemoglobin using colorimetry

4. Total and count of WBC and RBC

5. Differential count of WBC

6. Estimation of the rate of oxygen consumption of a Fish

7. Demonstration of cell forms from invertebrate blood smear preparation

8. Demonstration of Single radial immunodiffusion of antibody and antigen

9. Demonstration of the Influence of Ammonium level in water on fish life (Physiology and behavior)

10.Reactions of Urine: Normal components: chloride, sodium, potassium, urea and creatinine Abnormal components: Bile pigments, Bile salt and Ketone bodies

11.Estimation of Urine: Ammonia and Creatinine

12.Demonstration of the effect of Hormonal analogues (JH and Ecdysone) on larval development in Insects.

References

1. Arvy, L. (1971). *Histoenzymology of the endocrine glands.* Pergamon Press, Oxford, NY.
2. Dounersberger, A. B.; Lesak, A. E. & Maichael, T. J. (1992). *A Laboratory Text Book of Anatomy and Physiology.* 5th Ed. D. C. Heath and Co.
3. Hill R. W. & Wyse, G. A. (1989). *Animal Physiology,* 2nd Ed. Harper Collins Publishers Inc. NY.
4. Lytle, C. F. & Meyer, J. R. (2005). *General Zoology Laboratory Guide.* 14th Ed.
5. Schmidt-Nielsen, K. (1997). *Animal Physiology, Adaptation and Environment*, 5th Ed. Cambridge University Press, NY.

MSZNG01&02C06: Cell Biology, Genetics, Molecular Biology, Bioinformatics and Biophysics - Practical (3 Credits)

Cell Biology and Genetics

CO1 Understand the basic principles of chromosome disorders

CO2 Develop practical skill on the preparation of chromosome mapping

CO3 Identify and interpret clinical features of chromosomal abnormalities

CO4 Attain knowledge in different staining techniques and slide preparations

CO5 Achieve professional knowledge in several cytogenetic techniques

1. Study of meiosis in grasshopper testis squash and determination of chiasma frequency.

2. Preparation of Human karyotype from photographs of chromosome spreads- normal and abnormal – Turner, Klinefelter's, Down's, CDC, normal male and female.

3 Preparation of human blood smears to demonstrate drumsticks in neutrophils.

4. Induction of chromosome aberration in onion root tips by a suitable clastogenic agent and its demonstration by means of root tip squashes. Blocked metaphase and polyploidy.

5. Cell fractionation isolation of nuclei and mitochondria from any suitable material.

6. Study of mutation using Rhoeo plant.

7. Gene mapping of Drosophila melanogaster, using text book problems.

8. Preparation and analysis of salivary gland chromosomes of Drosophila

9. Extraction and estimation of chromosomal DNA from animal tissues (by diphenylamine test).

10. Extraction and estimation of total RNA from any suitable material (by Orcinol test).

11. Extraction and estimation of protein from any suitable material (by Lowry test)

12. Hypo and hyper chromic effect of DNA- spectrophotometric analysis. For lab experience.

References

1. Winchester, A. M. & Wejksnora, P. J. (1995). *Laboratory Manual of Genetics*. William C Brown Publishers.

2. Jayaraman, J. (2011) *Laboratory Manual in Biochemistry*. New Age International Pvt. Ltd.

3. Neidharth, F. C. & Beyd, R. F. (1965). *Cell Biology – A Laboratory Text.* Burgees Publishing Co.

Molecular Biology and Bioinformatics

CO1 Students will gain skills in methods and techniques of Nucleic acid isolation

CO2 Students will gain skills in methods of quantification nucleic acids

CO3 Students will apply the skills in manipulating the DNA for the desired purpose

CO4 Understand the importance and use the biological databases

CO5 Familiarize the basic bioinformatic tools and software

1. Building a phylogenetic tree using a character matrix prepared for a set of 8-10 specimen from the college zoology museum

2. Multiple sequence alignment of a selected set of sequences using open source software or online resources

3. Translating nucleotide sequences to protein sequences using various genetic codes and different reading frames using open-source software or online resources

4. Preparation of a Neighbor-Joining Phylogenetic Tree using open source software or online resources

5. 3D structure of protein visualisation with PyMol

6. Docking a ligand with a receptor (protein) in AutoDock Vina

7. Conducting a BLAST search to identify the best hit for the given sequence - at NCBI BLAST server or local installation

