To, Date: **12 June 2024**

The Academic Registrar
Bodoland University

Subject: Submission Four Years B. Sc. syllabus for Zoology under NEP, 2020

Dear Sir,

I am writing to inform you that the syllabus prepared by the Syllabus Preparation Subcommittee for FYIMP syllabus under Bodoland University has been approved by all members. We are pleased to submit the finalized syllabus for consideration and implementation by the university authority.

The subcommittee, consisting of experienced faculty members and subject matter experts, dedicated considerable time and effort in developing a comprehensive syllabus that aligns with the academic standards and objectives set by the university. The syllabus encompasses all the necessary components, including the course content, learning outcomes, and recommended resources, to ensure an enriching learning experience for the students.

Throughout the process, the subcommittee members thoroughly discussed and deliberated on various aspects of the syllabus to ensure its relevance, coherence, and adherence to the curriculum guidelines. We believe that the approved syllabus will effectively cover the essential knowledge, skills, and competencies required for the successful completion of the course.

We trust that the university authority will recognize the efforts put forth by the subcommittee and the value this syllabus will bring to the academic program.

We would like to express our gratitude to the university authority for entrusting us with the responsibility of developing the syllabus.

Yours sincerely,

(Dr. Kushal Choudhury)
Convenor
FYIMP syllabus sub-committee
Bodoland University

Meeting Proceeding – June 9, 2024

Date: June 9, 2024 Department of Zoology, Bodoland University

Proceedings:

The meeting was called to order at 3.30 pm by Convenor of NEP FYIMP syllabus sub-committee. The purpose of the meeting was to discuss and finalize the proposed syllabus prepared by the committee members. The attendees consisted of undermentioned sub-committee members responsible for preparing the syllabus.

During the meeting, the committee members showed the proposed syllabus, outlining the changes and updates made based on previous discussions and suggestions. The sub-committee members expressed their agreement with the proposed syllabus, acknowledging that it aligns well with the desired learning outcomes and addresses the key objectives of the curriculum.

After a thorough discussion and deliberation, it was unanimously agreed upon by all the sub-committee members present that the proposed syllabus is comprehensive, well-structured, and suitable for the intended academic program. They commended the committee members for their diligent efforts in preparing the syllabus and acknowledged the inclusivity of diverse perspectives throughout the development process.

The sub-committee members further decided to submit the proposed syllabus to the relevant authority for further review and approval.

Conclusion

With the agreement and support of all the sub-committee members, the proposed syllabus prepared by the committee members will be submitted to the authority. The meeting adjourned at 4.30 pm with a sense of accomplishment and optimism for the positive impact of the revised syllabus on the academic program.

NAME AND DESIGNATION OF THE FYIMP SYLLABUS SUB-COMMITTEE MEMBERS

Sl. no.	Name of Faculties	Designation	Institution
1	Prof. Dhiraj Saha	Subject Expert	Department of Zoology University of North Bengal West Bengal, India
2	Dr. Pradip Sarma, Associate Professor	Subject Expert	Department of Zoology Bhattadev University, Assam, India
3	Dr. Kushal Choudhury	Convenor	Department of Zoology Bodoland University, Assam, India
4	Prof. Hilloljyoti Singha	Member	Department of Zoology Bodoland University, Assam, India
5	Dr. Dulur Brahma	Member	Department of Zoology Bodoland University, Assam, India
6	Dr. Ananta Swargiary	Member	Department of Zoology Bodoland University, Assam, India
7	Mr. Bihung Basumatary	Member	Department of Zoology Bodoland University, Assam, India

UNIVERSITY OF NORTH BENGAL

ACCREDITED BY NAAC WITH GRADE B++

DEPARTMENT OF ZOOLOGY

DST-FIST & UGC SAP Sponsored

समानो मन्त्रः समितिः समानी

P.O. North Bengal University
Raja Rammohunpur, Dist. Darjeeling
West Bengal, India, PIN - 734013

Ref: Zoo/1316/2024

Date: 18th June, 2024

To,
The Head
Department of Zoology
Bodoland University, Assam

Sub: Report on PG syllabus of Zoology as per NEP-2020, Bodoland University, Assam

Sir,

In reference to the above, I am to state that the PG syllabus has been prepared with utmost care focussing the main theme of NEP-2020. The syllabus meets the standard focuses the learning flexibility, skill development, employability, and entrepreneurship skills. It has followed prescribed format of NEP-2020.

This is for your kind information and necessary action.

Thanking you,

18/06/24

Prof. Dhiraj Saha
Head and Professor
Department of Zoology
University of North Bengal

Head
Department of Zoology
University of North Bengal
Dist. Darjeeling, Pin- 734013

DEPARTMENT OF ZOOLOGY * N.B.U. *

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Bodoland University
Kokrajhar, Assam

As per National Education Policy -2020
Syllabus for Theory and Practical for FYIMP syllabus under NEP, 2020

Subject: Zoology, 2024

Under auspices of Department of Higher Education
Assam

SEMESTER-WISE TITLES OF THE PAPERS IN FYIMP

YEAR	SEMESTER	PAPER CODE	PAPER TITLE	CREDITS TH+PR	Marks TH+PR+IN	TOTAL MARKS
UG Certificate in Zoological Techniques with internship of 4 credits						
1	1	ZOOMAJ1014	Cell Biology and Histology	3+1	50+20+30	100
	1	ZOOMIN1014	Cell and Molecular Biology	3+1	50+20+30	100
	1	ZOOIDC1013	Environmental Studies and Wildlife Conservation	2+1	40+10	50
	1	ZOOSEC1013	Non-Mulberry Sericulture	2+1	40+10	50
	1	ZOOVAC1014	Basic Ecotourism	2+2	50	50
	I	ZOOINT1014	Summer Internship	4		
	2	ZOOMAJ2014	Biological Techniques	3+1	50+20+30	100
	2	ZOOMIN2014	Biostatistics and Bioinstrumentation	3+1	50+20+30	100
	2	ZOOIDC2013	Basic Lab Safety & Techniques	2+1	40+10	50
	2	ZOOSEC2013	Aquaculture	2+1	40+10	50
	2	ZOOVAC2014	Vermicompost Technology	2+2	50	50
UG Diploma in Zoological Techniques with internship of 2 years						
2	3	ZOOMAJ3014	Basics of Biochemistry	3+1	50+20+30	100
	3	ZOOMAJ3024	Principles of Ecology and Animal Behaviour	3+1	50+20+30	100
	3	ZOOMIN3014	Evolutionary Biology and Genetics	3+1	50+20+30	100
	3	ZOOIDC3013	Human-Wildlife Conflict and Management	2+1	40+10	50
	3	ZOOSEC3013	Animal Husbandry and Livestock Management	2+1	40+10	50
	4	ZOOMAJ4014	Physiology: Life-sustaining systems	3+1	50+20+30	100
	4	ZOOMAJ4024	Principles of Genetics	3+1	50+20+30	100
	4	ZOOMAJ4034	Animal Biotechnology	3+1	50+20+30	100
	4	ZOOMIN4014	Physiology and Biochemistry	3+1	50+20+30	100
	4	ZOOINT4014	Internship	2		
Bachelor's Degree in Zoology						
3	5	ZOOMAJ5014	Basic systematic and Diversity of life-I (Non-chordates)	3+1	50+20+30	100
		ZOOMAJ5024	Developmental Biology	3+1	50+20+30	100
		ZOOMAJ5034	Organic Evolution	3+1	50+20+30	100
		ZOOMAJ5044	Biochemistry of metabolic processes	3+1	50+20+30	100
		ZOOMIN5014	Taxonomy and Diversity of life-I (Non-chordates)	3+1	50+20+30	100

		ZOOINT5014	Internship	4		
	6	ZOOMAJ6014	Diversity of life-II (Chordates)	3+1	50+20+30	100
		ZOOMAJ6024	Comparative Anatomy of Vertebrates	3+1	50+20+30	100
		ZOOMAJ6034	Molecular Biology	3+1	50+20+30	100
		ZOOMAJ6044	Biostatistics & Bioinformatics	3+1	50+20+30	100
		ZOOMIN6014	Diversity of life-II (Chordates)	3+1	50+20+30	100
Bachelor Degree in Zoology with Honours						
4	7	ZOOADL7014	Cell Structure and Function	3+1	50+20+30	100
		ZOOADL7024	Overview of Immune System	3+1	50+20+30	100
		ZOOADL7034	Endocrinology and Hormonal Regulation	3+1	50+20+30	100
		ZOOADL7044*	Ecology & Environmental Biology	3+1	50+20+30	100
		ZOOREM7014	Research Methodology	3+1	50+20+30	100
		ZOOMIN7014	Ecology & Environment	3+1	50+20+30	100
	8	ZOOADL8014	Fundamental Biostatistics	3+1	50+20+30	100
		ZOOADL8024	Ethnozoology	3+1	50+20+30	100
		ZOOADL8034	Reproductive & Developmental Biology	3+1	50+20+30	100
		ZOOADL8044	Fundamental Animal Physiology	3+1	50+20+30	100
		ZOOADL8054	Biochemistry	3+1	50+20+30	100
		ZOOMIN8014	Introduction to Developmental Biology	3+1	50+20+30	100
Bachelor Degree in Zoology with Research						
	8	ZOOADL8014	Fundamental Biostatistics	3+1	50+20+30	100
		ZOODISS80112	Dissertation	12		
Total Credits				**160**		

Programme Outcomes (POs)

PO 1: This will improve both the fundamental theoretical understanding and practical knowledge of Zoology.

PO 2: This will assist students in developing the foundational concepts necessary for future projects and advanced studies.

PO 3: It will promote an understanding of the evolutionary foundations of diverse animal species and their development, while also addressing the current state of animal diversity.

PO 4: It will enable students to comprehend the principles related to different applied sciences.

PO 5: It will contribute to the conservation of wild animals and enhance the economic value of the zoological content present in the environment.

PO 6: All the above POs will lead to a mind that can develop modern technologies to address the problems and to give solution to it.

SEMESTER I

Cell Biology and Histology

Paper Code: ZOOMAJ1014

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objects

The course aims to develop a comprehensive understanding of cell structure and function, histology principles, and practical skills for cellular analysis and tissue identification.

Course Outcomes

Upon completion of the course, students will have acquired sufficient knowledge on the fundamental structure, function, and biochemistry of the cell.

Course Contents

Theory **Credit: 03**

Unit I

Cell Biology: Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membrane structure, Active and Passive transport, Facilitated-transport, cell junctions; Cell Division: Mitosis, Meiosis, Cell cycle and its regulation and Cell Signaling: Receptors (types) and signaling molecules.

Unit II

Structure and Function of different cell components: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mitochondria and Peroxisomes, Microtubules, Microfilaments and Intermediate filament; Structure of Nucleus: Nuclear envelope, Nuclear pore complex, Nucleolus, Chromatin: Euchromatin and Heterochromatin and packaging (nucleosome).

Unit III

Histology: Structure of epithelium, connective tissue, cartilage, bone, smooth, striped and cardiac muscles, nervous tissue; Histology of organs: gonads, liver, lung, pancreas and kidney in mammals; Basic principles of fixation and staining: Classification, Composition and properties of dye, Use of mordants and metachromatic dyes; Principle and procedure of histological staining of carbohydrates, amino acids, proteins, lipids and nucleic acids.

Practical C**redit: 01**

1. Study of prokaryotic and eukaryotic cells.
2. Preparation of temporary stained squash of onion root tip to study various stages of mitosis.
3. Study of various stages of meiosis in grass hopper testis.
4. Preparation of permanent slide to show the presence of Barr body in human female blood cells/buccal epithelial cell.

5. Study of different tissue through permanent slides: Epithelial (simple, squamous, cuboidal, columnar Compound, stratified, transitional) muscular tissue, Connective tissue (bone, cartilage, areolar, tendon, adipose, reticular) and nervous tissue.

SUGGESTED READINGS

1. De Roberties, E. D. P. *et al. Cell and Molecular Biology* TMH
2. Bhaskaran, K. K. &Biju Kumar, A. *Cell Biology, Genetics & Molecular Biology*.
3. Karp G. (2005). *Cell and Molecular Biology*.4 e, John Wiley & Sons, Inc.
4. Sadava, D. E. *Cell Biology*. Jones & Bartlett Publishers, London
5. Sheeler, P. and Bianchi D. E. *Cell Biology - Structure, Biochemistry and Functions*.
6. Verma, P. S. &Agarwal, V. K. *Cytology*. S. Chand & Co.
7. Vijayakumaran Nair, K. & Jayaprakash, M. *Cell Biology, Genetics, Molecular Biology*, Academica.

Semester I

Cell and Molecular Biology

Paper Code: ZOOMIN1014

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objects

The course aims to develop a comprehensive understanding of cell structure and function, histology principles, and practical skills for cellular analysis and tissue identification.

Course Outcome

Upon completion of the course, students will have acquired sufficient knowledge on the fundamental structure, function, and biochemistry of the cell.

Course Contents

Theory **Credits: 03**

Unit I

Overview of Cells: Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions; Plasma Membrane: Various models of plasma membrane structure; Transport across membranes: Active and Passive transport, Facilitated transport.

Unit II

Endomembrane System: Structure and Functions of Endoplasmic Reticulum, Golgi Apparatus, Lysosomes, Mitochondria, Peroxisomes; Cytoskeleton: Structure and Functions of Microtubules, Microfilaments and Intermediate filaments; Nucleus: Structure and Function; Chromatin: Euchromatin and Heterochromatin; Cell Division: Mitosis, Meiosis, Cell cycle and its regulation

Unit III

Nucleic Acids: Salient features of DNA and RNA, Watson and Crick model of DNA; DNA Replication: Replication in prokaryotes and eukaryotes, mechanism of DNA replication, Semi-conservative, bidirectional and semi-discontinuous replication; Transcription: RNA polymerase and transcription Unit, mechanism of transcription in prokaryotes and eukaryotes.

Practical **Credits: 01**

1. Preparation of temporary stained squash of onion root tip to study various stages of mitosis
2. Study of various stages of meiosis
3. Preparation of permanent slide to show the presence of Barr body in human female blood
4. cells/cheek cells.
5. Study of Polytene chromosomes from Chironomus / Drosophila larvae

SUGGESTED READINGS

1. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. (2006). Cell and Molecular Biology. VIII Edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. (2009). The Cell: A Molecular Approach. V Edition. ASM Press and Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. (2009). The World of the Cell. VII Edition. Pearson Benjamin Cummings Publishing, San Francisco.

