Introduction

Content: The learning outcomes-based curriculum framework for a B. Sc degree in Zoology is structured to offer a broad outline within which a Zo programme could be developed. The course is upgraded keeping in mind the aspirations of students, changing nature of the subject as well as lear environment. Courses within zoology have been revisited to incorporate recent advancements, techniques to upgrade the skills of learners. The ne structure is expected to enhance the level of understanding among students and maintain the standard of Zoology degrees/programmes across th country. Effort has been made to integrate use of recent technology and use of MOOCs to assist teaching-learning process among students. This framework permits the review of agreed graduate attributes, qualification descriptors, programme learning outcomes and course-level learning out periodically. The framework offers flexibility and innovation in syllabi designing and in methods adopted for teaching- learning process and learning assessment. The major objective is to elevate the subject knowledge of the students making them critical thinkers and able to solve problems and related to zoology logically and efficiently. Overall, this course has been modified to upgrade skills related to biological science and provide our stu competitive edge in securing a career in academia, industry, pharmaceutical research & development in private as well as public sectors.

Learning Outcome based approach to Curriculum Planning

>> Nature and extent of the B.Sc/B.A./B.Com Programme

Content: Zoology is broad subject encompassing classical and modern systemic aspect of animal diversity as well as contemporary subjects like molecular biology, bioinformatics, biotechnology and medical diagnostics to foster comprehensive understanding about various aspects of animal s The scope of zoology as a subject is wide-ranging. The major areas of study with in the discipline of zoology are: Diversity of Non-chordates and chordates; Comparative Anatomy of Vertebrates; Cell Biology;Developmental biology; Biochemistry; Molecular Biology; Evolutionary Biology; Princ of Genetics; Principles of Ecology and Physiology. Diversity of Non-chordates and chordates deals with the classification and adaptive diversity of a from diverse phylums; Comparative Anatomy of Vertebrates deals with structural comparisons among all vertebrates; Cell Biology deals with the s structure and functions of the cell; Biochemistry deals with the study of chemical substances and vital processes occurring within the living organis Molecular Biology deals with the nature of biological phenomena at the molecular level; Evolutionary biology studies the evolutionary processes tha produced the diversity of life on Earth, starting from a single common ancestor; Principles of Genetics deals with the molecular structure and funct genes, and gene behavior in context of a cell or organism; Principles of Ecology studies the structure and function of nature; Physiology deals with functions and activities of life or of living matter (such as organs, tissues, or cells) and of the physical and chemical phenomena involved. Degree programme in Zoology dealt with other topics that overlap with the areas outlined above (Immunology; Parasitology; Basics of Neurosciences; Ani Behaviour and Chronobiology; Animal Biotechnology; Biology of insecta; Endocrinology; Computational Biology; Fish and Fisheries; Reproductive B and Wildlife Conservation and Management); and that address the topics related to applied fields (such as Apiculture; Aquarium Fish Keeping; Mec Diagnostics; Research Methodology and Sericulture). In addition, some topics are interdisciplinary that are offered for students of other disciplines as Animal Cell Biotechnology; Animal Diversity; Aquatic Biology; Environment and Public Health; Exploring the Brain: Structure and Function; Fooc Nutrition and Health; Human Physiology and Insect Vectors and Diseases. The applied topics like Sericulture, Apiculture, Aquarium Fish Keeping et required to include visits to industries, fields or commercial culture units to get in-depth knowledge of the subject and also to explore employment opportunities in the field.

Learning Outcome based approach to Curriculum Planning

>> Aims of Bachelor's degree programme in (CBCS) B.SC.(HONS.) ZOOLOGY

Content: Zoology is one of the most fundamental branch of biology to be studied at undergraduate level. It is required to learn and understand ab animal diversity to appreciate the variability in relation to their morphology, anatomy and behaviour among different animals. Our students will be equipped to learn and know about different human systems, their coordination and control. This course will also provide an opportunity to learn ab their own evolution along with other animals. They will be able to qualitatively and quantitatively analyse evolutionary parameters using various bioinformatics and computational tools used in modern sciences. This will provide them ample opportunities to explore different career avenues. This course will also provide a platform to learn classical genetics to understand distribution of different traits among populations, their inheritance ethnicity and can correlate with contemporary and modern techniques like genomics, metagenomics, genome editing and molecular diagnostic too Practical and theoretical skills gained in this course will be helpful in designing different public health strategies for social welfare. Zoology course v also provide a knowledge of applied subjects to develop various skills to make a career and become an entrepreneur in the field of aquatic biology, sericulture, apiculture etc. After completion of this course students will be able to contribute as policy makers in wild life conservation animal preservation and environment protection.

Graduate Attributes in Subject

>> Disciplinary knowledge

Content: Capable of demonstrating (i) comprehensive knowledge of major concepts, theoretical principles and experimental findings in zoology an different subfields including biodiversity, anatomy, physiology, biochemistry, biotechnology, ecology, evolutionary biology, cell biology, molecular bi immunology and genetics, and some of the other applied areas of study such as wildlife conservation and management, apiculture, sericulture, neurosciences, aquatic biology, fish and fisheries sciences, bioinformatics and research methods; (ii) Interdisciplinary knowledge of allied biologica sciences, environmental science and chemical science; (iii) learning of the various techniques, instruments, computational softwares used for analy animal's forms and functions.

Graduate Attributes in Subject

>> Critical thinking

Content: Ability to rationally analyze and solve the problems related to animal sciences without relying on assumptions and guesses.