8. Isolation of Genomic DNA from suitable animal tissue

9. Determination of purity of DNA sample using spectrophotometer (A260/A280 method)

10. Agarose Gel Electrophoresis of λ phage DNA digested with HIND III (Demonstration)

11. Polymerase Chain Reaction (Demonstration)

References

1. Brown T.A. (1998). *Molecular biology Lab Fax. Vol. 1. Recombinant DNA*. 2nd Ed. Academic Press.

2. Brown, T.A. (2007). *Essential Molecular Biology a practical approach Vol.2.* 2nd Ed. Oxford University press.

3. Anson, D. A. (2007). Ed. *Reporter Genes: A Practical Guide (Methods in Molecular Biology).* Humana Press.

4. Green, M. R. & Sambrook, J. (2012). *Molecular Cloning- A Laboratory Manual.* 4th Ed. Cold Spring Harbor Laboratory Press.

5. Plummer, D. (2017) *An introduction to Practical Biochemistry*, 3rd Ed.. Tata Mc Graw- Hill, New Delhi.

6. Sambrook, M.J. & Russel., D.W. (2006).*The condensed Protocols from Molecular cloning: A Laboratory Manual.* Cold Spring Harbor laboratory Press, Cold Spring Harbor, New York.

7. Keith, W. & John, W. (2006). *Principles and Techniques of Biochemistry and Molecular Biology.* 6th Ed. Cambridge University Press.

Biophysics

CO1 Acquire a firm foundation in fundamental applications of instrumental techniques

CO2 Demonstrate and apply working comprehension of the technical aspects of different instrumentations

1. Absorption spectrum of potassium permanganate. Determination of absorption coefficient and concentration of unknown solutions by calibration and absorption coefficient.

2. Separation of mixtures of amino acids by paper chromatography.

References

1. Ackerman, E. (1962). *Biophysical Chemistry*, Prentice Hall Inc.

2. White, D.C.S. (1974). *Biological Physics*, Chapman and Hall, London.

3. Hoppe, W. (ed.) (1983). *Biophysics,* Springer Verlag.

4. Slayter, E.M. (1970). *Optical Methods in Biology.* Wiley.

5. Gassey, E.J. (1962). *Biophysics Concepts and Mechanics*. Van Norstrant Reinhold Co.

6. Daniel, M. (1998). *Basic Biophysics for Biolgists.* Agro Botanica, Bikaner.

7. Das, D. (2015). *Biophysics and Biophysical Chemistry*. 6th Ed..Academic Publishers, Calcutta.

MSZNG01&02C07: Systematics, Evolutionary Biology, Environmental Biology, Biostatistics and Behavioural Science - Practical (3 credits)

Systematics

CO1 Understand and interpret fish species in hierarchy
CO2 Develop knowledge to construct phylogenetic trees

1. Preparation of simple dichotomous key to identify common genera of fishes.

2. Construction of phylogenetic trees - Conventional and Computational Method
3. References
4. 1. Heywood, V. H & Watson, R. T. (1995*). Global biodiversity assessment. UNEP*, Cambridge University Press.
5. 2. Mayr, E.; Linsley, E .G. & Usinger, R. L. (1953). *Methods and Principles of Systematic Zoology*. McGraw Hill Inc. NY.
6. 3. Mayr, E. (1969). *Principles of Systematic Zoology*. McGraw Hill Inc., New York.
7. 4. Kapoor, V. C. (1998). *Theory and Practice of Animal Taxonomy.* Oxford & IBH Publ. Co., New Delhi.

Environmental Biology and Evolutionary Biology

CO1 Develop practical knowledge about environmental quality assessment

CO2 Hand own experience to design and interpret the results of environmental relevance

CO3 Equipped the stakeholders to apply scientific knowledge to measure ecological index

1. Identification, qualitative and quantitative estimation of marine and freshwater plankton.
2. Study of museum specimens of ecological and evolutionary importance.
3. Study of animal associations – parasitism, mutualism, commensalism, symbiosis.
4. Estimation of BOD in pond, sea and polluted waters.
5. Estimation of chloride in water samples.
6. Estimation of nitrate in water samples.
7. Estimation of silicate in water samples.
8. Estimation of phosphate in water samples.
9. Estimation of primary productivity using light and dark bottle method.
10. Study of a pond ecosystem.
11. Study of intertidal sandy, muddy and rocky shores- observation of fauna and their adaptations.
12. Determination of biodiversity index
13. Principles and application of Rain Gauge, Plankton net, GIS, GPS and remote sensing.
14. Determination of water holding capacity of soil.