Semester I

Environmental Studies and Wildlife Conservation

Paper Code: ZOOIDC1013

No. of Credits 3: {2(T) + 1(P)}

Total hours: 30 (Theory) (2 hour/ Week)

Objective

The objective of studying the anthropogenic impact on the environment is to understand the detrimental effects of human activities on ecosystems and biodiversity.

Course outcome

The outcome of such studies is to foster a sense of responsibility and encourage sustainable practices for the preservation and conservation of the environment. This knowledge can help in formulating policies and strategies to mitigate the damage caused by human activities and work towards achieving a more harmonious relationship between man and nature.

Course content

Theory **Credits: 02**

Unit I

Anthropogenic impact on environment: Man, as an animal species in the ecosystem. Population explosion. carrying capacity, exploitation of resources due to urbanization, industrialization and agricultural practices. Pollution of air, water, soil and noise; radioactive pollution. Eutrophication. Deforestation; Threats to biodiversity, Extinction of species. Greenhouse effect and global warming; climate change; Shrinking of glaciers. Threats to sustainable development.

Unit II

Value of wildlife and its conservation: Definition, value and importance of wildlife; Types of ecosystems. Causes of depletion of wildlife; Factors responsible for the extinction of animals; Biodiversity conservation– In-situ e.g., Sanctuaries, National Parks, Biosphere Reserves, World Heritage Sites; Ex-situ e.g., botanical gardens, gene banks, cryopreservation etc.; Rainwater harvesting, groundwater water recharge.

Practical **Credits: 01**

1. Visit to an area to document environmental assets including natural resources/flora/fauna, etc.
2. To determine the chemical conditions of water: pH, temperature, conductivity, dissolved oxygen and carbon-di-oxide, hardness etc.

Suggested readings

1. Odum, E.P, 1971. Fundamentals of Ecology. W.B. Saunders Co. USA 57

2. Singh, J.S., Singh, S.P. & Gupta, S.R. 2006. Ecology, Environment and Resource Conservation. Anamaya Publications.
3. Wilson, E. O. 1985. The Biological Diversity Crisis. BioScience 35: 700-706.
4. Mitra, A.P., Sharma, S., Bhattacharya, S., Garg, A., Devotta, S. &Sen, K. 2004. Climate Change and India. Universities Press, India.
5. Gaston, K J. & Spicer, J.I. 1998. Biodiversity: An Introduction. Blackwell Science, London, UK.
6. Primack, R.B. 2002. Essentials of Conservation Biology (3rd edition). Sinauer Associates, Sunderland, USA.

Semester I
Non-Mulberry Sericulture
Paper Code: ZOOSEC1013
No. of Credits – 3: {2(T) + 1(P)}
Total hours: 30 (Theory) (2 hour/ Week)

Objective
By the end of this section, students will have a clear understanding of sericulture, its historical significance, and the current status of mulberry and non-mulberry sericulture.

Course outcome
They will also have knowledge of the life cycles of Eri and Muga silkworms, the structure of silk glands, and the characteristics of silk. Additionally, readers will be informed about the food plants suitable for Eri and Muga silkworm rearing. Overall, this section will lay a strong foundation for understanding the subsequent topics related to sericulture.

Course contents

Theory **Credits: 02**

Unit I
Sericulture: Definition, history and present status of Mulberry and Non-Mulberry Sericulture; Silk route; Varieties of Silk; Life cycle of silkworm- Eri and Muga; Structure of silk gland and Nature of Silk; Food plants of Eri and Muga Silkworm; Rearing Operation: Rearing house/Site and rearing appliances. Disinfectants: Formalin, bleaching powder. Rearing technology: Early age and Late age rearing; Environmental conditions in rearing: temperature, Humidity, Light and Air. Harvesting and storage of cocoons; Spinning and Reeling of silk

Unit II
Pests and Diseases: Pests of eri and muga silkworm. Pathogenesis of eri and muga silkworm diseases: Protozoan, viral, fungal and bacterial. Prevention and control measures of pests and diseases. Entrepreneurship in Non-Mulberry Sericulture: Varieties of Non-Mulberry Silk products and economics in India Prospectus of Non-Mulberry Sericulture in India: Non-Mulberry Sericulture industry in different states, employment generation and potential.

Practical **Credit: 01**
1. Study of life cycle of Muga and Eri silkworm.
2. Visit to various sericulture Govt. /Private Farm/ Centers and report submission.

Suggested readings
1. F.A.O. (1984). Manual on Sericulture published by Food and Agriculture Organization
2. S.B. Dandin, J. Jayaswal and K. Giridhar (2001). Handbook of Sericulture Technologies. Publisher-Central Silk Board, Bangalore.

3. Muga Culture. 2013. Author: RN Singh, CM Vaspayi, A. Tikader and B. Sarat Chandra. Publisher – APH Publishing Corporation, New Delhi.
4. Ericulture- A comprehensive Profile. Authors: MC Sarmah, BN Sarkar, SA Ahmed and J Dewry. 2013.
5. Directorate of Sericulture, BTC, Silkworm Egg Production. 1997. Publisher – Oxford and IBH Publishing Co. Pvt. Lt.
6. Krishnamurthy, K.V. 2004. An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi.

Semester I

Basic Ecotourism

Paper Code: ZOOVAC1014

No. of Credits – 4: {2(T) + 2(P)}

Total hours: 30 (Theory) (2 hour/ Week)

Objective

The objective of this course is to provide a comprehensive understanding of tourism as a concept and its basic components.

Course outcome

- Students will understand the concepts of tourism demand and supply and will be able to identify the unique features of the tourism industry.
- Overall, this course will equip students with a solid foundation in tourism studies, enabling them to analyze and understand the various aspects and impacts of the industry.

Theory **Credits: 02**

Unit I

Definition of Tourism; Basic Components and types of Tourism: accessibility, attraction and accommodation; Motivation for Tourism; scope; leisure, recreation and tourism, and their interrelationship. Components of Tourist Resources: Tourist oriented resources, resident oriented resources, background of tourism resources and retrieval tourist resources. Tourism Demand and Supply: concept, unique features, constraint and opportunity in creating ideal destination; Ethnic hospitality: nature and dimensions.

Unit II

Economic impacts of Tourism: income and employment; Socio-cultural impacts of Tourism; Ecological and Environmental impacts of Tourism; Tourism planning: Concept, nature and type of tourism planning; Tourism policy of Assam; Planning for the development of a tourist destination; Definition and types of Tour operator and Travel agency; Marketing: concept and definition and its significance in tourism industry; Basic concept of need, demand and services. Definition and types of tourist guide, Job description, duties and responsibilities of tourist guide: Importance of tourist guide in tourism industry; Income source of a tourist guide.

Practical **Credits: 02**

1. Visit to important wetland or forest and report preparation related to ecotourism
2. Tour programme preparation
3. Tour operating Broucher preparation

Suggested readings

1. Introduction to Tourism : A. K. Bhatia
2. Tourism System: Mill R.C & Morrison
3. Tourism Development: R. Garther
4. Successful Tourism Management: Pran Nath Seth

Semester II
Biological Techniques
Paper Code: ZOO MAJ 2014
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objectives of the course are to understand the principles, techniques, and applications of various bio-instrumentation methods and to gain knowledge of diagnostic methods used for blood and urine analysis, including detection and prevention of diabetes and hypertension.

Course Outcome
- After completing the objectives related to Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions, Various models of plasma membrane structure, Active and Passive transport, Facilitated-transport, Cell junctions, Structure and Function of different cell components, Cell Division, and Cell Signaling, students will be able to demonstrate a comprehensive understanding of the structure, function, and processes involved in cellular biology.
- Upon achieving the objectives related to Histology and Bio-instrumentation, students will acquire the ability to apply principles and techniques of microscopy, histological staining, and diagnostic methods for blood and urine analysis. They will also develop skills in utilizing various bio-instrumentation tools and methods for research, analysis, and diagnostic purposes in the field of biology.

Course Contents

Theory **Credits: 03**

Unit I
Principles and Techniques of Microscopy; Magnification and Resolution Parameters of Light, Simple Microscope, Compound Microscope; Types of Compound Microscopes: Bright Field, Dark Field, Phase Contrast Microscope, Scanning & Transmission Electron Microscope and; Microtome.

Unit II
Principle & Applications of Centrifuge machine, pH Meter, distillation plant, hot-air oven, Colorimetry; Introduction to Chromatography: Mobile phase, stationary phase, solvent system, Rf value; Paper Chromatography, Thin Layer Chromatography, Column Chromatography: Gas Chromatography, Ion Exchange, Affinity Chromatography, HPLC; Basics of Electrophoresis.

Unit III
Diagnostics Methods Used for Analysis of Blood: Blood composition, Preparation of blood smear and cell count using haemocytometer, Blood grouping; Urine Analysis: Physical

characteristics, Abnormal constituents; Diagnosis and prevention of Diabetes (Type I and Type II), Testing of blood glucose.

Practical **Credits: 01**

1. Preparation of blood smear and cell counting
2. Detection of blood Group
3. Detection of sugar in urine
4. Demonstration of instrumentations
5. Detection of pH level from different samples

SUGGESTED READINGS

1. Wilson, K. and Walker, J. Principles and Techniques of Practical Biochemistry Cambridge University Press.
2. Scopes, R. Protein Purification - Principles and Practices. Springer Verlag.
3. Pattabhi V and Gautham N. Biophysics, Kluwer Academic Publishers.
4. Narayanan P. Essentials of Biophysics, New Age International Pvt Ltd.
5. Volkenshtein, M.V. General Biophysics Academic Press, Inc.
6. Daniel, M. Basic Biophysics for biologists Agrobios.

Semester II
Biostatistics and Bioinstrumentation
Paper Code: ZOOMIN2014
No. of Credits 3: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective of this course on Introduction to Biostatistics and Laboratory Techniques is to provide students with a foundational understanding of biostatistics and key laboratory techniques used in biological research.

Course Outcome
- By the end of this course, students will have a solid understanding of the principles and concepts of biostatistics. They will be able to utilize appropriate terminology, symbols, and statistical methods to analyze and interpret biological data.
- Additionally, students will gain practical knowledge of laboratory techniques such as microscopy, centrifugation, spectrophotometry, various chromatography techniques, electrophoresis, and PCR. Overall, this course will equip students with the necessary statistical and laboratory skills to conduct and analyze biological research effectively.

Couse Contents

Theory **Credits: 03**

Unit I
Introduction to Biostatistics: Research and Types of Research, sampling design, Applications of Statistics in Biological Research; Data, Collection and Representation of Data (Pie Chart, Bar Diagram, Histogram, Frequency Polygon), Measures of Central Tendency (Mean, Median, Mode), Variance, Coefficient of Variation, Standard Deviation, Standard Error of Mean,

Unit II
Analysis of Variation (ANOVA): One Way ANOVA and Two-Way ANOVA. Measures of Dispersion, Distribution Patterns (Binomial, Poisson & Normal), Tests of Significance ('T' Test, 'F' Test & Chi-Square Test); Probability; Correlation and Regression Analysis.

Unit III
Principles and Techniques of Microscopy; Magnification and Resolution Parameters of Light, Simple Microscope, Compound Microscope; Types of Compound Microscopes: Bright Field, Dark Field, Phase Contrast Microscope, Scanning & Transmission Electron Microscope; Principle & Applications of Centrifuge machine, pH Meter, Spectrophotometry, Paper Chromatography, Column Chromatography, Thin Layer Chromatography, Gas Chromatography, Ion Exchange, Affinity Chromatography and Introduction to HPLC.

Practical **Credits: 01**

1. To learn graphical representations of statistical data with the help of computers.
2. To calculate mean, median and mode of a given data
3. To perform a “two-sample t- test” for a given set of data
4. Demonstration of instrumentations

SUGGESTED READINGS

1. Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc. and Dorling Kindersley Publishing Inc.USA.
2. Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.

Semester II
Basic Lab Safety & Techniques
Paper Code: ZOOIDC2013
No. of Credits 3: {2(T) + 1(P)}
Total hours: 30 (Theory) (2 hour/ Week)

Objective
The objective of the course on Introduction to Laboratory Safety is to provide students with a comprehensive understanding of laboratory safety principles and practices.

Course outcome
- Understand the importance of laboratory safety and the consequences of inadequate safety practices.
- Recognize their roles and responsibilities as laboratory personnel in maintaining a safe working environment.
- Identify and assess common laboratory hazards, including chemical, biological, and physical hazards.

Course contents

Theory **Credits: 02**

Unit I
Introduction to Laboratory Safety: Importance of laboratory safety, Roles and responsibilities of laboratory personnel, Regulatory agencies and guidelines; Hazard Identification and Risk Assessment: Common laboratory hazards (chemical, biological, physical), Hazard communication and labeling, Risk assessment and mitigation strategies; Personal Protective Equipment (PPE): Selection and proper use of PPE (e.g., gloves, lab coats, goggles), PPE maintenance and disposal, PPE for specific hazards (e.g., respiratory protection, cryogenic protection).

Unit II
Chemical Safety: Safe handling and storage of chemicals, Hazardous chemical waste management, Chemical spill response and cleanup procedures; Biological Safety: Handling and disposal of biological materials, Biosafety levels and containment practices, Safe use of biological safety cabinets and other equipment; Physical Safety: Fire safety and emergency procedures, Electrical safety and equipment usage, Ergonomics and injury prevention; Equipment and Instrument Safety: Proper operation and maintenance of laboratory equipment, Calibration and validation of instruments, Safety precautions for specific equipment (e.g., centrifuges, autoclaves); Emergency Preparedness and Response: Emergency evacuation procedures, First aid and medical emergencies.

Practical **Credits: 01**

1. Handling of equipment and chemicals.
2. Handling of First aid.
3. Visit to an advance laboratory.

Suggested Readings

1. Fuscaldo, AA, Erlick, BI, Hindman, B. Laboratory Safety: Theory and Practice. New York: Academic Press, 1980.
2. CRC Handbook of Laboratory Safety. **(**A. Keith Furr, ed.). 5th ed.: CRC Press, 2000.
3. Laboratory Biosafety Manual. Edition: 2nd ed.: World Health Organization, 1993.

Semester II
Aquaculture
Paper Code: ZOOSEC2013
No. of Credits 3: {2(T) + 1(P)}
Total hours: 30 (Theory) (2 hour/ Week)

Objective
The objective of the course on Aquaculture Theory is to provide students with a comprehensive understanding of the principles, practices, and techniques involved in aquaculture.