Graduate Attributes in Subject

>> Problem solving

Content: Capability of seeking solutions and logically solving them by experimentation and data processing either manually or through softwares.

Graduate Attributes in Subject

>> Information/digital literacy

Content: Digitally literate: Capable of using computers for biological simulation, computation and appropriate software for biostatistics, and emplo search tools to locate, retrieve, and evaluate zoology-related data.

Graduate Attributes in Subject

>> Moral and ethical awareness/reasoning

Content: Avoiding unethical behaviour such as fabrication, falsification or misrepresentation of data or committing plagiarism, as well as appreciate environmental and sustainability issues.

Graduate Attributes in Subject

>> Lifelong learning

Content: Capable of self-paced and self-directed learning aimed at personal and social development.

Graduate Attributes in Subject

>> Communication Skills

Content: Capability to convey the intricate zoological information effectively and efficiently.

Graduate Attributes in Subject

>> Cooperation/Team work

Content: Ability to work effectively in a heterogeneous team. Through projects and field work our students will learn to work in a team and perforr groups.

Qualification Description

Content: The qualification descriptors for a Bachelors Degree programme in Zoology may include the following:
Demonstrate
(i) a logical and consistent understanding of the broad concepts in Zoology and applications, and its related interdisciplinary subjects;
(ii) technical knowledge that produces varied types of professionals in the fields like research and development, teaching, government and public s service
(iii) Use wide-range knowledge, logical thinking and skills for evaluating problems and issues related to zoology.
(iv)Collection of pertinent quantitative and/or qualitative data obtained from various sources/ experiments, analysis of the data using appropriate research methodologies for formulating evidence-based solutions.
(v) Effective and precise communication of the investigations undertaken in a variety of contexts using the major concepts, principles and techniqu the subject (s).
(vi) Meet one's own learning desires, employing broad range of research and development work and professional materials.
(vii) Apply one's subject knowledge and skills to novel circumstances to solve complicated problems with evidence based well-defined elucidations.
(viii) Demonstrate subject-related skills that are relevant to zoology related jobs and employment opportunities.

Programme Learning Outcome in course

Content: Students enrolled in B.Sc (Honours) degree programme in zoology will study and acquire complete knowledge of disciplinary as well as a biological sciences. At the end of graduation they should have following expertise which will provide them competitive advantage in pursuing highe studies from India and abroad or seek jobs in academia, research or industries.
(i) Students should be able to identify, classify and differentiate different types of chordates and non-chordates based on their morphological, anat and systemic organisation. They will also be able to describe economic, ecological and medical significance of various animals in human life. This w create a curiosity and awareness among them to explore the animal diversity and take up wild life photography or wild life explorer as a career opt The procedural knowledge about identifying and classifying animals will help students professional advantages in teaching, research and taxonomis advertised by zoological survey of India or national sanctuaries of government of India.
(ii) Acquired practical skills in biotechnology, biostatistics, bioinformatics and molecular biology can be used in pursuing career as a scientist in dru development industry in India or abroad.
(iii) Our students will be acquiring basic experimental skills genetics, sectioning, staining, qualitative, quantitative microscopy, enzymology and ana biochemistry. These methodology will provide extra edge to our students, who wish to undertake higher studies.
(iv) Demonstrate in-depth knowledge and understanding about comparative anatomy and developmental biology of various biological systems. Lea about the organisation, functions, strength and weaknesses of various systems will let student critically analyse how the evolution has shaped thes traits in human body.
(v) Students undertaking skill enhancement courses like aquaculture, sericulture and apiculture will develop skills involved in rearing fish, bees and moth for starting their own industry and generate self employment.
(vi) Demonstrate skills used in diagnostic testings, haematology, histopathology, staining procedures etc used in clinical and research laboratories. will provide them opportunity to work in diagnostic or research laboratory.
(vii) Demonstrate deep understanding about different physiological system and methods available to measure vital physiological parameters as we demonstrate the mechanism behind occurrence of different life threatening disease. They will acquire the ability to demonstrate laboratory procedu used to examine and assess some basic physiological functions and interpret physiological charts.
(viii) Students undertaking wild life management courses would gain expertise in identifying key factors of wild life management and aware about different techniques of estimating, remote sensing, Global positioning of wild life. They would demonstrate skills associated with wild life conservation.This course will motivate students to pursue career in the field of wildlife conservation and management.Course-level learning outcon

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Animal Physiology: Controlling and Coordinating Systems (32231302)
Core Course - (CC) Credit:6

Course Objective(2-3)

Physiology is the study of life, specifically, how cells, tissues and organisms function. It is important because it is the foundation upon which we build our knowledge of what "life" is, how to treat diseases and how to cope with the stresses imposed upon our bodies by different environments.

It is a core and fundamental scientific discipline that underpins the health and well being of living organisms.

Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of literally all the part and systems of the body. It is also of central importance in medicine and related health sciences, psychological and philosophical view point Hence it also helps us to understand the nervous system and behaviour as well as learning.

This paper is intended for the second year undergraduate students pursuing B.Sc(H) course in Zoology. In third semester, the students are introduced to controlling and coordinating systems and the fourth semester aims to introduce the students to physiological concepts of homeostasis and life sustaining systems.

Purpose of this paper is

(a) To standardize and achieve uniformity in teaching of physiology at the undergraduate level in the universities.

(b) To develop a holistic understanding of the complex physiological systems of the body , through lectures, practical and laboratory exercises, assignments, seminars and occasional field trips, visits to hospitals and research Institutes.

(c) To acquire the knowledge to introspect and understand the core concepts of physiology.