References

1. Rice, E. W.; Baird, R.B.; Eaton, A.D. & Clesceri, L.S. (ed.) (2017). *Standard methods for the examination of water and waste water.* 22nd Ed. American Public Health Association, American water,Water Environment Federation. APHA 22nd Edition.
2. Michael, P. (1984). *Ecological methods for field and laboratory investigations.* Tata–McGraw –Hill Publ. Company.
3. Webber, W. J. (1972). *Physicochemical Processes: For Water Quality Control.* Wiley Inter-Science.

Biostatistics

CO1 Develop the ability to plot graphs and charts

CO2 Develop the ability to plot graphs and charts using R

CO3 Understand various statistical methods to work on a research project

1. Application of standard tests (z-test, t-test, x2 test)
2. Analysis of variance
3. Regression analysis
4. Calculation of coefficient of correlation
5. Calculation of mean, standard deviation and standard error using computer
6. Calculation of Coefficient of correlation using R
7. Graphics using R – Construction of histogram

References

1. John, T. (2002). *Practical Statistics for Environmental and Biological Scientists*.John Wiley & Sons.
2. Goss-Sampson, M. (2020). *Statistical analysis in JASP - A guide for students*. 4th Ed.

Animal Behaviour

CO1 Demonstrate and identify various behaviours of animals

CO2 Develop practical skill to identify various patterns of behaviour

1. Study of social hierarchy among mammals
2. Field study on vocal communication in birds

References

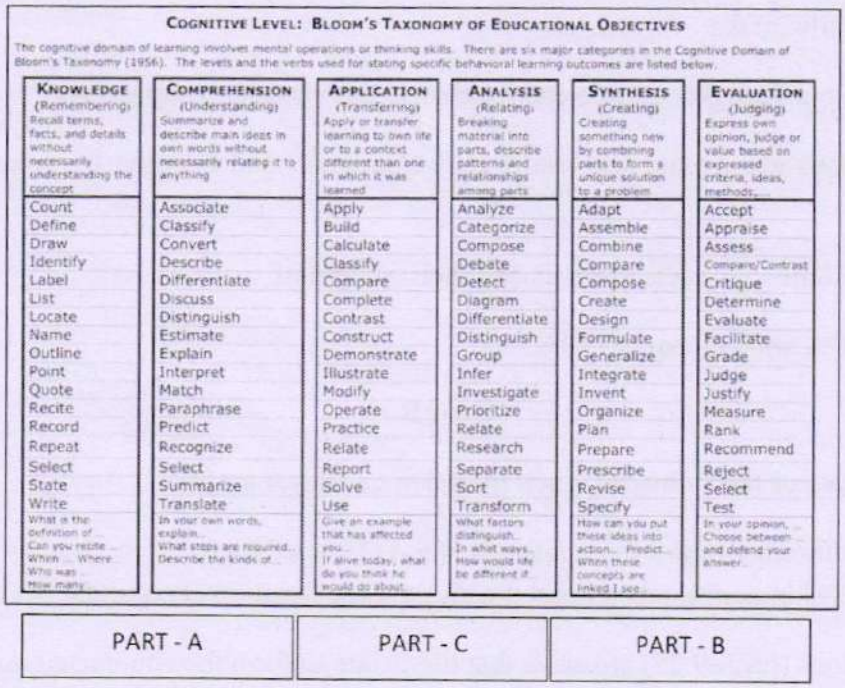
1. Goodenough, J., Mc. Guire, B. and Robert, W. (1993). *Perspectives on Animal Behaviour*. John Wiley press.
2. Manning, A. and Dawkins, M.S. (1995). *An introduction to Animal Behaviour*. Cambridge Press.
3. Bonnie J. Ploger and Ken Yasukawa (2003) *Exploring Animal Behaviour in Laboratory and Field*. Academic press.
4. Noble S. Proctor and Patrick J. Lynch, *Manual of ornithology -Avian structure and function*

5. Elliott Coues, *Handbook of Field and General Ornithology: A Manual of the Structure and Classification of Birds, with Instructions for Collecting and Preserving Specimens*
6. Richard Grimmett,Carol Inskipp,Tim Inskipp, *Birds of India: Pakistan, Nepal, Bangladesh, Bhutan, Sri Lanka, and the Maldives* – Second Edition
7. Bikram Grewal,Sumit Sen, Sarwandeep Singh., *Birds of India: Pakistan, Nepal, Bhutan, Sri Lanka and Bangladesh*

END SEMESTER EVALUATION

Evaluation in outcome-based education is designed to measure the attainment of specific learning outcomes. It involves aligning assessments with the outcomes, using criterion-referenced assessment methods, providing continuous feedback, and evaluating the effectiveness of the overall educational program. By focusing on clear outcomes and providing regular feedback, evaluation in outcome-based education supports student learning and helps improve the quality of education. Outcome evaluation goes beyond assessing individual knowledge and comprehension and focuses on the broader application and integration of knowledge, skills, and attitudes. In outcome evaluation, learners are expected to demonstrate their ability to critically analyze and evaluate the overall impact and effectiveness of what they have learned or the program they have participated in.