Course Outcome
- Understand the historical development and current state of aquaculture.
- Identify and describe important aquaculture species.
- Apply principles and criteria for site and species selection in aquaculture.

Course contents

Theory **Credits: 02**

Unit I
Introduction to Aquaculture: History and present state. Important aquaculture species. Site and species selection. Water-quality criteria for Aquaculture. Types of culture systems. Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Integrated fish farming. Aquatic weed management. Sustainable Aquaculture;

Unit II
Fish Seed: natural collection; Bundh breeding, Induced breeding; Construction and layout of fish ponds: Productivity and its measurement; Concept of brood fish pond, hatchery, nursery and grow out ponds. Care and stocking rate; water quality management; Preparation of compound diets for fish; Breeding and culture of carps; Ornamental fish culture: Preparation and maintenance of fish aquarium; Common diseases: Bacterial, viral and parasitic; Application of biotechnology in fish production.

Practical **Credit: 01**
1. Identification and study of some important Indian common cultivable freshwater fish species.
2. Determination of dissolved oxygen, Free CO_2, alkalinity, hardness of given water sample.
3. Study of common phytoplankton and zooplankton from natural resources.
4. Collection and identification of aquatic weeds and aquatic insects.
5. Demonstration of Induced breeding of Indian major carps/catfishes

References

1. Jhingran V.G. 1997. Fish and Fisheries of India. Hindustan Publications, Delhi, India.
2. Srivastava, C.B.L. A Text Book of Fishery Science and Indian Fisheries, Kitab Mahal, Allahabad
3. S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House

Semester II
Vermicompost Technology
Paper Code: ZOOVAC2014
No. of Credits 4: {2(T) + 2(P)}
Total hours: 30 (Theory) (2 hour/ Week)

Objective
The objective of the course on Introduction to Vermiculture is to provide students with a comprehensive understanding of vermiculture, its definition, history, and economic importance.

Course outcome
- Recognize the economic importance of vermiculture in various sectors.
- Appreciate the value of vermiculture in maintaining soil structure and fertility.
- Comprehend the role of vermiculture in the four R's of recycling: reduce, reuse, recycle, and restore.
- Understand the bio-transformation process of residues generated by human activities through vermiculture.

Course contents

Theory **Credits: 02**

Unit I
Introduction to vermiculture: definition, meaning, economic importance, maintenance of soil structure; role as four Rs of recycling: reduce, reuse, recycle, restore. Role in bio-transformation: residues generated by human activity, production of organic fertilizers; Selecting the right worm: Ground population, transformation process in organic matter.

Unit II
Useful species of earthworms: Local and Exotic species of earthworms, Identification keys the species of earthworms; Biology of suitable species for vermicompost (i.e. *Eisenia fetida, Eudrilus eugeniae*); Small Scale Earthworm farming for home gardens— Earthworm compost for home gardens, Conventional commercial composting; Enemies of Earthworms.

Practical **Credits: 01**
1. Key to identify different types of earthworms
2. Field trip- Collection of native earthworms & their identification
3. Study of Systematic position, habits, habitat & External characters of studied earth worms
4. Micro vermicompost preparation.
5. Study of Life stages & development of studied earth worms
6. Field visit

Suggested readings

1. Bhatt J.V. & S.R. Khambata (1959) “Role of Earthworms in Agriculture” Indian Council of Agricultural Research, New Delhi
2. Dash, M.C., B.K. Senapati, P.C. Mishra (1980) “Verms and Vermicomposting” Proceedings of the National Seminar on Organic Waste Utilization and Vermicomposting Dec. 5-8, 1984, (Part B), School of Life Sciences, Sambalpur University, Jyoti Vihar, Orissa.
3. Edwards, C.A. and J.R. Lofty (1977) “Biology of Earthworms” Chapman and Hall Ltd., London.

Semester-III
Basics of Biochemistry
Paper Code: ZOO MAJ 3014
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
A comprehensive understanding of the structures, functions, and significance of carbohydrates, lipids, proteins, and nucleic acids, as well as the ability to apply the knowledge of biological catalysts in analyzing enzyme reactions and their regulation.

Course outcome
- After completing the objectives, the students will understand the structure, classification, and biological significance of carbohydrates, including monosaccharides, disaccharides, polysaccharides, and glycoconjugates, as well as the structure and importance of lipids, such as saturated and unsaturated fatty acids, triacylglycerols, phospholipids, glycolipids, and steroids.
- Besides, they will know about the structure and classification of amino acids, including α-amino acids, and their physiological importance, along with the bonds stabilizing protein structure, levels of organization in proteins, denaturation, introduction to simple and conjugate proteins, as well as the structure of nucleic acids, including purines, pyrimidines, nucleosides, nucleotides, and nucleic acids. Additionally, to understand the nomenclature, classification, specificity, mechanism, kinetics, and regulation of enzyme action as biological catalysts.

Theory **Credits: 03**

Unit I
Carbohydrates: Structure and Biological importance: Monosaccharides, Disaccharides, Polysaccharides and Glycoconjugates; Lipids: Structure and Significance; Physiologically important saturated and unsaturated fatty acids, Tri-acylglycerols, Phospholipids, Glycolipids, Steroids.

Unit II
Proteins and Nucleic acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids; Proteins: protein structure, Levels of organization in proteins, Denaturation, Introduction to simple and conjugate proteins; Nucleic Acids: Structure of Purines and pyrimidines, Nucleosides, Nucleotides, Types of Nucleic acids.

Unit III
Biological Catalysts: Nomenclature and classification; Cofactors; Specificity of enzyme action; Isozymes; Mechanism of enzyme action; Enzyme kinetics; Factors affecting rate of

enzyme-catalyzed reactions; Derivation of Michaelis-Menten equation, Concept of Km and Vmax, Lineweaver-Burk plot; Enzyme inhibition; Allosteric enzymes and their kinetics.

Practical **Credits: 01**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.
2. Protein Estimation by Lowry's method.
3. Action of salivary amylase under optimum conditions.
4. Effect of pH in salivary amylase enzyme

Suggested Readings

1. Cox, M.M and Nelson, D.L. (2008). Lehninger's Principles of Biochemistry, V Edition,W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well,
4. P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc.
5. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.
6. Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R. (2008). Molecular Biology of the Gene, VI Edition, Cold Spring Harbor Lab. Press, Pearson Pub.

Semester-III
Principles of Ecology and Animal Behaviour
Paper Code: ZOO MAJ 3024
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective of this course is to provide students with a basic understanding of ecosystems and their services to mankind.

Course outcome
The course aims to provide students with a basic understanding of ecosystems and their services to mankind. They will learn about the interrelationships between living organisms and their environment, and how ecosystems contribute to human well-being.

Course Contents
Theory **Credit: 03**

Unit I
Introduction to Ecology: Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors. Population: Unitary and Modular populations. Unique and group attributes of population: Density, natality, mortality, life tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion, Exponential and logistic growth, equation and patterns, r and K strategies, Population regulation– density-dependent and density-independent factors.

Unit II
Community: Community characteristics: species richness, dominance, diversity, abundance, Ecotone and edge effect; Ecological succession, Climax community. Ecosystem: Types of ecosystems Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains; Food web; Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies.

Unit III
Animal Behaviour: Introduction to Ethology, scope and methods of ethology, stimuli, stimulus filtering; Patterns of Behaviour: Individual behavioural Pattern, Homing behaviour; Genetic basic of behaviour; Neural and hormonal control of behaviour; Circadian rhythm; Motivation: Models of motivation, feeding and drinking; Learning behavior: types of learning, habituation, conditional reflex, insight learning, association learning, Reasoning and Imprinting; Social organization, Animal communications, Social behavior of Insects: dance language of honey bees.

Practical **Credits: 01**

1. Study of life tables and plotting of survivorship curves of different types from the hypothetical/real data provided.
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon- Wiener diversity index for the same community.
3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, turbidity/penetration of light, temperature, determination of pH, and Dissolved Oxygen content (Winkler's method), and free CO2.
4. To submit report on a visit to National Park/Biodiversity Park/Wild life sanctuary within N.E. India.
5. Use of apparatus for to study ecological parameters (eg. pH meter, Hygrometer, Maximum & minimum thermometer)
6. Students are required to submit a brief project report on animal behavioural study with appropriate photographs, drawings etc. conducted on domestic animals/ pets).

SUGGESTED READINGS

1. Colinvaux, P. A. (1993). Ecology. I Edition. Wiley, John and Sons, Inc.
2. Krebs, C. J. (2001). Ecology.VI Edition. Benjamin Cummings.
3. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
4. Robert Leo Smith. Ecology and field biology Harper and Row publisher
5. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press.

Semester-III

Evolutionary Biology and Genetics

Paper Code: ZOOMIN3014

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

It aims to familiarize individuals with the historical development of evolutionary concepts, the evidences supporting evolution, and the various mechanisms that drive genetic variation and inheritance. Additionally, it aims to explore the role of mutations, chromosomal aberrations, and genetic elements in shaping the genetic makeup of organisms.

Course outcome

- The outcome of studying these topics is to equip individuals with a solid foundation in evolutionary biology, genetics, and inheritance, enabling them to apply this knowledge to various fields such as medicine, agriculture, and conservation.
- Individuals will develop critical thinking and analytical skills necessary for evaluating scientific evidence and conducting further research in these areas.

Course contents

Theory **Credits: 03**

Unit I

Evolution of eukaryotes; Evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism; Evidences of Evolution: Fossil record, Molecular evolution, molecular clock; Isolating mechanisms, modes of speciation—allopatric, sympatric, Adaptive radiation / macroevolution, Natural selection: types of selection, density-dependent selection, heterozygous superiority, kin selection, adaptive resemblances, sexual selection. Genetic Drift, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies.

Unit II

Mendelian Genetics and its Extension: Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance. Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two-factor and three-factor crosses, Interference and coincidence, Somatic cell hybridization. Mutations: Types of gene mutations and chromosomal aberrations.

Unit III

Chromosomal mechanisms of sex determination in Drosophila and Man. Extra-chromosomal Inheritance: Criteria for extra-chromosomal inheritance. Polygenic inheritance with suitable examples. Recombination in Bacteria and Viruses: Conjugation, Transformation, Transduction, Complementation test in Bacteriophage. Transposable Genetic Elements:

Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans.

Practical **Credit 01**

1. To study the Mendelian laws and gene interactions.
2. Linkage maps based on data from conjugation, transformation and transduction.
3. Linkage maps based on data from *Drosophila* crosses.
4. Study of human karyotype (normal and abnormal).
5. Study of fossils from models/ pictures
6. Study of homology and analogy from suitable specimens
7. Study and verification of Hardy-Weinberg Law by chi square analysis

Suggested readings

1. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition. Jones and Barlett Publishers.
2. Campbell, N.A. and Reece J.B. (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.
3. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
4. Snustad. S. Principles of Genetics.

Semester-III
Human-Wildlife Conflict and Management
Paper Code: ZOO IDC 3013
No. of Credits 3: {2(T) + 1(P)}
Total hours: 30 (Theory) (3 hour/ Week)

Objective
This paper deals with the conflicts that have arisen as a result of shrinkage of wildlife habitats and the same being shared by human communities. It raises questions about the moral obligations of humans, need for conservation, and social impacts of conflicts. The paper aims at introducing the students to the scientific and social perspective of conservation.

Course outcome
- The course provides students with a comprehensive understanding of the evolution of wildlife management, the importance of conservation efforts, the significance of protected areas, and the socio-economic aspects of conflicts and coexistence between humans and wildlife.
- Students will develop critical thinking skills and gain insights into the complexities of wildlife conservation and sustainable development.

Course contents
Theory **Credit: 02**

Unit I
Evolution of the concept of wildlife management: Journey of mankind from predator to conservator; prehistoric association between wildlife and humans: conservation of wildlife in the reign of king Ashoka: excerpts from rock edicts; understanding wildlife management, conservation and policies regarding protected areas in 21st century; positive values of wildlife conservation (monetary, recreational, scientific and ecological benefits). The role of government, wildlife biologists and social scientists in conservation.

Unit II
Types of protected areas (Wildlife Sanctuaries, National Parks, Biosphere Reserves; concept of core and buffer area in a protected range); IUCN categories of protected areas, Natural World Heritage sites; brief introduction to Wildlife Protection Act of 1972. Socio-economic and legal basis of conflicts: Concepts of development and encroachment, Impact of conflict on humans and wildlife, impact of habitat fragmentation; social inequality in terms of forest conservation: forest produce as a need vs. forest exploitation; introduction to tribal rights in India. Human wildlife coexistence: Symbiotic relationship between tribals and forest, community participation in forest management, Chipko movement, India's Bishnoi community and their conservation practices.

Practical **Credit: 01**

1. Visit to a fringe village to a protected area and interview with the local community.
2. Socio-economic survey around a protected area.

Suggested readings

1. Woodroffe, R. 2005. People and Wildlife: Conflict and Coexistence. Cambridge.
2. Woodroffe, R., Thirgood, S., & Rabinowitz, A. 2005. People and Wildlife, Conflict or Coexistence? (No. 9). Cambridge University Press. Conover, M. 2001. Resolving Human Wildlife Conflicts, CRC Press.
3. Dickman, A. J. 2010. Complexities of conflict: the importance of considering social factors for effectively resolving human–wildlife conflict. Animal Conservation 13: 458-466.
4. Messmer, T. A. 2000. The emergence of human–wildlife conflict management: Turning challenges into opportunities. International Biodeterioration & Biodegradation 45: 97-102.
5. Paty, C. 2007. Forest Government and Tribe. Concept Publishing Company.
6. Treves, A. & Karanth, K. U. 2003. Human---carnivore conflict and perspectives on carnivore management worldwide. Conservation Biology 17: 1491-1499.

Semester III

Animal Husbandry and Livestock Management

Paper Code: ZOO SEC 3013

No. of Credits 3: {2(T) + 1(P)}

Total hours: 30 (Theory) (3 hour/ Week)

Objective

The objective of the course "Introduction to Poultry Husbandry" is to provide participants with a comprehensive understanding of poultry farming.

Course outcome

- Demonstrate proficiency in housing management, providing appropriate facilities for the comfort, health, and productivity of dairy cattle.
- Understand the principles and practices of meat production, abattoir management, and processing of meat and milk products.
- Comprehend the importance of animal welfare and apply relevant guidelines to ensure the ethical treatment of dairy cattle.