To provide in-depth knowledge of physiological phenomena.

1. To provide a course of study aimed on building knowledge of basic physiological principles.

2. To introduce latest concepts in line with the research developments in physiological sciences.

3. To apply the theoretical concepts to the laboratory exercises for acquiring skills of assessment and analysis

4. To extend the fundamental or coherent understanding of the subject to related disciplinary areas/subjects. e.g. through understanding of normal body functions, enables more effective treatment of abnormal or diseased states.

5. To equip students with skill based knowledge enabling them to undertake further studies in physiology and related areas as well as in multidisciplinary subjects.

Course Learning Outcomes

· The students should have a clear knowledge of basic fundamentals as well as understanding of advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue advanced degree courses .

· Should be able to comprehend and analyze problem based questions

· Should be able to recognize and explain how all physiological systems work in unison to maintain **homeostasis** in the body and use of feedback loops to control the same i.e., should learn about an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body. e.g. Cardiovascular and Respiratory systems to meet the oxygen demand of the body.

· Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances i.e. how physiological mechanisms adapt in response to various external and internal stimuli in order to maintain health.

· Knowledge of role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes.

In general, to develop investigative, communication, analytical and personal skills of the students w.r.t. the subject.

Unit 1

Unit 1: Tissues **6**

Structure, location, classification and functions of epithelial tissue, connective tissue, muscular tissue and nervous tissue

Unit 2

Unit 2: Bone and Cartilage **4**

Histology of different types of bones and cartilages, ~~Ossification, bone growth and resorption~~

Unit 3

Unit 3: Nervous System **12**

Structure of neuron, resting membrane potential, Origin of action potential and its propagation across the myelinated and unmyelinated nerve fibers; Types of synapse, Synaptic transmission and, Neuromuscular junction; ~~Reflex action and its types - reflex arc;~~ Physiology of hearing and vision.

Unit 4

Unit 4: Muscle **12**

Histology of different types of muscle; Ultra structure of skeletal muscle; Molecular and chemical basis of muscle contraction; Characteristics of muscle twitch; Motor unit, summation and tetanus

Unit 5

Unit 5: Reproductive System **8**

Histology of testis and ovary; Physiology of male and female reproduction; ~~Puberty, Methods of contraception in male and female~~

Unit 6

Unit 6: Endocrine System **18**

Histology of endocrine glands - pineal, pituitary, thyroid, parathyroid, pancreas, adrenal; hormones secreted by them and their physiological action; Classification of hormones; Regulation of their secretion; Mode of hormone action - Signal transduction pathways for steroidal and non-steroidal hormones; ~~Hypothalamus (neuroendocrine gland) - principal nuclei involved in neuroendocrine control of anterior pituitary and endocrine system; Placental hormones~~

Practical

*1. Recording of simple muscle twitch with electrical stimulation (or Virtual)

2. Demonstration of the unconditioned reflex action (Deep tendon reflex such as knee jerk reflex)

3. Preparation of temporary mounts: Squamous epithelium, Striated muscle fibres and nerve cells

4. Study of permanent slides of Mammalian skin, Cartilage, Bone, Spinal cord, Nerve cell, Pituitary, Pancreas, Testis, Ovary, Adrenal, Thyroid and Parathyroid

5. ~~Microtomy: Preparation of permanent slide of any five mammalian (Goat/white rat) tissues~~

5. Demonstration of technique of MICROTOMY to have hands on experience and learning of the technique.

6. Submission of a Project report on Methods of Contraception in male and female.

(*Subject to UGC guidelines)

SUGGESTED BOOKS

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. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition.Lippincott W. & Wilkins.
4. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders

References

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, Mc Graw Hills

Additional Resources:

Suggested Readings

1. Ganong WF: Review of Medical Physiology 26th ed Mc Graw-Hill,2019

2.Guyton, A.C & Hall,J.E (2006).Textbook of Medical Physiology, XI Edition.Hercourt Asia PTE Ltd/W.B.Saunders Company

3. Marieb E.N. (1998) Human Anatomy and Physiology, Fourth Edition, Addison Wesley Longman,Inc.

4. E-portals like Swayam or MOOCs

Journals

1. Journal of Applied Physiology
2. Physiology
3. The Journal of Physiology
4. American Journal of Physiology
5. Physiological Reviews
6. Experimental Physiology

Teaching Learning Process

The Learning Outcomes-Based Approach to curriculum planning and execution requires that the teaching learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. This, particularly in the context of undergraduate studies, requires a significant shift from teacher centric to **learner**/ **student centric**, pedagogies and from passiv to **active /participatory pedagogies**. Therefore Planning for teaching becomes critical. The underlined suggestions can be incorporated:

1. Practical skills, including an appreciation of the link between theory and experiment , will constitute an important aspect of the teaching-learning process in this regard, as this subject involves learning of functioning of the body systems.

2.Teaching methods guided by such a framework, may include:

(a) Lectures supported by group tutorial work; invited lectures

(b) Practical and field based learning;

(c) The use of prescribed textbooks and e-learning resources and other self-study materials;

(d) Open-ended project work, some of which may be team based;

(e) Assignments, seminars, oral presentations

(f) Activities designed to promote the development of generic/transferable and subject specific skills;

(g) Internships and visits to field sites and hospitals or other research facilities

(h) Guidance by the 'mentors' and specialists in the field etc.