The end semester examination is based on Bloom's taxonomy criteria (1956), both in the case of theory and practical, given as follows;



COGNITIVE LEVEL: BLOOM'S TAXONOMY OF EDUCATIONAL OBJECTIVES

The cognitive domain of learning involves mental operations or thinking skills. There are six major categories in the Cognitive Domain of Bloom's Taxonomy (1956). The levels and the verbs used for stating specific behavioral learning outcomes are listed below.

KNOWLEDGE (Remembering) Recall terms, facts, and details without necessarily understanding the concept	COMPREHENSION (Understanding) Summarize and describe main ideas in own words without necessarily relating it to anything	APPLICATION (Transferring) Apply or transfer learning to own life or to a context different than one in which it was learned	ANALYSIS (Relating) Breaking material into parts, describe patterns and relationships among parts	SYNTHESIS (Creating) Creating something new by combining parts to form a unique solution to a problem	EVALUATION (Judging) Express own opinion, judge or value based on expressed criteria, ideas, methods,...
Count	Associate	Apply	Analyze	Adapt	Accept
Define	Classify	Build	Categorize	Assemble	Appraise
Draw	Convert	Calculate	Compose	Combine	Assess
Identify	Describe	Classify	Debate	Compare	Compare/Contrast
Label	Differentiate	Compare	Detect	Compose	Critique
List	Discuss	Complete	Diagram	Create	Determine
Locate	Distinguish	Contrast	Differentiate	Design	Evaluate
Name	Estimate	Construct	Distinguish	Formulate	Facilitate
Outline	Explain	Demonstrate	Group	Generalize	Grade
Point	Interpret	Illustrate	Infer	Integrate	Judge
Quote	Match	Modify	Investigate	Invent	Justify
Recite	Paraphrase	Operate	Prioritize	Organize	Measure
Record	Predict	Practice	Relate	Plan	Rank
Repeat	Recognize	Relate	Research	Prepare	Recommend
Select	Select	Report	Separate	Prescribe	Reject
State	Summarize	Solve	Sort	Revise	Select
Write	Translate	Use	Transform	Specify	Test
What is the definition of... Can you recite ... When ... Where ... Who was ... How many ...	In your own words, explain... What steps are required... Describe the kinds of...	Give an example that has affected you... If alive today, what do you think he would do about...	What factors distinguish... In what ways... How would life be different if...	How can you put these ideas into action... Predict... Within these concepts are linked I see...	In your opinion, ... Choose between ... and defend your answer...

PART - A	PART - C	PART - B

Question Paper Pattern

Part	No. of questions	No. of Questions to be answered	Mark for each question	Total	Cognitive level
A	6	5	3	15	Remembering Understanding
B	5	3	6	18	Creative Judging
C	5	3	9	27	Application Analysis
TOTAL MARKS				60	

Model Question Paper – MSZNG01C01

Biochemistry

Time 3 hours **Total Marks - 60**

Part A

Answer any five of the following each question carries 3 marks

1. List out various non-covalent bonds and interactions found in biomolecules.

2. Enumerate the different water soluble vitamins, list down their sources and recommended daily intake.

3. Record your thoughts on free energy change and its role in metabolism.

4. List various glucogenic and ketogenic amino acids and mention the basis for such a classification.

5. List out some metabolic diseases and their symptoms.

6. Compare A and B form of DNA.

Part B

Answer any three of the following each question carries 6 marks

7. a) The laboratory report for a patient's blood pH was 7.08 (reference range =7.37-7.43) What was the [H+] in her blood compared with the concentration at a normal pH of 7.4?

b) Ammonium ions (pKa=9.25) are acids that dissociate to form the conjugate base, ammonia, and hydrogen ions. What is the form present in blood (normal pH 7.4)? In urine (pH 5.5-7.0)?

8. A patient is diagnosed with megaloblastic anaemia and elevated homocysteine levels in her blood. What may be reasons for the condition. Explain the pathways that are affected which causes this condition.

9. Protein aggregates resulting from decreased degradation is observed in many neuro-degenerative diseases; Hypothesise which pathways or processes may be affected in such patients and also explain the process in normally behaving cells.