Course contents

Theory **Credit: 02**

Unit I

Introduction to poultry husbandry: Different species of poultry, Housing management, Feeds Management, Management of chicken, Selection of eggs and hatchery management, Diseases of poultry, economics of poultry farm, Sanitation and hygiene of farm, management of waste disposal; Introduction to Diary Farming: cattle breeds, Farm management – feed, fertility, newborn and pregnant animal management, housing management, milk and milk products, Zoonotic diseases, Animal welfare, and food safety guidelines.

Unit II

Introduction to piggery sector in India and Assam, Scientific piggery farming, Types of pig breeds and its selection, Breeding management, Care during pregnancy and farrowing, Piglet care, Creep feeding, Orphan pigs, Feeding management; Housing: Important points for pig housing, Diseases and health Care; Livelihood with piggery, Sanitation and hygiene of farm, management of waste disposal.

Practical **Credits: 01**

1. Identification of locally available poultry breeds.
1. Identification of locally available cattle breeds.
2. Identification of locally available pig breeds.
3. Designing of housing for local small pig breeders
4. Visit of nearby poultry/dairy/pig farm and submission of a project report.

Suggested Readings

1. Das D, Das BC and Nayak N (2021). Text Book on Poultry Management. Publisher:

Narendra Publishing House
2. Singh RA. (2009). Poultry Production. Publisher: Kalyani Production
3. Prasad J. (2016). Principles and Practices of Dairy Farm Management
4. Eri Board (2008). Hand Book of Pig Farming. Publisher: Engineers India Research Institute
5. Sharda DP. (2005). Swine Production. Publisher: ICAR, New Delhi
6. Training Manuals provided by different Govt. Departments.

Semester-IV
Physiology: Life-Sustaining Systems
Paper Code: ZOO MAJ 4014
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective

The objective of the course is to provide students with a fundamental understanding of the physiology of digestion, respiration, renal function, blood, and the heart.

Course outcome

- Students will be gaining knowledge on important life sustaining systems.
- Students will have detail knowledge on important processes of animal body.
- Students will have laboratory-oriented knowledge for handling some of important physiological& biochemical tests.

Course contents

Theory **Credits: 03**

Unit I

Physiology of Digestion: Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food. Absorptions of carbohydrates, lipids, proteins, water, minerals and vitamins. Hormonal control of secretion of enzymes in Gastrointestinal tract. Physiology of Respiration: Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Respiratory pigments, Dissociation curves and the factors influencing it; Carbon monoxide poisoning.

Unit II

Renal Physiology: Structure of kidney and its functional unit (Nephron); Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance. Blood: Components of blood and their functions; Structure and functions of haemoglobin; Haemostasis: Blood clotting system, Kallikrein-Kinninogen system, Fibrinolytic system, Haemopoiesis, Blood groups: Rh factor, ABO and MN.

Unit III

Physiology of Heart: Structure of mammalian heart; Coronary circulation; Structure and working of conducting myocardial fibers. Origin and conduction of cardiac impulses Cardiac cycle; Cardiac output and its regulation, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation.

Practical **Credits: 01**

1. Determination of ABO Blood group.

2. Enumeration of red blood cells and white blood cells using haemocytometer.
3. Estimation of haemoglobin using Sahli's haemoglobinometer
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer.
6. Examination of permanent slide of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney.

Suggested readings:

1. Guyton, A.C. & Hall, J.E. (2006). Textbook of Medical Physiology. XI Edition. Hercourt Asia PTE Ltd. W.B. Saunders Company.
2. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
3. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.

Semester IV
Principles of Genetics
Paper Code: ZOO MAJ 4024
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The course aims to provide students with a comprehensive understanding of Mendelian genetics and its extensions, equipping them with the knowledge to analyze and interpret complex genetic phenomena.

Course outcome
- Demonstrate a comprehensive understanding of the principles of inheritance and the various extensions of Mendelian genetics, including incomplete dominance, co-dominance, multiple alleles, lethal alleles, epistasis, pleiotropy, sex-linked inheritance, linkage, crossing over, chromosomal mapping, mutations, sex determination, extra-chromosomal inheritance, polygenic inheritance, recombination in bacteria and viruses, and transposable genetic elements.
- Apply their knowledge to analyze and interpret complex genetic phenomena, enabling them to explain patterns of inheritance, predict outcomes of genetic crosses, and understand the molecular basis of genetic mutations.
- Develop critical thinking and problem-solving skills in the field of genetics, allowing them to approach genetic research and practical applications with a solid foundation of knowledge and analytical abilities.

Course Contents
Theory **Credits: 03**

Unit I
Mendelian Genetics and its Extension: Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, Sex-linked inheritance. Linkage, Crossing Over and Chromosomal Mapping: Linkage and crossing over, Cytological basis of crossing over, Molecular mechanisms of crossing over including models of recombination, Recombination frequency as a measure of linkage intensity, Two-factor and three-factor crosses, Interference and coincidence, Somatic cell hybridization.

Unit II
Mutations: Types of gene mutations, Types of chromosomal aberrations, Molecular basis of mutations in relation to UV light and chemical mutagens; Detection of mutations: ClB method, attached *X*-method. Sex Determination: Chromosomal mechanisms of sex determination in Drosophila and Man. Extra-chromosomal Inheritance: Criteria for extra-chromosomal inheritance, Antibiotic resistance in *Chlamydomonas*, Mitochondrial mutations in *Saccharomyces,* Infective heredity in *Paramecium* and Maternal effects.

Unit III

Polygenic Inheritance: Polygenic inheritance with examples; Recombination in Bacteria and Viruses: Conjugation, Transformation, Transduction; Complementation test in Bacteriophage; Transposable Genetic Elements: Transposons in bacteria, Ac-Ds elements in maize and P elements in *Drosophila*, Transposons in humans.

Practical **Credits: 01**

1. To study the Mendelian laws and gene interactions.
2. Chi-square analyses using seeds/beads/*Drosophila*.
3. Linkage maps based on data from conjugation, transformation and transduction.
4. Linkage maps based on data from *Drosophila* crosses.
5. Study of human karyotype (normal and abnormal).
6. Pedigree analysis of some human inherited traits.

Suggested Readings

1. Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India
2. Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc
3. Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings
4. Russell, P. J. (2009). *Genetics- A Molecular Approach.* III Edition. Benjamin Cummings
5. Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co
6. Fletcher H. and Hickey I. (2015). *Genetics.* IV Edition. GS, Taylor and Francis Group, New York and London.

Semester IV
Animal Biotechnology
Paper Code: ZOO MAJ 4034
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
Introduce students to biotechnology concepts and molecular techniques in gene manipulation.

Course outcome
- Students will have a concept and aids of technology on biological study.
- They will learn culture techniques and their application.

Course contents
Theory **Credits: 03**

Unit I
Molecular Techniques in Gene manipulation: Restriction enzymes: Nomenclature, detailed study of Type II; Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, artificial vectors (M13, BAC, YAC, MAC); Genomic and cDNA libraries; Expression vector and cloning.

Unit II
Gene Transfer Techniques: DNA microinjection: Calcium chloride method and electroporation; screening by colony and plaque hybridization; Southern, Northern and Western blotting; PCR; DNA sequencing: Sanger method and Maxam-Gilbert method, DNA Fingerprinting; DNA and RNA micro array.

Unit III
Genetically Modified Organisms: Transgenic animals: Nuclear Transplantation, Retro-viral Method; Applications of transgenic animals: Production of pharmaceuticals, knock-out mice; Production of transgenic plants; Applications of transgenic plants: insect and herbicide resistant plants; Culture Techniques and Applications: Animal cell culture, Molecular diagnosis of genetic diseases (e.g., cancer); rDNA technology in medicines: Recombinant insulin and human growth hormone, Gene therapy.15

Practical **Credits: 01**
1. Genomic DNA isolation from *E. coli.*
2. Estimation of DNA by colorimetric method.
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs:
    a) Southern Blotting

b) Northern Blotting
c) Western Blotting
d) DNA Sequencing (Sanger's Method)
e) PCR
f) DNA fingerprinting

Suggested Readings

1. Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
2. Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
3. Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
4. Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics.* V Edition, John Wiley and Sons Inc.

Semester IV

Physiology and Biochemistry

Paper Code: ZOO MIN 4014

No. of Credits –4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

The objective of the course is to provide students with a fundamental understanding of the physiology of digestion, respiration, renal function, blood, and the heart.

Course outcome

- Students will be gaining knowledge on important life-sustaining systems.
- Students will have detail knowledge on important processes of animal body.
- Students will have laboratory-oriented knowledge for handling some of important physiological& biochemical tests.

Course contents

Theory **Credits: 03**

Unit I

Physiology of Digestion: Structural organization and functions of gastrointestinal tract and associated glands; Mechanical and chemical digestion of food; Absorptions of carbohydrates, lipids, proteins. Physiology of Respiration: Mechanism of respiration, Pulmonary ventilation; Respiratory volumes and capacities; Transport of oxygen and carbon dioxide in blood; Control of respiration.

Unit II

Renal Physiology: Structure of kidney and its functional unit (Nephron); Mechanism of urine formation. Blood: Components of blood and their functions; Structure and functions of haemoglobin; Haemostasis: Blood clotting system, Blood groups: Rh factor, ABO and MN. Structure of mammalian heart, Origin and conduction of cardiac impulses Cardiac cycle, Blood pressure and its regulation.

Unit III

Biomolecules of Life: Structure and Biological importance of Monosaccharides, Disaccharides, Polysaccharides; Structure and Significance of lipids, saturated and unsaturated fatty acids, Tri-acylglycerols; Proteins and Nucleic acids: Structure and Classification; Enzymes and Cofactors; Specificity of enzyme action; Mechanism of enzyme action; Enzyme kinetics; Factors affecting enzyme-catalyzed reactions; Allosteric enzyme; Enzyme inhibition.

Practical **Credits: 01**

1. Qualitative tests of functional groups in carbohydrates, proteins and lipids.

2. Protein Estimation by Lowry's method.
3. Determination of ABO Blood group.
4. Preparation of haemin and haemochromogen crystals
5. Recording of blood pressure using a sphygmomanometer.

Suggested readings

1. Tortora, G.J. & Grabowski, S. (2006). Principles of Anatomy & Physiology. XI Edition John Wiley & sons,
2. Vander A, Sherman J. and Luciano D. (2014). Vander's Human Physiology: The Mechanism of Body Function. XIII Edition, McGraw Hills.
3. Cox, M.M and Nelson, D.L. (2008). *Lehninger's Principles of Biochemistry*, V Edition, W.H. Freeman and Co., New York.
4. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). *Biochemistry*, VI Edition, W.H. Freeman and Co., New York.
5. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). *Harper's Illustrated Biochemistry*, XXVIII Edition, International Edition, The McGraw- Hill Companies Inc

Semester V

Basic Systematics and Diversity of Life-I (Non-Chordates)

Paper Code: ZOO MAJ 5014

No. of Credits –4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

To provide the students the basic knowledge in Taxonomy& systematics and to provide knowledge on diversity of Non-chordates.

Course outcome

By the end of the course, students will have acquired a strong foundation in animal taxonomy, enabling them to understand and apply systematic principles, perform taxonomic procedures, and classify various organisms accurately. They will also gain insight into the diversity of life and the evolutionary significance of different animal groups.

Course Contents

Theory **Credits: 03**

Unit I

Introduction to Animal Taxonomy: Definition, Basic concepts and importance of Systematics and Taxonomy. Concepts of different conventional taxonomy, alpha(α) and beta (β) taxonomy. Newer aspects in biosystematics: Chemotaxonomy, Cytotaxonomy, Molecular taxonomy. Taxonomic procedures: taxonomic collection, preservation, Components of classification. Taxonomical hierarchy - taxon, category and rank, Linnaean hierarchy, Concepts of taxonomic terms. Nomenclature: Principles of nomenclature. International Code of Zoological Nomenclature (ICZN). Rules of nomenclature. Binominal and trinominal nomenclature. Mention taxonomic aids.

Unit II

Diversity of Life: Protista, Parazoa and Metazoa: General characteristics and Classification up to classes. Study of *Euglena*, *Amoeba* and *Paramecium* Locomotion and Reproduction in Protista. Evolution of symmetry and segmentation of Metazoa. Porifera Cnidaria & Ctenophora: General characteristics and Classification up to classes. Canal system and spicules in sponges. Metagenesis in *Obelia,* Polymorphism in Cnidaria, Corals and coral reefs. Evolutionary significance of ctenophora. Platyhelminthes & Nemathelminthes: General characteristics and Classification up to classes. Life cycle and pathogenicity of *Fasciola hepatica, Taenia solium, Ascaris lumbricoides* and *Wuchereria bancrofti.* Parasitic adaptations in helminthes.

Unit III

Annelida: General characteristics and Classification upto classes, Excretion in Annelida. Arthropoda & Onychophora: General characteristics and Classification upto classes. Vision, and Respiration in Arthropoda. Evolutionary significance of onychophoran. Mollusca & Echinodermata. General characteristics and Classification up to classes. Respiration in

Mollusca. Torsion and detorsion in Gastropoda, Pearl formation in bivalves. Water-vascular system in Asteroidea, Affinities of echinoderms with Chordates.

Practical **Credits: 01**

1. Observation on morphological characters of Cockroach as a part of taxonomical study. Students will note down and draw mouth parts and wing venation of cockroach.
2. To perform morphometric and meristic study of locally available fish.
3. Study of whole mount of *Euglena, Amoeba* and *Paramecium,* Binary fission and Conjugation in *Paramecium.*
4. Study of *Sycon* (T.S. and L.S.), *Hyalonema, Euplectella, Spongilla*
5. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
6. One specimen/slide of any ctenophore
7. Study of adult *Fasciola hepatica*, *Taenia solium* and their life cycles (Slides/microphotographs)
8. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs)
9. Museum specimen: *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta,* termites and honey bees Onychophora - *Peripatus* Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* Echinodermates - *Pentaceros*/*Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*
10. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
11. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta.*

Suggested readings

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science

Online Tools and Web Resources:

3. Advances in Animal Diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology) ·
4. ePGPathshala (MHRD) Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35.

Semester V

Developmental Biology

Paper Code: ZOO MAJ 5024

No. of Credits –4: {4(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

Acquiring Knowledge on Embryonic Development:

Course outcome

- Students will be able to acquire knowledge on embryonic development of sexually reproducing animals.
- They also obtain knowledge on metamorphic changes and the role of placenta in mammals.

Course contents

Theory **Credits: 03**□5

Unit I

Basic concepts: Phases of embryonic development: zygote, morula, blastula, gastrula, archenteron; Cell-Cell interaction; Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division.