Assessment Methods

A variety of assessment methods for this will be used to assess progress towards the course learning outcomes. Priority will be accorded to formative assessment. Progress towards achievements of learning outcomes will be assessed using the following :

(1) Time-constrained examinations - both theory and practical

(2) Closed-book and open-book tests;

(3) Problem based assignments;

(4) Practical assignment, laboratory exercises and reports; observation of practical skills; (5) Individual project reports (case-study reports team project reports;

(6) Oral presentations, including seminar presentations; viva voce interviews;

(7) Peer and self assessment, literature survey evaluations etc.

Keywords

Epithelial and connective tissues, Bones, Cartilage, Neuron, Membrane potential, Graded potential, Synapse, Neuromuscular junction, Neurotransmitter, Skeletal muscle, Sarcomere, Testes, Ovary, Endocrine glands, Hormones, Negative feedback mechanism, Signal transduction pathway.

Biochemistry of Metabolic Processes (32231403) Core Course - (CC) Credit:6

Course Objective(2-3)

The program is designed to enable a student acquire sound knowledge of Biochemistry and its practicable applicability. To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. The new and updated syllabus is based on a basic and applied approach to ensure that students develop problem solving skills, laboratory skills, chemistr communication skills, team skills as well as ethics.

Course Learning Outcomes

· Students gain knowledge and skill in the interactions and interdependence of physiological and biomolecules and the understand essentials of the metabolic pathways along with their regulation.

· To understand the principles, instrumentation and applications of bioanalytical techniques.

· To expose the students to various processes used in industries.

· Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation and be able to design and conduct scientific experiments and analyze the resulting data.

Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals

Unit 1

Unit 1: Overview of Metabolism 10

Catabolism *vs* Anabolism, Stages of catabolism, Compartmentalization of metabolic pathways, ~~E~~rrors in metabolism.

Unit 2

Unit 2: Carbohydrate Metabolism 16 Sequence of reactions and regulation of Glycolysis, Citric acid cycle, Phosphate pentose pathway, Gluconeogenesis, Glycogenolysis and Glycogenesis

Unit 3

Unit 3: Lipid Metabolism ~~10~~**12**

β-oxidation and omega -oxidation of saturated fatty acids with even and odd number of carbon atoms and their regulation; Biosynthesis of palmitic acid; Ketogenesis;

Unit 4

Unit 4: Protein Metabolism ~~**10**~~**8**

Catabolism of amino acids: Transamination, Deamination, Urea cycle; Fate of C-skeleton of Glucogenic and Ketogenic amino acids

Unit 5

Unit 5: Oxidative Phosphorylation **10**

Redox systems; Review of mitochondrial respiratory chain : Electron carriers, sites of ATP production, inhibitors and un-couplers of Electron Transport System, Oxidative phosphorylation: structure of ATPase complex, chemiosmotic hypothesis, mitochondrial shuttle system and membrane transporters.

Unit 6

Unit 6 Liver as Major Metabolic Hub **4**

Interconnection of glucose-6-phosphate, pyruvate and acetyl-CoA; fates of amino acids, fatty acids and glucose in liver cells; cascade of metabolic events that occur in fasting and starvation.

Practical

PRACTICALS **(CREDITS 2)**

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. Study of biological oxidation (SDH) [goat liver]

5. To perform the Acid and Alkaline phosphatase assay from serum/ tissue.

6. Dry Lab: To trace the labelled C atoms of Acetyl-CoA till they evolve as CO_2in

the TCA cycle

7. To estimate the bilirubin by clinical method and to know the physiological significance of the bilirubin or

7. To explore the biochemical/clinical diagnosis tests to assay liver functions

References

SUGGESTED READINGS

· Cox, M.M and Nelson, D.L. (2008). Lehninger Principles of Biochemistry, VEdition, W.H. Freeman and Co., New York.

· Berg, J.M., Tymoczko, J.L. and Stryer, L. (2007). Biochemistry, VI Edition, W.H. Freeman and Co., New York.

Additional Resources:

FURTHER READINGS

· 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.

· Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

e-Resources & e-Learning Websites:

1. The Consortium for Educational Communication (CEC) is one of the Inter University Centres set up by the University Grants Commission of India to address the needs of Higher Education through the use of powerful medium of Television along with the appropriate use of emerging Information Communication Technology (ICT). *CEC* Gurukul (www.cec.nic.in) provides regular live transmission of educational lectures delivered by eminent academicians/subject experts. The lectures are also available in their YouTube webpage (https://www.youtube.com/user/cecedusat/featured).

2. SWAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality. The objective of this effort is to take the best teaching learning resources to all, including the most disadvantaged. SWAYAM seeks to bridge the digital divide for students who have hitherto remained untouched by the digital revolution and have not been able to join the mainstream of the knowledge economy. (https://swayam.gov.in/courses/5638-biochemistry)

Teaching Learning Process

At the end of the IV Semester, the UG student is expected to demonstrate clear understanding of general concepts and fundamental biochemical principles such as structure/function of biomolecules metabolic pathways, regulation of biological and biochemical processes. Should be able to discuss various aspects of metabolism under different physiological conditions, explain the occurrence, regulation and interrelationship of metabolic events, identify the molecular/metabolic basis of a disease, describe the principles of various biochemical techniques and instrumentations and analyse and interpret the data. The course aims to provide an advanced understanding of biochemistry and their experimental basis, and to enable students to acquire a specialised knowledge and understanding of selected aspects by means lecture series and practicals

Assessment Methods

The learners/ students can be assessed in many different ways- such as:

· Continuous assessment will be made during entire semester. Summative assessment will be collected through as mid semester and semester end evaluations.

· Students will be asked to give powerpoint or black-board presentation on related topics to increase their basic presentation skills and knowledge.