10. Summarise how ruminants use propionate, produced in the rumen as a result of bacterial fermentation, in energy production and metabolism.

11. Assess the effect of Carbon Monoxide and Cyanide on mitochondrial Electron Transfer Chain.

Part C

Answer any three questions each question carries 9 marks

12. Explain Photosynthesis

13. Summarize the pathways involved in Purine Synthesis.

14. Differentiate Glycolysis and Gluconeogenesis

15. Illustrate the various mechanisms involved in enzyme catalysis with suitable examples.

16. Outline the oxidation of even numbered and odd numbered fatty acids.

Biophysics and Biostatistics

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1.

2.

3.

4.

5.

6.

Part B

Answer any three of the following each question carries 6 marks

7.

8.

9.

10.

11.

Part C

Answer any three questions each question carries 9 marks

12.

13.

14.

15.

16.

TIME: 3 HOURS **TOTAL: 60**

PART A (Knowledge and Understand level)

Answer any five of the following. Each question carries 3 marks

1. Comment on plasma membrane modification with illustration
2. Briefly describe the role of mitochondria in ageing
3. Write a note on stem cells and their significance
4. Explain numerical changes in human chromosomes
5. Write a note on IS elements
6. Explain palaeogenetics.

Part B (Evaluate and Creative level)

Answer any three of the following. Each question carries 6 marks

7. Comment on epigenetic control in gene regulation
8. Write on different recombination methods
9. Comment on role of ER and Golgi complex in cellular transport
10. Discuss the term cell signalling with suitable examples.
11. Discuss the term post mendelian genetics

PART C (Apply and Analyse level)

Answer any three questions. Each question carries 9 marks

12. Elaborate your understanding on Cell adhesion with examples and sketches.
13. Summarise the pathways associated with cancer development
14. Explain various pathways and regulatory mechanisms involved in apoptosis
15. Write an account on transposable elements with suitable examples
16. Elaborate the stages of cell cycle with their regulatory mechanism

Model Question Paper – MSZNG01C04

SYSTEMATICS, EVOLUTIONARY BIOLOGY

AND BEHAVIOURAL SCIENCE

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1.

2.

3.

4.

5.

6.

Part B

Answer any three of the following each question carries 6 marks

7.

8.

9.

10.

11.

Part C

Answer any three questions each question carries 9 marks

12.

13.

14.

15.

16.

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1.

2.

3.

4.

5.

6.

Part B

Answer any three of the following each question carries 6 marks

7.

8.

9.

10.

11.

Part C

Answer any three questions each question carries 9 marks

12.

13.

14.

15.

16.

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1. What is D-loop? Where do you find it?

2. Explain the structure of nucleosome.

3. Explain the 'Adaptor' and 'Messenger' Hypotheses proposed by Francis Crick.

4. What are the channels found in RNA polymerase enzyme?

5. Explain Multiple Sequence Alignment?

6. What is Wobble concept?

Part B

Answer any three of the following each question carries 6 marks

7. If you were asked to study the gene expression following a drug administration and before it in an organism, which methods and techniques would you use? Substantiate.

8. Design an experiment to crack the genetic code of a newly described phylum of animals?

9. If you encounter an Adenine in place of a Guanine during a genome scan in an organism, what explanation would you provide for the scenario, given that the organism was never exposed to mutagens.

10. Summarize, how could you identify a specific clone from a DNA library?

11. If you find high expression of TFIIH in a cell – how would you explain the scenario?

Part C

Answer any three questions each question carries 9 marks

12. Explain PCR and qPCR.

13. Explain the replication of DNA in prokaryotes with special reference to the structure and mechanisms in the DNA polymerase.

14. Differentiate between replication errors and DNA damage and explain the error repair mechanisms.

15. Explain the mechanism of translation in prokaryotes and eukaryotes.

16. Detail the early experiments confirming DNA as the genetic material.

Model Question Paper – MSZNG02C10

ENVIRONMENTAL BIOLOGY

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1.

2.

3.

4.

5.

6.

Part B

Answer any three of the following each question carries 6 marks

7.

8.

9.

10.

11.

Part C

Answer any three questions each question carries 9 marks

12.

13.

14.

Model Question Paper – MSZNG02C11

Immunology

Time 3 hours **Maximum Marks: 60**

Part A

Answer any five of the following each question carries 3 marks

1.

2.

3.

4.

5.

6.

Part B

Answer any three of the following each question carries 6 marks

7.

8.

9.

10.

11.

Part C

Answer any three questions each question carries 9 marks

12.

13.

14.