Unit II

Early Embryonic Development: Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Fate maps; Early development of frog and chick up to gastrulation; Embryonic induction and organizers; Late Embryonic Development: Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, structure and function of Placenta.

Unit III

Post Embryonic Development: Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration; Ageing: Concepts and Theories; Implications of Developmental Biology: Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

Practical **Credits: 01**

1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)

2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

Suggested readings

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

Semester V

Organic Evolution

Paper Code: ZOO MAJ 5034

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

The objective of this course is to provide students with a comprehensive understanding of the origins and processes of life on Earth.

Course outcome

- Students will be able to acquire knowledge on origin of life
- They also obtain knowledge micro evolutionary of the life forms on earth.

Course contents

Theory **Credit: 03**

Unit I

Life's Beginnings: Chemogeny, RNA world, Biogeny, Origin of photosynthesis, Evolution of eukaryotes; Historical review of evolutionary concept: Lamarckism, Darwinism, Neo-Darwinism. Evidences of Evolution: Fossil record (types of fossils, transitional forms, geological time scale, evolution of horse, Molecular evolution: molecular clock, globin gene family, rRNA, cyt c.

Unit II

Population genetics: Hardy-Weinberg Law, Evolutionary forces affecting H-W equilibrium; Natural selection: concept of fitness, selection coefficient, dominant allele, genetic load; heterozygous superiority; kin selection; adaptive resemblances; sexual selection; Genetic drift: Founder's effect, Bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies.

Unit III

Product of evolution: Micro evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation — allopatric, sympatric, adaptive radiation / macroevolution; Extinctions: mass extinctions (causes and effects), K-T extinction; Origin and evolution of man: Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular aspect of human origin.

Practical **Credits:01**

1. Study of fossils from models/ pictures
2. Study of homology and analogy from suitable specimens
3. Study and verification of Hardy-Weinberg Law by chi square analysis
4. Demonstration of role of natural selection and genetic drift in changing allele frequencies

using simulation studies

5. Graphical representation and interpretation of data of height/ weight of a sample of 100 humans in relation to their age and sex.

Suggested readings

1. Ridley, M (2004) Evolution III Edition Blackwell publishing
2. Hall, B.K. and Hallgrimson, B (2008). Evolution IV Edition.Jones and Barlett Publishers.
3. Campbell, N.A. and Reece J.B. (2011).Biology. IX Edition. Pearson, Benjamin, Cummings.
4. Douglas, J. Futuyma (1997). Evolutionary Biology. Sinauer Associates.
5. Snustad. S Principles of Genetics.
6. Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley-Blackwell

Semester V

Biochemistry of Metabolic Processes

Paper Code: ZOOMAJ5044

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objective

The objective of this course is to provide students with a comprehensive understanding of the principles and processes involved in metabolism, focusing on catabolism and anabolism.

Course outcome

- Students will have acquired a comprehensive understanding of the fundamental principles and processes involved in metabolism.
- They will be able to explain and analyze the various metabolic pathways, their regulation, and the interconnections between different metabolic processes.
- Students will also develop the ability to apply this knowledge to understand the metabolic basis of various physiological and pathological conditions.

Course Contents

Theory **Credits: 03**

Unit I

Overview of Metabolism: Catabolism *vs* Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, Shuttle systems and membrane transporters; ATP as "Energy Currency of cell"; coupled reactions; Use of reducing equivalents and cofactors; Intermediary metabolism and regulatory mechanisms.

Unit II

Carbohydrate Metabolism: Glycolysis, Citric acid cycle, pentose phosphate pathway, Gluconeogenesis, Glycogenolysis, glycogenesis; Oxidative Phosphorylation: mitochondrial respiratory chain, Redox potential; Chemiosmotic process, proton motive force, Inhibitors of electron transport chain.

Unit III

Lipid Metabolism: β-oxidation and omega-oxidation of saturated fatty acids with even and odd number of carbon atoms; Biosynthesis of palmitic acid; Ketogenesis; Protein Metabolism: Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids.

Practical **Credits: 01**

1. Estimation of total protein in given solutions by Lowry's method.
2. Detection of SGOT and SGPT or GST and GSH in serum/ tissue.
3. To study the enzymatic activity of Trypsin and Lipase.
4. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

Suggested readings

1. Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, V Edition, W.H. Freeman and Co., New York.
2. Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.
3. Murray, R.K., Bender, D.A., Botham, K.M., Kennelly, P.J., Rodwell, V.W. and Well, P.A. (2009). Harper's Illustrated Biochemistry, XXVIII Edition, International Edition, The McGraw-Hill Companies Inc.
4. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

Semester V

Taxonomy and Diversity of Life-I (Non-chordates)

Paper Code: ZOOMIN 5014

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Objectives

To provide the students the basic knowledge in Taxonomy& systematics along with the knowledge on diversity of Non-chordates.

Course outcome

By the end of the course, students will have acquired a strong foundation in animal taxonomy, enabling them to understand and apply systematic principles, perform taxonomic procedures, and classify various organisms accurately. They will also gain insight into the diversity of life and the evolutionary significance of different animal groups.

Course contents

Theory **Credits:03**

Unit I

Introduction to Animal Taxonomy: Definition, Basic concepts and importance of Systematics and Taxonomy; Alpha (α) and beta (β) taxonomy; Molecular taxonomy; Taxonomic procedures: taxonomic collection, preservation, Components of classification; Nomenclature: Principles of nomenclature; International Code of Zoological Nomenclature (ICZN); Rules of nomenclature: Binominal and trinominal nomenclature.

Unit II

Diversity of Life: Protista, Parazoa and Metazoa: General characteristics and Classification up to classes; Study of *Euglena*, *Amoeba* and *Paramecium* Locomotion and Reproduction in Protista; Evolution of symmetry and segmentation of Metazoa; Porifera, Cnidaria & Ctenophora: General characteristics and Classification up to classes; Canal system and spicules in sponges; Metagenesis in *Obelia,* Polymorphism in Cnidaria; Corals and coral reefs; Evolutionary significance of Ctenophora; Platyhelminthes & Nemathelminths: General characteristics and Classification up to classes; Life cycle and pathogenicity of *Taenia solium;* Parasitic adaptations in helminths.

Unit III

Annelida: General characteristics and Classification upto classes, Excretion in Annelida. Arthropoda & Onychophora: General characteristics and Classification upto classes; Vision, and Respiration in Arthropoda. Evolutionary significance of onychophoran. Mollusca & Echinodermata. General characteristics and Classification up to classes; Respiration in Mollusca. Torsion and detorsion in Gastropoda. Water-vascular system in Asteroidea, Affinities of echinoderms with Chordates.

Practical **Credits:01**

1. Observation on morphological characters of any specimen as a part of taxonomical study.
2. Study of whole mount of *Euglena*, *Amoeba* and *Paramecium*, Binary fission and Conjugation in *Paramecium.*
3. Study of *Sycon* (T.S. and L.S.)
4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium, Pennatula, Fungia, Meandrina, Madrepora*
5. One specimen/slide of any ctenophore
6. Study of adult *Taenia solium*
7. Museum specimen: *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria* Arthropods - *Limulus, Palamnaeus, Palaemon, Daphnia, Balanus, Sacculina, Cancer, Eupagurus, Scolopendra, Julus, Bombyx, Periplaneta,* termites and honey bees Onychophora - *Peripatus* Molluscs - *Chiton, Dentalium, Pila, Doris, Helix, Unio, Ostrea, Pinctada, Sepia, Octopus, Nautilus* Echinodermates - *Pentaceros*/*Asterias, Ophiura, Clypeaster, Echinus, Cucumaria* and *Antedon*
8. Study of digestive system, septal nephridia and pharyngeal nephridia of earthworm
9. Mount of mouth parts and dissection of digestive system and nervous system of *Periplaneta.*

Suggested readings

1. Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
2. Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
3. **Online Tools and Web Resources**:
4. Advances in Animal Diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology) ·
5. ePGPathshala (MHRD) Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35.

Semester VI
Diversity of Life-II (Chordates)
Paper Code: ZOO MAJ 6014
No. of Credits 4: {4(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objectives

- To learn the general characteristics and classification of different classes of vertebrates.
- To understand the vertebrate evolutionary tree.
- To understand general aspects of applied interest in relation to vertebrates.

Course outcome

- By the end of the course, students will have acquired a strong foundation in animal taxonomy, enabling them to understand and apply systematic principles, perform taxonomic procedures, and classify various organisms accurately.
- They will also gain insight into the diversity of life and the evolutionary significance of different animal groups.

Course contents

Theory **Credits: 03**

Unit I

Diversity of Life: Salient features and outline classification (up to order) of various chordate groups as covered under respective taxonomic groups. Protochordata: Salient features of body organisation and systematic position of *Balanoglossus* and *Amphioxus* as a type and its affinities. Agnatha**:** External features of *Petromyzon*.

Unit II

Pisces: Scales and fins in fishes. Parental care in fishes. Fishes in relation to man. Amphibia: General characters and affinities of Gymnophiona. Parental care in Amphibia. Reptilia: A brief knowledge of extinct reptiles. Poisonous and non- poisonous snakes. Poison apparatus of snake. Snake venom and anti-venom. Adaptive radiation in reptiles. Adaptations of reptiles to desert life.

Unit III

Aves: Flightless birds and their distribution. Flight adaptations in birds. Mammalia: General organisation, distribution and affinities of Prototheria. Economic importance. Adaptive radiation with particular reference to aquatic mammals.

Practical **Credits: 01**

1. Study of the following specimens: *Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo,Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon,*

Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Bat, Funambulus, Loris.

2. Key for Identification of poisonous and non-poisonous snakes.
3. Preparation of permanent slides of fish scales.
4. To prepare an "**animal album**" containing drawing photographs, cut outs, with appropriate write up about the above-mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

Suggested Readings

1. Hickman, Roberts & Hickman: Integrated principles of Zoology (7^{th}) ed Times- mirror, Mosby
2. Kotpal R.L: Modern Textbook of Zoology: Invertebrates. Rastogi
3. Nigam: Biology of Non-Chordates, Nagin Chand.
4. Parker TJ & haswell WA: Textbook of zoology Vol I & II, Mcmillan.
5. Hyman L: Invertebrate Series, Academic Press

Semester VI
Comparative Anatomy of Vertebrates
Paper Code: ZOO MAJ 6024
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective is to acquire a comprehensive understanding of the structure, function, and evolutionary significance of the integumentary system, skeletal system, digestive system, respiratory system, circulatory system, urinogenital system, nervous system, and sense organs.

Course outcome
- Students will be gaining knowledge on development and modifications of important anatomical structures in vertebrates.
- Students will have detail knowledge body organization in terms of different tissues.
- Students will have laboratory-oriented knowledge to study microscopic structure of tissues and cells.

Course contents
Theory **Credit: 03**

Unit I
Integumentary System: Structure and derivatives of integument, functions of skin. Skeletal System: Outline of axial and appendicular skeleton: basic plan of bones of skull, girdles and limbs. Classification of vertebrae, structure of a typical vertebra, Jaw suspensorium, Visceral arches. Digestive System: Brief account of alimentary canal and digestive glands, dentition.

Unit II
Respiratory System: Skin, gills, lungs and air sacs; swim bladder and Accessory respiratory organs. Circulatory System: General plan of circulation, Evolution of heart and aortic arches. Urinogenital System: Succession of kidney, Evolution of urinogenital ducts Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.

Unit III
Nervous System: Comparative account of brain; Autonomic nervous system, Spinal cord, Cranial nerves in Mammals; Sense Organs: Types and Classification of receptors; Brief account of visual and auditory receptors in man.

Practical **Credit: 01**
1. Disarticulated skeleton of fowl and rabbit
2. Study of different types of beaks found in birds.
3. Mammalian skulls: One herbivorous and one carnivorous animal.

4. Study of different tissue through permanent slides: Epithelial (simple, squamous, cuboidal, columnar Compound, stratified, transitional) muscular tissue, Connective tissue (bone, cartilage, areolar, tendon, adipose, reticular) and nervous tissue.

Suggested readings

1. Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IVEdition. McGraw-Hill Higher Education.
2. Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition,The McGraw-Hill Companies.
3. Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and SonsWalter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.

Semester VI
Molecular Biology
Paper Code: ZOO MAJ 6034
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective of this course is to provide students with a comprehensive understanding of the fundamental principles and concepts in genetics.

Course outcome
- By the end of the course, students will have acquired a comprehensive understanding of the history, development, and scope of genetics.
- They will be able to explain the nature of genetic material, including DNA and RNA, understand the processes of DNA replication, transcription, and translation, and comprehend the concepts of gene expression and gene regulation.
- Students will also gain knowledge about the genetic code, its deciphering, and the contributions of key scientists in the field of genetics.

Course contents
Theory **Credit: 03**

Unit I
Introduction: Nature of genetic material: Search for the genetic material, Griffith's experiment, transformation experiment, Avery, MacLeod and McCarty, Hershey & Chase experiment; Watson - Crick model of DNA, clover leaf model of tRNA, different types of DNA and RNA; DNA replication in prokaryotes and eukaryotes, Stahl experiment, replication machinery and mechanism; modification and repair of DNA.

Unit II
Gene Expression: One gene-one enzyme hypothesis, one genome polypeptide hypothesis, central dogma of Molecular Biology, co-linearity of genes and gene products; Genetic code - deciphering / cracking the genetic code, characteristics of genetic code, codon assignment and wobble hypothesis; Transcription of RNA, post-transcriptional modifications of mRNA, reverse transcription, Translation - machinery and mechanism; post translational modification of proteins.

Unit III
Gene regulation: Prokaryotes (inducible and repressive systems); Operon concept - Lac operon and Trp operon; Bacterial Recombination: transformation, conjugation and transduction (general and specialized transduction)

Practical **Credit: 01**

1. Models of ribosome structure
5. Preparation of DNA by Feulgen reaction.
6. Study of Polytene chromosomes from Chironomous / Drosophila larvae.
7. Identification of male and female Drosophila.
8. Study and interpretation of electron micrographs/ photograph showing
   a) DNA replication b) Transcription.
9. Study of genetic syndromes and abnormal karyotypes of human (Klinefelter's syndrome. Turner's syndrome. Down syndrome and Edward syndrome (Through diagrams)

Suggested readings

1. Alberts, B. et al. Molecular Biology of the Cell. Garland Pubg. Inc., New York
2. Karp G. (2005). *Cell and Molecular Biology*.4 e, John Wiley & Sons, Inc.
3. Kleinsmith, L. J. & Kish, V. M. (1995). *Principles of Cell and Molecular Biology*. Harper Collins College Pubs
4. Sheeler, P. and Bianchi D. E. *Cell Biology - Structure, Biochemistry and Functions*.
5. Veera Bala Rastogi. (2006). *Fundamentals of Molecular Biology* 1 e. Ane Books, India
6. Watson, J.D. *et al*., *Molecular Biology of the Gene*, 4e, Benjamin Cummings.