· Students will be provided feedback on assignments to improve their writing skills and academic performance.

· From time to time learners will be given theoretical & practical problems to test their theoretical skills and promote practical knowledge.

Keywords

Metabolism: Anabolism, Catabolism, Biosynthesis, Phosphorylation, metabolic hub-Liver,

Cell Biology
(32231202)
Core Course - (CC) Credit:6

Course Objective(2-3)

Course Objectives:

The objective of the course is to help the students to learn and develop an understanding of a cell as basic unit of life. This course is designe to make them able to understand the construction of a cell, functions of cellular organelles and how a cell carries out and regulate cellular functions.

Course Learning Outcomes

A student should to be able to:

- Understand fundamental principles of cell Biology such as difference between Eukaryotic and Prokaryotic cells, their structure and composition, microscopic and cytochemical techniques to study them.
- Explain structure and functions of cell organelles involved in diverse cellular processes.
- Understand how cells grow, divide, survive, die and regulate these important processes.
- Understand the process of cell signaling and its role in cellular functions.
- Have an insight of how defects in functioning of cell organelles and regulation of cellular processes can develop into diseases. Learn the advances made in the field of cell biology and their applications

Unit 1

Overview of Cells: [3 hrs]

Prokaryotic and Eukaryotic cells, Virus, Viroids, Mycoplasma, Prions.

Unit 2

Plasma Membrane: [7hrs]

Various models of plasma membrane structures, Transport across membranes: Active and Passive transport, Facilitated transport.

Cell-Cell Junctions structures and functions: Tight junctions, Adhesive junctions, Gap junctions.

Unit 3

Endomembrane System: (12Hrs)

Structure and Functions: Endoplasmic Reticulum, Golgi Apparatus, Lysosomes; Endoplasmic Reticulum: Structure and functions, Signal Hypothesis, Vesicular transport from ER to Golgi Apparatus; Golgi Apparatus: Structure and functions, Protein sorting and transport from Golgi Apparatus; Vesicular transport: `Coated Vesicles'; Lysosomes: Structure and functions; Peroxisomes: Structure and functions.

Unit 4

Mitochondria: (8 hrs)

Mitochondria: Structure, Semi-autonomous nature, Endosymbiotic hypothesis Mitochondrial Respiratory Chain, Chemi-Osmotic Hypothesis and ATP Synthase.

Unit 5

Cytoskeleton: [7hrs]

Structure and Functions: Microtubules, Microfilaments and Intermediate filaments.

Unit 6

Nucleus: (10 hrs)

Structure of Nucleus: Nuclear envelope, Nuclear Pore Complex, Transport of molecules across nuclear membrane, Chromatin: Euchromatin and Hetrochromatin and packaging (nucleosome) Nucleolus: Ribosome formation.

Unit 7

Cell Division**: (**8 hrs)

Mitosis, Meiosis, Cell cycle and its regulation

Unit 8

Cell Signaling: (5 hrs)

Cell Signalling through GPCR and Role of secondary messenger:cAMP and Protein Kinase).

Practical

Practical [Credits: 2]

1. To Study Principle of the Light microscope, Phase Contrast Microscope and Electron microscope and principle of cell fixation, staining and fractionation.
2. Preparation of temporary stained squash of onion root tip to study various stages of Mitosis.
3. Study the effect of Colchicine on Mitosis at 24 hrs and 48 hrs.
4. Study of various stages of meiosis.
5. Preparation of temporary stained mount to show the presence of Barr body in human female blood cells/ cheek cells.
6. Cytochemical staining and Preparation of permanent slide to demonstrate:DNA by Feulgen reaction, Mucopolysaccharides by PAS reaction,
7. Proteins by Mercuric Bromophenol Blue/ Acid Fast Green.

References

Recommended:

Suggested Readings:

- 1. Cooper, G.M., Hausman, R.E. (2009) The Cell: A molecular approach. ASM Press and Sinauer Associates (Fifth Edition).
- 2. Becker, Kleinsmith, and Hardin. (2009) The World of the Cell (eighth Edition)Benjamin Cummings Publishing, San Francisco.

Suggested Readings:

- 1 Cooper, G.M., Hausman, R.E. (2009) The Cell: A molecular approach. ASM Press and Sinauer Associates (Fifth Edition).

  2. Becker, Kleinsmith, and Hardin. (2009) The World of the Cell (eighth Edition).
  Benjamin Cummings Publishing, San Francisco.

  3. Karp, G. (2010). Cell and Molecular Biology: Concepts and Experiments (Sixth Edition) John Wiley & Sons Inc.

  4. De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins. Philadelphia.

  5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Robert Keith and Watson James. (2008). Molecular Biology of the Cell (Fifth Edition) Garland publishing Inc. New York and London.

- Additional Readings:
- 4. De Robertis, E.D.P. and De Robertis, E.M.F. (2009) The Cell and Molecular Biology, Lippincott Williams & Wilkins. Philadelphia.
- 5. Bruce Albert, Bray Dennis, Levis Julian, Raff Martin, Robert Keith and Watson James. (2008). Molecular Biology of the Cell (Fifth Edition) Garland publishing Inc. New York and London.

Additional Resources:
ONLINE TOOLS AND WEB RESOURCES:

- https://swayam.gov.in/course/150-cell-biology
- https://swayam.gov.in/courses/5173-biochemistry-and-cell-biology
- https://www.jove.com/science-education-library/9/cell-biology
- https://www.khanacademy.org/science/biology

Teaching Learning Process

· The teaching strategy will emphasize on problem based learning to develop the requisite knowledge, skills and learning attitude of the student.