Semester VI
Biostatistics & Bioinformatics
Paper Code- ZOO MAJ 6044
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective

The objective of this course is to provide students with a comprehensive understanding of the fundamental concepts and principles of genetics.

Course outcome

- By the end of the course, students will have acquired a solid understanding of genetics, enabling them to analyze genetic patterns, interpret pedigrees, and understand the molecular basis of inheritance.
- They will be able to apply their knowledge to real-world situations and make informed decisions regarding genetic testing, genetic engineering, and ethical considerations in genetics.

Course contents

Theory **Credits: 03**

Unit I

Biostatistics: Introduction to Biostatistics, Research and Types of Research, sampling design, Applications of Statistics in Biological Research; Data, Collection and Representation of Data (Pie Chart, Bar Diagram, Histogram, Frequency Polygon), Measures of Central Tendency (Mean, Median, Mode), Variance, Coefficient of Variation, Standard Deviation, Standard Error of Mean, Analysis of Variation (ANOVA); One Way ANOVA and Two-Way ANOVA. Measures of Dispersion, Distribution Patterns (Binomial, Poisson & Normal), Tests of Significance ('T' Test, 'F' Test & Chi-Square Test); Probability; Correlation and Regression Analysis.

Unit II

Bioinformatics: Introduction to Bioinformatics: Importance, Goal, Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics. Applications of Bioinformatics: Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome- wide and high throughput approaches to gene and protein function), Drug discovery method (Basic concepts).

Unit III

Biological Databases: Introduction to biological databases; Primary, secondary and composite databases; Nucleic acid databases (GenBank, DDBJ, EMBL and NDB); Protein databases (PIR, SWISS-PROT, TrEMBL, PDB); Metabolic pathway database (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD). Data Generation and Data Retrieval: Generation of data (Gene sequencing, Protein

sequencing, Mass spectrometry, Microarray), Sequence submission tools (BankIt, Sequin,Webin); Sequence file format (flat file, FASTA, GCG, EMBL, Clustal,Phylip, Swiss-Prot); Sequence annotation; Data retrieval systems (SRS, Entrez); Basic Concepts of Sequence Alignment: Types of sequence alignment; Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences.

Practical **Credits: 01**

1. Accessing biological databases
2. Retrieval of nucleotide and protein sequences from the databases.
3. To perform pair-wise alignment of sequences (BLAST) and interpret the output
4. Predict the structure of protein from its amino acid sequence.
5. To perform a "two-sample t- test" for a given set of data
6. To learn graphical representations of statistical data with the help of computers.

Suggested Readings

1. Ghosh Z and Mallick B. (2008). Bioinformatics: Principles and Applications, Oxford University Press.
2. Pevsner J. (2009). Bioinformatics and Functional Genomics, II Edition,
3. Wiley Blackwell. Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA.
4. Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc. and Dorling Kindersley Publishing Inc. USA.
5. Antonisamy, B., Christopher S. and Samuel, P. P.(2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India.
6. Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics, Duxberry Press, USA

Semester VI
Diversity of Life-II (Chordates)
Paper Code: ZOOMIN6014
No. of Credits 4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
To provide the students with an in-depth knowledge of the diversity in form, structure and habits of Chordates.

Course outcome
- To learn the general characteristics and classification of different classes of vertebrates.
- To understand the vertebrate evolutionary tree.
- To understand general aspects of applied interest in relation to vertebrates.

Theory **Credit: 03**

Unit I
Diversity of Life: Salient features and outline classification (up to order) of various chordate groups as covered under respective taxonomic groups. Protochordata: Salient features of body organisation and systematic position of *Balanoglossus* and *Amphioxus* as a type and its affinities. Agnatha**:** External features of *Petromyzon*.

Unit II
Pisces: Scales and fins in fishes. Parental care in fishes. Fishes in relation to man. Amphibia: General characters and affinities of Gymnophiona. Parental care in Amphibia. Reptilia: A brief knowledge of extinct reptiles. Poisonous and non- poisonous snakes. Poison apparatus of snake. Snake venom and anti-venom. Adaptive radiation in reptiles. Adaptations of reptiles to desert life.

Unit III
Aves: Flightless birds and their distribution. Flight adaptations in birds. Mammalia: General organisation, distribution and affinities of Prototheria. Economic importance. Adaptive radiation with particular reference to aquatic mammals.

Practical **Credits: 01**
1. Study of the following specimens: Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo,Labeo, Exocoetus, Anguilla, Ichthyophis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone, Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six common birds from different orders, Bat, Funambulus, Loris.
2. Key for Identification of poisonous and non-poisonous snakes.
3. Preparation of permanent slides of fish scales.

4. To prepare an "**animal album**" containing drawing photographs, cut outs, with appropriate write up about the above-mentioned taxa. Different taxa/ topics may be given to different sets of students for this purpose.

Suggested readings

1. Hickman, Roberts & Hickman: Integrated principles of Zoology (7^{th}) ed Times- mirror, Mosby
2. Kotpal R.L: Modern Textbook of Zoology: Invertebrates. Rastogi
3. Nigam: Biology of Non-Chordates, Nagin Chand.
4. Parker TJ & Haswell WA: Textbook of zoology Vol I & II, McMillan.
5. Hyman L: Invertebrate Series, Academic Press

Semester VII

Cell Structure and Function

Paper Code: ZOOADL7014

No. of Credits 4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hour/ Week)

Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

The course aims to explore cell organization, including classification, metabolic evolution, viral and bacterial structure, eukaryotic origin, and cellular modeling, alongside investigating the cell membrane's composition, transport mechanisms, and the structure and function of the nucleus and nucleolus.

Course outcome

Upon completion, students will be able to

- classify cells based on morphology and function,
- comprehend viral and bacterial structures, analyze the structure and function of the nucleus and nucleolus
- explain transport mechanisms across cell membranes, and

Course contents

Theory **Credit 03**

Unit I

Cell Organization: Cell classification, cell variability (size, shape, complexity, functions); Prokaryotes - origin and evolution of metabolism, Viruses - structure and replication; Bacteriophage (Lambda phage, phi x 174), Animal DNA virus (SV 40), Retroviruses (HIV); Bacteria - Structure and reproduction of E. coli; Plasmid and their functions, Eukaryotes – origin of eukaryotes, development of multicellular eukaryotes; cells as experimental models

Unit II

Cell Membrane and Transport System: Models of cell membrane; fluid mosaic model of membrane; composition and organization of lipid bilayer and membrane proteins, Fluidity of cell membrane; transport across cell membrane – Channels and transporters, Diffusion, osmosis and measurement of osmotic pressure, Ionic concentration and membrane potential; Active transport and ion transports- types, ATP powered pumps, Co-transport by symporters and antiporters; transcellular transport.

Unit III

Nucleus and Nucleolus: Structure and organization of nucleus - nuclear membrane, nuclear lamina, and nuclear pore complex – structure and function, Organization of nuclear membrane during cell division, chromosome territory inside nucleus, selective transport of

molecules into and out of the Nucleus, Nucleo-skeleton and nuclear matrix; Nucleolus and its structure; Assembly and biogenesis of ribosomes.

Practical **Credit 01**

1. Differential staining techniques (Wright-Giemsa) for morphological studies of the cell
2. Differential centrifugation to separate cellular organelle
3. Identification of organelle (mitochondria, nuclei) by using biochemical assay
4. Trypan blue cytotoxicity assay
5. Staining of cells with fluorescent dyes (immunofluorescence)

Suggested readings

1. Lodish et al: Molecular Cell Biology. 8th edition 2016, W. H. Freeman and Company
2. Alberts et al: Molecular Biology of the Cell. 5th edition, 2008, Garland Science
3. Cooper and Hausman: The Cell. 4th edition, 2007; Sinauer Associates, USA
4. Lynne Cassimeris et al.: Lewin's cells. 3rd edition, 2015. Jones & Bartlett Learning, USA

Semester VII

Overview of Immune System

Paper Code: ZOOADL7024

No. of Credits –4: {3(T) + 1(P)}

Total hours: 45 (Theory) (3 hours/ Week)

Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

The objective of this course is to provide students with a comprehensive understanding of the immune system, its components, functions, and the various aspects related to immunology.

Course Outcomes

- By the end of the course, students will have acquired a thorough understanding of the immune system, its components, and their functions. They will be able to explain the principles of innate and adaptive immunity, antigen-antibody interactions, and the roles of immunoglobulins, cytokines, and complement in immune responses.
- Students will also gain knowledge about hypersensitivity reactions, major histocompatibility complex (MHC), and the different types of vaccines. They will be equipped with the ability to apply their knowledge to analyze and interpret immunological processes and their significance in disease prevention, diagnosis, and therapeutics.

Course contents

Theory **Credit 03**

Unit I

Overview of Immune System: Historical perspective of Immunology, Early theories of Immunology, Cells and organs of the Immune system. Innate and Adaptive Immunity: Anatomical barriers, Inflammation, Cell and molecules involved in innate immunity, Adaptive immunity (Cell mediated and humoral), Passive: Artificial and natural Immunity, Active: Artificial and natural Immunity, Immune dysfunctions (brief account of autoimmunity with reference to Rheumatoid Arthritis and tolerance, AIDS).

Unit II

Antigens: Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes. Immunoglobulins: Structure and functions of different classes of immunoglobulins, Antigen antibody interactions, Immunoassays (ELISA and RIA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis.

Unit III

Major Histocompatibility Complex: Structure and functions of MHC molecules. Endogenous and exogenous pathways of antigen processing and presentation. Cytokines: Properties and functions of cytokines, Therapeutics Cytokines; Complement System: Components and

pathways of complement activation; Hypersensitivity: Gell and Coombs' classification and types of hypersensitivities. Vaccines: types of vaccines.

Practical **Credit 01**

1. Demonstration of lymphoid organs.
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
4. Ouchterlony's double immuno-diffusion method.
5. ABO blood group determination.
6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of:
   a. ELISA
   b. Immuno electrophoresis

Suggested Readings

1. Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
2. David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.

Semester VII

Endocrinology and Hormonal Regulation

Paper Code: ZOOADL7034

Paper credit: 04 (3T+1P)

Total hours: 45 (Theory) (3 hour/ Week)

Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

- Understand hormone biochemistry and molecular mechanisms of action.
- Describe the endocrine physiology of major vertebrate glands.
- Explain hormonal regulation of reproduction and environmental responses.
- Analyze endocrine disorders and prostaglandin physiology.
- Demonstrate practical skills in endocrine organ identification and functional assays.

Course Outcome

- Make students proficiency in hormone biochemistry and physiology.
- Identification and understanding of major endocrine glands.
- Competence in reproductive and environmental hormonal regulation.
- Analysis of endocrine disorders and prostaglandin roles.
- Practical skills in endocrine organ study and functional assays.

Course contents

Theory **Credit 03**

Unit I

Characteristic and Transport of Hormones, Neurosecretions and Neurohormones, Chemical nature and classification of hormones, endocrine, paracrine and autocrine hormones; hormone receptors and target organs; Hormones as 2nd messengers, molecular basis of hormone action: structure and signal transduction mechanisms (steroid and peptide hormones); Hormonal regulation of ovulation: gestation, parturition and lactation, Hormonal regulation of spermatogenesis.

Unit II

Endocrine physiology in vertebrates: Pituitary, thyroid, parathyroid, adrenal and pancreas, hormones of islets of Langerhans and their functions, insulin and glucagon in carbohydrate metabolism, calcium regulating hormones, Biosynthesis of T3, T4, epinephrin and nor-epinephrin, melatonin, steroid hormone and, their metabolic functions. Chemical structure and function of JH, JH as a gonadotropin, Prothoracic gland and ring gland, Role of Juvenile hormone analogues and ecdysteroids in pest control.

Unit III

Neuroendocrine systems in vertebrates, Tropic hormones and their feedback system and response to various stimuli (tolerance to temperature, stress, osmotic regulation); Pathophysiology of pituitary dwarfism, gigantism and acromegaly; Grave's disease; Prostaglandins: Source, chemical nature, structure, functions, physiological significance and clinical implications; gastrointestinal hormones and their regulation and functions.

Practical **Credit 1**

1. Demonstration of endocrine organs in vertebrates.
2. Dissection and display of pituitary gland of mouse/fish
3. Dissection and display of thyroid and parathyroid gland of mouse/chicken
4. Histological study of pituitary, adrenal, testis, ovary, corpus luteum, pancreas and thyroid gland (Permanent slide)
5. Assess the roles of insulin and glucagon in carbohydrate metabolism through glucose tolerance tests or insulin sensitivity assays.

Suggested readings

1. Norris: Vertebrate Endocrinology (2nd Edition) Lea & Febriger. 1997.
2. Text book of Medical Physiology 11th Edition. By C. Guyton, M.DJohn E. Hall (2006)
3. Mammalian Endocrinology (4th edition), NCBA, by Ashoke kumar Boral (2011).
4. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. Oxford: BIOS Scientific Publishers; 2001.
5. Hadley, M.E. and Levine J.E. 2007.Endocrinology, 6th Edition.Pearson Prentice-Hall, Pearson Education Inc., New Jersey.
6. Insect Physiology and Biochemistry, 3rd Edition by James L. Florida, U.S.A. (2015)

Semester VII
Ecology & Environmental Biology
Paper Code: ZOOADL7044
Paper credit: 04(3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective
The objective of studying Introduction to Ecology is to provide individuals with a strong foundation in ecological principles and processes. This knowledge can be applied to various aspects of ecological research, conservation efforts, and environmental management to contribute to the understanding and preservation of our natural world.

Course outcome
- The outcome of studying Introduction to Ecology is to develop a foundational understanding of ecological principles and processes.
- This knowledge can be applied to various aspects of ecological research, conservation efforts, and environmental management.

Course contents
Theory **Credits: 03**

Unit I
Population interactions: intra-specific and inter-specific interaction; Competitive Exclusion principle, Gause's experiment, Lotka-Volterra model for competition and Predation; Concept of niche: types of niches, niche dimension, fundamental and realized niche. Community concept; Individualistic and organismic nature of communities; Qualitative and quantitative characters of community.

Unit II
Soil Ecology: structure of soil, soil formation, soil fertility, soil profile, physical properties of soil (soil colour, texture, bulk density and porosity); Carbon storage and sequestration: Carbon management through biotic sequestration: forest ecosystems, agroforestry systems, wetlands; Soil carbon sequestration.

Unit III
Restoration Ecology: Definition and scope, The Society for Ecological Restoration (SER), principles of restoration ecology, types of eco-restoration, components of restoration. Restoration in conservation biology. Global warming, greenhouse effect.

Practical **Credits: 01**
1. Plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Wiener diversity index for the same community

3. Study of an aquatic ecosystem: Phytoplankton and zooplankton study, Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2
4. Study on soil soil colour, texture, bulk density and porosity.
5. Report on a visit to National Park/Biodiversity Park/Wildlife sanctuary

Suggested Readings

1. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
2. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
3. Robert Leo Smith Ecology and field biology Harper and Row publisher
4. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Press.
5. Begon, M., Harper, J.L. and Townsend, C.R. (2006). Ecology: Individuals, Populations and Communities. Blackwell Scientific Publications.
6. Kormondy, E. J. (1996). Concepts of Ecology (4th eds.). Prentice-Hall of India Pvt. Ltd.
7. Dash, M.C. and Dash, S.P. (2009). Fundamentals of Ecology (3rd eds.). Tata McGraw-Hill Publishing Co., New Delhi.
8. Brady, N.C. and Weil, R. (2008) The Nature and Properties of Soils (14thedn.). Pearson International.
9. Coleman, D.C., Crossley, D.C.and Hendrix, P.F. (2004) Fundamentals of Soil Ecology (2ndedn.). Elsevier.
10. Miller, R.W. and Gardiner, D.T. (2007) Soils in Our Environment (11thedn.). Prentice Hall of India, New Delhi.
11. George D. Gann, Tein McDonald, Bethanie Walder, James Aronson, Cara R. Nelson, Justin Jonson, James G. Hallett, Cristina Eisenberg, Manuel R. Guariguata, Junguo Liu, Fangyuan Hua, Cristian Echeverría, Emily Gonzales, Nancy Shaw, Kris Decleer, Kingsley W. Dixon. International principles and standards for the practice of ecological restoration. Second edition. September 2019. https://doi.org/10.1111/rec.13035.

Semester VII

Research Methodology

Paper Code: ZOOREM7014

Paper credit: 04 (3T+1P)

Total hours: 45 (Theory) (3 hour/ Week)

Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

It aims to familiarize individuals with different types of research, approaches, and research design principles. Additionally, it aims to equip individuals with the necessary skills to critically analyze scientific literature, effectively communicate research results, and adhere to ethical standards in scientific publishing.

Course outcomes

- Individuals will develop the ability to critically evaluate scientific literature, communicate research results through various scientific writing formats, and adhere to ethical guidelines and standards in scientific publishing.
- This knowledge and skillset will contribute to the advancement of scientific knowledge, promote intellectual honesty, and foster a culture of integrity in scientific research.

Course contents

Theory **Credits: 03**

Unit I

Meaning of research, types of research, approaches; concept of Research Design: meaning, criteria of a good research design; types of research designs: experimental, observational, survey, and qualitative. Defining aim & objectives. Research Questions and Research hypotheses generation. Data collection methods: primary and secondary data; qualitative and quantitative survey, experimental research protocols.

Unit II

Reading and critical analysis of scientific literature; Writing various forms of scientific articles: structure of writing report, short communication, review article, original research article; citations and references. Citation databases: Web of Science, Scopus, Journal matrix.

Unit III

Research Ethics: science and research, intellectual honesty and research integrity; Scientific misconducts: redundant publications, duplicate and overlapping publications, selective reporting and misrepresentation of data; Publication Ethics: definition, introduction and importance; conflict of Interest; predatory publishers and journals. Open access publication. Plagiarism in research.

Practical **Credit: 1**

1. Research proposal writing exercise: identification of a research problem; generate research questions and hypotheses; develop aim and objectives; justification.
2. Research design and methodology: preparation of data sheet, preparation of experimental protocol.
3. Review of literature from selected literature and writing a review article including abstract.
4. Micro Research: students will choose a topic of research feasible to be carried out within short period and write a mini article.

Suggested readings

1. Baishya, K. (Ed.). (2024). Research and Publication Ethics. National Law University and Judicial Academy, Assam.
2. Emden, Helmut F.van (2008). Statistics for Terrified Biologists. Blackwell Publishing. 343pp.
3. Heard, S. B. (2022). The scientist's guide to writing: How to write more easily and effectively throughout your scientific career. Princeton University Press.
4. International Editions. 718 pp.
5. Kothari, C.R. (2004) Research Methodology: Methods and Techniques. 2nd Edition, New Age International Publishers, New Delhi.
6. Schimel, J. (2012). Writing science: how to write papers that get cited and proposals that get funded. OUP USA.
7. Zar, J.H. (1984). Biostatistical Analysis (Second Edition). New Jersey: Prentice-Hall

Semester VII
Ecology & Environment
Paper Code: ZOOMIN7014
No. of Credits –4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective of studying Introduction to Ecology is to provide individuals with a strong foundation in ecological principles and processes. This knowledge can be applied to various aspects of ecological research, conservation efforts, and environmental management to contribute to the understanding and preservation of our natural world.

Course outcome
- The outcome of studying Introduction to Ecology is to develop a foundational understanding of ecological principles and processes.
- This knowledge can be applied to various aspects of ecological research, conservation efforts, and environmental management.

Course contents
Theory **Credits: 03**

Unit I
Introduction to Ecology: Autecology and synecology, Laws of limiting factors, study of physical factors. Population: Unitary and Modular populations, Unique and group attributes of population: Density, natality, mortality, life tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion. Exponential and logistic growth, equation and patterns, r and K strategies. Population regulation—density-dependent and independent factors.

Unit II
Community characteristics: species richness, dominance, diversity and its types (alpha, beta, and gamma), abundance, vertical stratification, Distribution of species in different habitats; Ecotone and edge effect; Ecological succession: primary and secondary succession, climax community.

Unit III
Ecosystem: Types of ecosystems, Food chain: Detritus and grazing food chains, Linear and Y-shaped food chains, Food web, Energy flow through the ecosystem, Ecological pyramids and Ecological efficiencies Nutrient and biogeochemical cycle. Human-modified ecosystem. Ecology in Wildlife Conservation and Management

Practical **Credits: 01**
1. Plotting of survivorship curves of different types from the hypothetical/real data provided
2. Determination of population density in a natural/hypothetical community by quadrat method and calculation of Shannon-Wiener diversity index for the same community

3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, temperature, turbidity/penetration of light, determination of pH, Dissolved Oxygen content (Winkler's method), free CO_2.
4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary.

Suggested Readings

1. Krebs, C. J. (2001). Ecology. VI Edition. Benjamin Cummings.
2. Odum, E.P., (2008). Fundamentals of Ecology. Indian Edition. Brooks/Cole
3. Robert Leo Smith Ecology and field biology Harper and Row publisher
4. Ricklefs, R.E., (2000). Ecology. V Edition. Chiron Pres

Semester VIII
FUNDAMENTAL BIOSTATISTICS
Paper Code: ZOOADL8014
Paper credit: 04(3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

The objective of this course is to develop skills in analyzing biological data and provide a foundation for designing experiments, conducting research studies, and interpreting findings in a statistical manner.

Course Outcomes

- Studying statistics yields skills in data analysis, interpretation, and decision-making, applicable across various fields from scientific research to business analytics.
- Additionally, it will allow for critical thinking and enhance problem-solving abilities, enabling students to make informed conclusions and predictions based on empirical evidence.

Course Contents

Theory **Credit 03**

Unit I

Descriptive statistics: Concepts of statistical Population and Sample— sampling unit, observation, variable; Simple random sampling. Graphical representation of data: diagrams and graphs - scattergram, simple bar diagram, multiple bar diagram, percentage stack bar diagram, histogram, pie diagram, frequency polygon, frequency curve. Measures of central tendency: mean, median and mode from raw data as well as from frequency distribution; Measures of dispersion: range, mean deviation, standard deviation, variance, standard error; Measures of relative dispersion: coefficient of variance.

Unit II

Probability theory: probability distributions; normal distribution— definition and statement of properties, skewness and kurtosis; bionomial distribution; poisson distribution; critical probability values, confidence limits; Test statistics of significance**:** Test of hypothesis: Null and alternative hypothesis; one-tail test and two-tail test; Type I and Type II errors.

Unit III

Parametric and non-parametric tests: Product moment Correlation test, coefficient of correlation; Regression analysis, regression line, regression coefficient; z-test; t-tests: independent and dependent t-test; F-test, One-way and Two-way Analysis of Variance; Spearman Rank Correlation test; Mann-Whitney U-test; Wilcoxon matched pair test; Chi-square test; Kruskal-Wallis test; Randomized Complete Block Design; Latin Square Design.

Practical **Credit: 1**

1. Graphical representation of data of data collected in the field.
2. Calculating central tendency from data.
3. Generating hypotheses from given topic with one-tail test and two-tail tests.
4. Statistical analyses of qualitative and quantitative data

Suggested readings

1. B.Sc. statistics theory and practicals. Dwijaraj Bhattacharjee.2010. Second edition, Ludhiana: Kalyani Publishers. ISBN: 9788127263980
2. Emden, Helmut F.van (2008). *Statistics for Terrified Biologists*. Blackwell Publishing.
3. Kothari, C.R. (2004) Research Methodology: Methods and Techniques. 2nd Edition, New Age International Publishers, New Delhi.
4. Zar, J.H. (1984). *Biostatistical Analysis (Second Edition)*. New Jersey: Prentice-Hall

SEMESTER VIII
Ethnozoology
Paper Code: ZOOADL8024
Paper credit: 04(3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

The course is unique in highlighting the comprehensive understanding of ethnozoology, ethno-aquaculture, and traditional sericulture, their cultural and medicinal significance, and the methods used to study these fields.

Learning outcomes

- Explain the historical context, relevance, and current status of ethnozoology, ethno-aquaculture, and traditional sericulture in India.
- Describe the methods used to study ethnozoology and the importance and applications of this field in various cultural and medical contexts.
- Identify and discuss the use of various animal species and their parts for medicinal purposes in Indian traditional medicine.
- Detail traditional fishing techniques and tools, preservation and processing methods, and the medicinal and nutritional uses of aquatic resources.
- Understand the traditional knowledge systems in sericulture, including the cultivation of mulberry trees and silkworm rearing practices, as well as the medicinal and nutritional uses of sericulture products.

Course Contents

Theory **Credit 03**

Unit I

Ethnozoology: Historical Context, relevance, scope and status. Methods to study ethnozoology; Importance and Applications of Ethnozoology. Indian Traditional Medicine: Basic concept of ethnozoological medicine, traditional practices using various animal species and their parts for medicinal purposes: Bones, Skins, Organs, Secretions and Excretions, Whole Animals, etc.; Use of venom or extracts to alleviate pain.

Unit II

Ethno-Aquaculture: Traditional Fishing Techniques and Tools: Handheld Nets, Fishing Traps, Lines and Hooks; Preservation and Processing: Drying and Smoking, Fermentation, Salting and Pickling of fish; shell fish as traditional food; Medicinal and Nutritional Uses: medicinal applications and nutritional importance.

Unit III

Traditional Knowledge Systems (TKS) in Sericulture: Definition and Scope, Cultivation of Mulberry Trees, Silkworm Rearing Practices Medicinal and Nutritional Uses of Sericulture Products; Traditional food practices: Entomophagy; Entomopathy.

Practical **Credit 01**

Field trip to tribal settlement to survey, document and frame hypothesis on people-animal relationship.

1. Collection, processing and preservation of ethnozoological specimens in the institutional repository.
2. Identify and document animal parts used in the preparation of crude drugs/herbal formulations.
3. Collection of Indigenous Fishing Tools.

Suggested readings

1. Traditional Fishery Practices of Assam. S. K. Bhattacharjee, Directorate of Fisheries, Assam, 1998
2. Treditional of Fishe hervesting gears of north east India, ML Khan & SS Mishra, APH Publication, 2001.
3. Unnikrishnan PM. Animals in Ayurveda. J Amruth. 1998:1–15.
4. Trivedi PC. Ethnobotany: an overview. In Ethnobotany edited by: Trivedi PC. Jaipur: Aavishkar publisher; 2002.
5. S.B. Dandin, J. Jayaswal and K. Giridhar (2001). Handbook of Sericulture Technologies. Publisher-Central Silk Board, Bangalore.

SEMESTER VIII

Reproductive and Developmental Biology

Paper Code: ZOOADL8034

Paper credit: 04(3T+1P)

Total hours: 45 (Theory) (3 hour/ Week)

Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

Understanding reproductive physiology involves studying folliculogenesis, steroidogenesis, gametogenesis, and hormonal regulation. Early developmental stages include fertilization, cleavage, blastula formation, gastrulation, and germ layer development. Developmental biology focuses on cell specification, commitment, determination, and differentiation. Model organisms like mammals, C. elegans, Drosophila, and amphibians help analyze these processes. Morphogenetic processes involve morphogen gradients, paracrine factors, and cell adhesion. Insights into reproductive health cover the menstrual cycle, hormonal regulation, and related disorders.

Course outcomes

- Comprehensive grasp of reproductive physiology, including folliculogenesis, steroidogenesis, gametogenesis, and hormonal regulation.
- Proficiency in understanding early developmental processes such as fertilization, cleavage, blastula formation, gastrulation, and germ layer formation.
- Mastery of fundamental developmental biology concepts including cell specification, commitment, determination, and differentiation.
- Ability to analyze developmental processes using various model organisms such as mammals, C. elegans, Drosophila, and amphibians.
- Appreciation of the role of morphogenetic processes including morphogen gradients, paracrine factors, and cell adhesion in guiding tissue patterning, organogenesis, and regeneration.

Course contents

Theory **Credit 03**

Unit I

Ovarian and Testicular Physiology: Folliculogenesis and their control mechanisms, steroidogenesis and its hormonal regulation, menstrual cycle and its hormonal regulation, Female reproductive disorder, estrus cycle and its regulation, sertoli cell: structure and function; function of Leydig cell.

Unit II

Gametogenesis, Fertilization and Early Developments: spermatogenesis and oogenesis, Structure of mammalian gametes mammals, zygote formation, cleavage, blastula formation, gastrulation and formation of germ layers in animals; embryogenesis, organogenesis, Capacitation, Signal transduction pathway in acrosome reaction, Prevention of Polyspermy, contraception; vulva formation in *Caenorhapdits elegans*.