· A variety of approaches to teaching-learning process, including lectures, seminars, power point presentations, workshops, peer teaching/learning, assignments, project based learning, simulation videos, group or co-operative learning, book reviews, research colloquiur will be adopted to achieve this.

· Laboratory sessions will constitute an important part of the course along with its theoretical background. The laboratory sessions will include pre lab questions and on completion of experiment post lab questions will be given to the students. The experiments will be presented in writing in the form of laboratory reports, which gives training to write and formulate scientific text.

Assessment Methods

The assessment of students' achievement in Cell Biology will be aligned with the course learning outcomes.

· Continuous evaluation of learning by formative and diagnostic evaluation should be followed.

Project work, quiz, problem solving exercise, classroom assessment methods, closed-book and open-book tests, problem-solving exercises, practical assignment, laboratory reports, seminar presentation, viva voce interviews, computerized adaptive testing, literature surveys and summative evaluations by end-semester examination *etc.* constitute the different components of the overall assessment.

Keywords

Cell organelles, cell membrane, cell junctions, endomembrane system, cytoskeleton, mitosis, meiosis, cell signaling

Comparative Anatomy of Vertebrates (32231401) Core Course - (CC) Credit:6

Course Objective(2-3)

Objective:

The core course VIII/Paper: Comparative anatomy of vertebrates aims to provide the undergraduate students a thorough knowledge of structural details and comparative account of the different organ systems of the body from lower to higher vertebrates, and also includes protochordates, thus enabling them to appreciate the incredible vertebrate diversity. Classification of vertebrates followed in zoology is base on the study of the morphological and anatomical differences. Hence, the paper furnishes an understanding of evolutionary basis of morphological and anatomical differences as well as similarities that occur among vertebrates. The paper helps students propose possible homology between structures, and understand how they evolved as the vertebrates dwelled different habitats. The structural modifications of digestive, circulatory, respiratory and skeletal system relates to the distribution of animals in their different comfort zones of habitat and ecological niches. The understanding of anatomical details of organ systems of mammals like rat and mice aims to gives the basic information for their use in experimental and research studies in different branches of zoology like immunology, medical zoology and reproductive biology etc.

Course Learning Outcomes

Learning Outcomes:

The paper aims at providing the following critical learning outcomes:-

- Comparative account of the different vertebrate systems. This would help to understand the pattern of vertebrate evolution, organisation and functions of various systems.
- Learn the comparative account of integument and its various derivatives, each assigned with a special function.
- Know the different skeletal components, their functions, differences and modifications in different vertebrates.
- Understand the change in structure of heart from two, three to four chambered and accordingly modification in aortic arches from fish to mammals.
- Know the structure of respiratory organs used in aquatic, terrestrial and aerial vertebrates that is skin, gills and lungs.
- Understand the comparative account of digestive system and its anatomical specializations with respect to different diets and feeding habits.
- Learn the detailed structure of brain, its comparative account and its change to a complex, highly evolved form in mammals. Knowledge of cranial nerves and general and specialized receptors.
- Understand how excretory organs evolved from simple pronephric to metanephric kidney and reasons for ammonotelism, uricotelism and ureotelism to get rid of nitrogenous waste.
- Learn the comparative method to analyze and critically evaluate the structure and functions of vertebrate systems, which helps them to discern the developmental, functional and evolutionary history of vertebrate species.
- Students admire the contribution of comparative anatomy to the society by learning how the adaptations of vertebrate structures like wings of birds, gills in fishes and mammalian eye help the engineers to mimic the design and develop various devices including wings of aircraft, optics, countercurrent exchange etc.

• Students understand the importance of comparative vertebrate anatomy to discern human biology. By learning about the organization, functions, strength and weaknesses of various systems, student can critically think how the evolution has been shaped these traits in human body.

Unit 1

III CONTENTS

THEORY **(CREDITS 4)**

Unit:1	Integumentary System	7-hrs
Structure and derivatives of integument, functions of skin.		

Unit 2

Unit:2	Skeletal System	9-hrs
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.		

Unit 3

Unit: 3	Digestive System	8-hrs
Alimentary canal and associated glands, dentition.		
Unit:4	Respiratory System	8-hrs
Skin, gills, lungs and air sacs; Accessory respiratory organs.		

Unit 4

Unit: 5	Circulatory System	8-hrs
General plan of circulation, evolution of heart and aortic arches.		

Unit 5

Unit:6	Urinogenital System	6-hrs
Succession of kidney, Evolution of urinogenital ducts, Types of mammalian uteri.		

Unit 6

Unit:7	Nervous System	8-hrs
Comparative account of brain Autonomic nervous system, Spinal cord, Cranial nerves in mammals		
Unit:8	Sense Organs	6-hrs

Classification of receptors

Brief account of visual and auditory receptors in man

Practical

Practicals [Credits: 2]
1. Study of placoid, cycloid and ctenoid scales of fishes through permanent slides/photographs.
2. Study of different types of feathers of birds.
3. Disarticulated skeleton of Frog, *Varanus*, Fowl, Rabbit (Skull, Limb bones, Vertebral Column, Sternum, Girdles, Ribs).
4. Carapace and plastron of turtle/tortoise.
5. Mammalian skulls: One herbivorous and one carnivorous animal.
6. Study of digestive, circulatory and urinogenital system of frog/rat through videos on dissection or through virtual dissections.
7. Study of anatomical details of any two organs (brain, heart, lung, kidney, eye and ear) through videos.
8. Project on modifications in skeletal structures/GI tract/Respiratory organs in vertebrates.
9. Documentary film show on vertebrates/Visit to Zoo, Biodiversity park or Sanctuary.