Unit III

Cell commitment and morphogenesis: Commitment, induction, competence; cell fate and cell lineages; imprinting**,** stem cells: Embryonic stem cells and adult stem cells, cell adhesion

molecules, Concept of morphogen gradients, role of paracrine factors in development, Hormonal control of amphibian metamorphosis, eye lens induction, limb development and regeneration in vertebrates; differentiation of neurons, post embryonic development- larval formation, formation of organ rudiments and nucleo-cytoplasmic interaction in development. Axes and pattern formation in Drosophila, amphibia and chick**;** sex determination.

Practical **Credit: 1**

1. Study of different types of eggs.
2. In vitro culture of chick embryo.
3. Study of developmental stages of frog/chick embryos from permanent slide.
4. Dissection of male/female reproductive system of cockroach/Grasshopper
5. Identification of larval forms of invertebrates.

Suggested Readings

1. Gilbert, S. F. (2014). Developmental Biology. Sinauer Associates.
2. Wolpert, L., Tickle, C., & Martinez Arias, A. (2015). Principles of Development. Oxford University Press. Hall, J. E., & Hall, M. E. (2020).
3. Guyton and Hall Textbook of Medical Physiology E-Book: Guyton and Hall Textbook of Medical Physiology E-Book. Elsevier Health Sciences.
4. Larsen, W. J. (2015). Human Embryology. Churchill Livingstone.
5. Rhoades, R. A., & Bell, D. R. (Eds.). (2012). Medical phisiology: Principles for clinical medicine. Lippincott Williams & Wilkins.
6. Alberts, B., Johnson, A., Lewis, J., et al. (2014). Molecular Biology of the Cell. Garland Science.

SEMESTER VIII
Fundamental Animal Physiology
Paper Code: ZOOADL8044
Paper credit: 04 (3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

Understanding blood circulation includes haemostasis and haemoglobin's role in gas transport. Analyzing the oxygen dissociation curve and respiratory center functions is key for oxygen delivery. Comprehending cardiac impulse conduction, the cardiac cycle, and ECG interpretation is essential for heart health. Differentiating between neurogenic and myogenic hearts reveals various cardiac mechanisms. Examining skeletal muscle fiber structure and actin-myosin interactions explains muscle function. Understanding macronutrient absorption and gastrointestinal hormone regulation is crucial for nutrition and digestion.

Course outcomes

- Understand blood circulation, haemostasis, and haemoglobin's role in gas transport.
- Comprehend cardiac impulse conduction, the cardiac cycle, and ECG interpretation.
- Analyze skeletal muscle structure, actin-myosin interactions, and muscle contraction mechanisms.
- Grasp macronutrient absorption and gastrointestinal hormone regulation.
- Understand tubular reabsorption, secretion, and hormonal regulation of urine formation.
- Comprehend axonal and synaptic transmission and neurotransmitter roles.

Course contents

Theory **Credit 03**

Unit I

Circulation and Respiration: Blood: Haemostasis, Haemoglobin: Role in oxygen and CO_2 transport, Oxygen dissociation curve and their physiological significance, Heart: Origin and conduction of cardiac impulse, cardiac cycle, ECG, Neurogenic and myogenic hearts; Respiratory centers: organization and function, Surfactant, Basal metabolic rate and its measurement, Respiratory adjustments, Hypoxia, Dyspnea, High altitude: decreased pressure of gas.

Unit II

Muscle, Nutrition and Excretion: Ultra structure of skeletal muscle fibers: Proteins of the myofilaments, actin-myosin interaction, sarcoplasmic reticulum and role of calcium in contraction, energetics of muscle contraction. Absorption of macronutrients, Gastrointestinal hormones and regulation, Obesity and starvation. Tubular reabsorption and secretion, RAS and hormonal regulation of urine formation, regulation of water balance, Acid-base balance and homeostasis.

Unit III

Nervous System, Sensory Perception, and Physiological Responses: Motor neuron and types of neurons, Synaptic transmission, Types of synapses and synaptic knobs, EPSP and IPSP, Chemical transmission, neurotransmitters; Retinal components, Photoreceptors: Ionic basis of potential generation: Basilar membrane, and organ of Corti: Genesis of action potential in afferent nerve fibers; Tactile response: Comfort zone, body temperature – physical, chemical, neural regulation, acclimatization; Stress and adaptation.

Practical **Credit: 1**

1. Analysis of Blood group
2. Quantitative estimation of hemoglobin content.
3. Temporary slide preparation for WBC observation.
4. Estimation of RBCs
5. Blood glucose estimation.
6. Urine glucose estimation.

Suggested Readings

1. Guyton, A. C., & Hall, J. E. (2015). Textbook of medical physiology (13th ed.). Elsevier.
2. Rhoades, R. A., & Bell, D. R. (Eds.). (2012). *Medical Physiology: Principles for clinical medicine*. Lippincott Williams & Wilkins.
3. Marieb, E. N., & Hoehn, K. (2018). Human anatomy & physiology (11th ed.). Pearson Publication.
4. Johnson, L. R. (2015). Essential medical physiology (3rd ed.). Academic Press.
5. Pocock, G., Richards, C., & Richards, D. (2013). Human physiology: The basis of medicine (3rd ed.). Oxford University Press.
6. Schmidt-Nielsen, K. (1997). Animal physiology: Adaptation and environment (5th ed.). Cambridge University Press.

SEMESTER VIII

Biochemistry
Paper Code: ZOOADL8054

Paper credit: 04(3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objectives
The objectives encompass understanding the structure and function of amino acids, peptides, and proteins, exploring the mechanisms of protein folding and denaturation, and analyzing the roles of carbohydrates and lipids in cellular function. Additionally, they include studying bioenergetics principles and metabolic pathways, learning enzyme catalysis mechanisms and regulation, and investigating metabolic pathways and hormonal regulation to comprehend how cells maintain homeostasis and respond to environmental changes.

Course outcomes
- Identify biomolecular structures effectively.
- Explain protein function through folding principles.
- Understand carbohydrate and lipid roles in cells.
- Analyze metabolic pathways using bioenergetics.
- Grasp enzyme function and regulation.
- Evaluate metabolic and hormonal interactions.

Course contents
Theory **Credit 03**

Unit I
Classification and structural features of amino acids; Peptides and peptide bonds; Conformation of proteins (Ramachandran plot, secondary structure, domains, motif and folds), Protein denaturation and folding; Structure and functional significance of mono, polysaccharides and glycoproteins; Glycosylation and its importance; lipid: structure and properties of important members of storage and membrane lipids; lipoproteins.

Unit II
Principles of bioenergetics, Equilibria, free energy; High energy compounds; Phosphoryl Group Transfers and ATP; Biological Oxidation-Reduction Reactions; Reducing power and Redox potential; Glycolytic pathways; Kreb's cycle; Oxidative phosphorylation; electron transport chain; Fo-F1 ATP synthase. Principles of enzyme catalysis; enzyme kinetics and mechanism of enzyme action, Michaelis-Menten kinetics; enzyme inhibition: types and mechanism; regulation of enzyme activity.

Unit III
Metabolism of carbohydrates, lipids, amino acids nucleotides and vitamins; Conformation of nucleic acids (A, B, & Z-DNA), t-RNA, micro-RNA); Stability of proteins and nucleic acids; Mammalian fuel metabolism integration and regulation: Hormonal regulation of fuel metabolism, metabolic homeostasis, metabolic disorders.

Practical **Credits 01**

1. Preparation of solutions of different normality, molarity, and dilutions.
2. Preparation of a 'Good' buffer.
3. Estimation of protein by Lowry's method.
4. Enzyme assay of any one enzyme.
5. Physico-chemical or Kinetic characterization of enzyme.
6. Downloading and visualizations of protein structures
7. Study of Ramachandran plot using 3D protein molecules.

Suggested Readings

1. Lehningers Principles of Biochemistry, Nelson and Cox, Sixth Edition or recent edition, Macmillan Press.
2. Principles of Biochemistry, Voet, Voet and Pratt, 5th edition (2012) or recent edition, Wiley International Publications.
3. Harper's Illustrated Biochemistry, Murray, Granner and Rodwell, (27th Ed.), McGraw Hill, New York, USA.
4. Practical Biochemistry – Principles and Techniques, Wilson and Walker, Cambridge University Press, Cambridge [Latest edition]

Semester VIII
Introduction to Developmental Biology
Paper Code: ZOOMIN8014
No. of Credits –4: {3(T) + 1(P)}
Total hours: 45 (Theory) (3 hour/ Week)

Objective
The objective of studying developmental biology is to equip individuals with a comprehensive understanding of the intricate processes involved in reproduction.

Course outcome
- Students will be able to acquire knowledge on embryonic development of sexually reproducing animals.
- They also obtain knowledge on metamorphic changes and the role of placenta in mammals.

Course contents
Theory **Credits: 03**□5

Unit I
Basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division; Early Embryonic Development: Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes.

Unit II
Fertilization (External and Internal): Changes in gametes, Blocks to polyspermy; Planes and patterns of cleavage; Types of blastula; Fate maps (including Techniques); Early development of frog and chick up to gastrulation; Embryonic induction and organizers; Late Embryonic Development: Fate of Germ Layers; Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta).

Unit III
Post Embryonic Development: Metamorphosis: Changes, hormonal regulations in amphibians and insects; Regeneration: Modes of regeneration, epimorphosis, morphallaxis and compensatory regeneration (with one example each); Ageing: Concepts and Theories; Teratogenesis: Teratogenic agents and their effects on embryonic development; In-vitro fertilization, Stem cell (ESC), Amniocentesis.

Practical **Credits: 01**
1. Study of whole mounts and sections of developmental stages of frog through permanent slides: Cleavage stages, blastula, gastrula, neurula, tail-bud stage, tadpole (external and internal gill stages)

2. Study of whole mounts of developmental stages of chick through permanent slides: Primitive streak (13 and 18 hours), 21, 24, 28, 33, 36, 48, 72, and 96 hours of incubation (Hamilton and Hamburger stages)
3. Study of the developmental stages and life cycle of *Drosophila* from stock culture
4. Study of different sections of placenta (photomicropgraph/ slides)
5. Project report on *Drosophila* culture/chick embryo development

Suggested readings

1. Gilbert, S. F. (2010). Developmental Biology, IX Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA
2. Balinsky B. I. and Fabian B. C. (1981). An Introduction to Embryology, V Edition, International Thompson Computer Press
3. Carlson, R. F. Patten's Foundations of Embryology
4. Kalthoff (2008). Analysis of Biological Development, II Edition, McGraw-Hill Publishers
5. Lewis Wolpert (2002). Principles of Development. II Edition, Oxford University Press.

SEMESTER VIII
(Bachelor Degree in Zoology with Research)

Fundamental Biostatistics
Paper Code: ZOOADL8014
Paper credit: 04(3T+1P)
Total hours: 45 (Theory) (3 hour/ Week)
Total Marks: 100 (Theory 50 + Practical 20 + Internal 30)

Objective

The objective of this course is to develop skills in analyzing biological data and provide a foundation for designing experiments, conducting research studies, and interpreting findings in a statistical manner.

Course Outcomes

- Studying statistics yields skills in data analysis, interpretation, and decision-making, applicable across various fields from scientific research to business analytics.
- Additionally, it will allow for critical thinking and enhance problem-solving abilities, enabling students to make informed conclusions and predictions based on empirical evidence.

Course Contents

Theory **Credit 03**

Unit I

Descriptive statistics: Concepts of statistical Population and Sample─ sampling unit, observation, variable; Simple random sampling. Graphical representation of data: diagrams and graphs─ scattergram, simple bar diagram, multiple bar diagram, percentage stack bar diagram, histogram, pie diagram, frequency polygon, frequency curve. Measures of central tendency: mean, median and mode from raw data as well as from frequency distribution; Measures of dispersion: range, mean deviation, standard deviation, variance, standard error; Measures of relative dispersion: coefficient of variance.

Unit II

Probability theory: probability distributions; normal distribution─ definition and statement of properties, skewness and kurtosis; bionomial distribution; poisson distribution; critical probability values, confidence limits; Test statistics of significance**:** Test of hypothesis: Null and alternative hypothesis; one-tail test and two-tail test; Type I and Type II errors.

Unit III

Parametric and non-parametric tests: Product moment Correlation test, coefficient of correlation; Regression analysis, regression line, regression coefficient; z-test; t-tests: independent and dependent t-test; F-test, One-way and two-way Analysis of Variance; Spearman Rank Correlation test; Mann-Whitney U test; Wilcoxon matched pair test; Chi-square test; Kruskal-Wallis test. Randomized Complete Block Design, Latin Square Design.

Practical **Credit: 1**

1. Graphical representation of data of data collected in the field.
2. Calculating central tendency from data.
3. Generating hypotheses from given topic with one-tail test and two-tail tests.
4. Statistical analyses of qualitative and quantitative data

Suggested readings

1. B.Sc. statistics theory and practicals. Dwijaraj Bhattacharjee.2010. Second edition, Ludhiana: Kalyani Publishers. 623pp. ISBN: 9788127263980
2. Emden, Helmut F.van (2008). *Statistics for Terrified Biologists*. Blackwell Publishing. 343pp.
3. Kothari, C.R. (2004) Research Methodology: Methods and Techniques. 2nd Edition, New Age International Publishers, New Delhi.
4. Zar, J.H. (1984). *Biostatistical Analysis (Second Edition)*. New Jersey: Prentice-Hall

Semester VIII
Paper Code: ZOODISS80112
Dissertation

Research thesis/ Project with minimum 1 conference paper. Peer-reviewed research publication should be encouraged.

- Research Thesis/Project: Choose relevant topics, conduct thorough literature reviews, and formulate research questions.
- Conference Papers: Produce a minimum of one paper for reputable conferences.
- Peer-Reviewed Publication: Peer-reviewed research publication should be encouraged.
- Research Methodology: Provide guidance on methodologies, data collection, and analysis.
- Supervision and Support: Assign dedicated supervisors, facilitate regular meetings, and offer additional support.
- Presentation and Defense: Prepare presentations and defend research findings before faculty and peers.
- Evaluation Criteria: Establish clear criteria for assessing originality, depth, clarity, and contribution.
- Ethical Considerations: Educate on research ethics and ensure adherence to ethical guidelines.
- Resources and Support Services: Provide access to research facilities, training, and funding opportunities.
- Timeline and Milestones: Set clear milestones and monitor progress to meet deadlines.