References

Recommended:

- Kardong, K.V. (2005) Vertebrate's Comparative Anatomy, Function and Evolution. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). Comparative Anatomy of the Vertebrates. IX
- Edition. The McGraw-Hill Companies.

Leiem C.F., Bermis W.E, Walker, W.F, Grande, L(2001) Functional anatomy of the vertebrates, An evolutionary perspective, III Edition, Brookes/ColeCengage Learning.

Additional Resources:

Suggested reading

- C.K Weichert and W. Presch, Elements of chordate anatomy, Fourth Edition, McGraw-Hill.
- Ronald G.Wolff, Functional Chordate anatomy,CBS Publishers and distributors.
- Walter H.E.and Sayles L.P .Biology of vertebrates, Khosla publishing house.
- Pough.H.Vertebrate life.VIII.Edition. Pearson International.
- SWAYAM (Functional anatomy and regulation of vision, hearing, taste, smell and touch, Link - https://www.swayamprabha.gov.in/index.php/program/upcoming/9).
- SWAYAM (Structure of heart), Link- https://www.swayamprabha.gov.in/index.php/program/archive/9.
- COURSERA (PALEONTOLOGY : Early vertebrate evolution, Link - https://www.coursera.org/learn/early-vertebrate-evolution).

Teaching Learning Process

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Teaching and learning :process

In order to ensure best understanding of concepts and learning of skills by students, the following strategies are adopted for the paper/course of Comparative anatomy of vertebrates to explore and compare the major vertebrate groups:

- Class room lectures and crossover learning: provide a conceptual foundation to the leaner and will bridge the informal learning to formal learning.
- Use of models and computer assisted learning by showing photographs/diagrams/models/animations/videos for clarification of theoretica as well as practical concepts, from referred textbooks and elsewhere. Use of E-resources available in NCBI, SWAYAM etc.
- Project work: Encouraging students to undertake projects on certain topics like modifications in GT tract, appendages, respiratory organs etc. with respect to different habitats.
- Peer teaching: including presentation and group discussions on various topics of vertebrate comparative anatomy. This will allow effectiv participation of students in class room and develop confidence in students.
- Dissection of representative of vertebrate classes help the learner to gain an intimate understanding of the detailed structure of each. Du to ban on use of animals for dissections, computer aided methods will be used that is by showing virtual dissections (V-frog,VR frog) or videos of anatomy of circulatory, digestive and reproductive systems of frog and rat.
- Viewing documentary films or visiting biodiversity parks, aquarium, sanctuaries and zoos helps students correlate the anatomical change in the vertebrates studied in the classroom with actual observation in living animals.

Assignments improve the writing and abstracting skills of students.

Assessment Methods

Assessment methods:

- Formative Assessment is done on regular basis. This includes putting up questions in order to monitor student learning. Students are marked on the basis of continuous assessment and end term exam. Continuous assessment includes class test, assignment and attendanc Marks given for the attendance of the students is to maintain regularity in the class. Practicals provide a great opportunity to assess students for their understanding about a concept lectured, and demonstrate activity in small groups. Additionally, regular assessment of the practical skills gained by students is also done.
- Summative Assessment includes project reports, assignments, oral presentations, viva-voce, evaluation of practical records, regular tests.

Keywords

Keywords:

Anatomy, integument , axial, appendicular, cranium, jaw suspensorium, pectoral and pelvic girdle, visceral arches, dentition, air sacs, accessory respiratory receptors, visual cranial, spinal,

Developmental Biology
(32231601)
Core Course - (CC) Credit:6

Course Objective(2-3)

The main aim of the paper on Developmental Biology is to provide the undergraduate students an in-depth knowledge on the embryonic and post embryonic developmental processes. An important aspect of developmental biology is its implication in medicine which is also dealt wit in this course. The approach of this paper is to make the students realize the most fascinating aspect of developmental biology that a single fertilized egg can give rise to a fully developed complex organism. The course explains the basic principles and concepts underlying the developmental processes at the cellular and molecular level. The important aspect of developmental biology is morphogenesis that is the formation of an organized animal body. To understand this aspect, the students are introduced to model organisms like Sea urchin, *Drosophila,*Frog and Chick to study different types of eggs, cleavage patterns and various morphogenetic movements during gastrulation leading to formation of germ layers and their fate. The role of developmental biology in medicine is well documented now. By understanding the developmental processes the students can relate to errors occurring in during development leading to congenital disorder and human diseases. The paper also addresses the problem of infertility in humans and how to overcome this. The students are familiarized with the technique of IVF and prediagonistic methods to identify any abnormality arising during development. The students are made aware of the areas of great interest including stem cell therapy, tissue engineering and regenerative medicine.

Course Learning Outcomes

Unit 1

Introduction: **4 Hrs**

Historical perspective and basic concepts: Phases of development, Cell-Cell interaction, Pattern formation, Differentiation and growth, Differential gene expression, Cytoplasmic determinants and asymmetric cell division

Unit 2

Early Embryonic Development **26 Hrs**

Gametogenesis, Spermatogenesis, Oogenesis; Types of eggs, Egg membranes; 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

Unit 3

Late Embryonic Development **10 Hrs**

Fate of Germ Layers; Formation of neural tube, Extra-embryonic membranes in birds; Implantation of embryo in humans, Placenta (Structure, types and functions of placenta)

Unit 4

Post Embryonic Development **11 Hrs**

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

Unit 5

Implications of Developmental Biology **9 Hrs**

Teratogenesis: Teratogenic agents and their effects on embryonic development; In vitro fertilization, Stem cell (ESC), Amniocentesis.

Practical

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 (Hamburger and Hamilton Stages): Stage 3(Intermediate Streak) -- 13 hours, Stage 4(Definitive Streak) 18 hours, Stage5 (Head Process) --21hours, Stage 7--24hours, Stage 8--28hours, Stage10--33hours, ~~36~~, Stage 11—40 hours, Stage 13-- 48hours, Stage 19--72hours and Stage 24-- 96 hours of incubation

3. Demonstration of culture of chick embryo from fertilized eggs.to study various developmental stages.

4. Study of the developmental stages and life cycle of *Drosophila* from stock culture

5. Study of different sections of placenta (photomicrographs/ slides)

6. Project report on *Drosophila* culture/chick embryo development.

7. A visit to Poultry Farm/ IVF Centre

References

Additional Resources:

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- Wolpert, L. (2002). Principles of Development. II Edition, Oxford University Press.
- Kalthoff, K. (2001). Analysis of Biological Development, II Edition, McGraw Hill Publishers.
- Carlson, B.M. (2007) Foundations of Embryology, VI Edition, Tata McGraw-Hill Publishers.
- Arora, R. and Grover, A. (2018) Developmental Biology: Principles and Concepts, I Edition, R. Chand & Company.

ONLINE REFERENCES

https://www.hhmi.org/biointeractive/human-embryonic-development

· https://www.khanacademy.org/science/biology/developmental-biology

· https://ocw.mit.edu/courses/biology/7-22-developmental-biology-fall-2005/index.htm

· https://embryology.med.unsw.edu.au/embryology/index.php/Main_Page

Teaching Learning Process

Assessment Methods

Keywords

Key words

Sexual reproduction, differentiation, adherins, cytoplasmic determinants, morphogens, gametogenesis, gamete, ovulation, vitellogenesis, megalecithal , micro and mesolecithal egg, Graafian follicle, embryo, fetus, fertilization, capacitation, Acrosome, cleavage, blastula, holoblastic cleavage, meroblastic cleavage, blastomeres, gastrula, germ layers, epiboly, emboly, Koller's sickle, organogenesis, notogenesis, somites, neurula, embryonic induction, Spemann's, extra embryonic membranes, amnion, chorion, allantois, yolk sac, organizer, placenta, direct development, and indirect development, larva, metamorphosis, neoteny, regeneration, epimorphosis, morphalaxis, blastema, aging, senescence, teratology, teratogens, stem cells*, in vitro*fertilization,**

Diversity of Chordates
(32231301)
Core Course - (CC) Credit:6

Course Objective(2-3)

To provide scope and historical background of chordates.

To impart knowledge regarding basic concepts of origin of chordates.

Understanding the characteristics and classification of animals with notochord.

Understanding exclusive phenomena present in chordates like biting mechanism in snakes, flight adaptations in birds etc.

To provide adequate explanation to the students regarding various mechanisms involved in thriving survival of the animals within their geographic realms

Course Learning Outcomes

- Understanding different classes of chordates, level of organization and evolutionary relationship between different subphylums and classes, within and outside the phylum.
- Studying about this phylum will make students understand about their distinguishing features.
- Understanding similarities and differences in life functions among various groups of animals in Phylum Chordata.
- How circulatory system, nervous system and a skeletal system along with other systems give proper shape and support to diverse forms of chordates.
- How Chordates exist in diverse habitats, including marine, freshwater and terrestrial

Unit 1

Introduction to Chordates: (2 hrs)

General characteristics and outline classification.

Unit 2

Protochordata: (9 hrs)

General characteristics of Hemichordata, Urochordata and Cephalochordata; Study of larval forms in protochordates; Retrogressive metamorphosis in Urochordata

Unit 3

Origin of Chordata: (2 hrs)

Dipleurula concept and the Echinoderm theory of origin of chordates,

Unit 4

Agnatha: (2 hrs)

General characteristics and classification of cyclostomes up to class

Unit 5

Pisces: (8 hrs)

General characteristics of Chondrichthyes and Osteichthyes, Classification up to order Migration,Osmoregulation and Swim bladder in Fishes.

Unit 6

Amphibia: (6 hrs)

Origin of Tetrapoda (Evolution of terrestrial ectotherms); General characteristics and classification up to order; Parental care in Amphibians

Unit 7:

Reptilia: (7 hrs)

General characteristics and classification up to order; Affinities of Sphenodon; Poison apparatus and Biting mechanism in snakes

Unit 8:

Aves: (8 hrs)

General characteristics and classification up to order Archaeopteryx-- a connecting link; ~~Principle and Aerodynamics of Flight~~, Flight adaptations and Migration in birds

Unit 9:

Mammals: (7 hrs)

General characters and classification up to order; Affinities of Prototheria; Adaptive radiation with reference to locomotory appendages

Unit 10:

Zoogeography: (9 hrs)

Zoogeographical realms, Plate tectonic and Continental drift theory, distribution of vertebrates in different realms

Practical

1. Protochordata: *Balanoglossus, Herdmania, Branchiostoma,* Colonial Urochordata, Sections of *Balanoglossus* through proboscis and branchiogenital regions, Sections of *Amphioxus* through pharyngeal, intestinal and caudal regions. Permanent slide of *Herdmania* spicules

2. Agnatha: *Petromyzon, Myxine*

3. Fishes: *Scoliodon, Sphyrna, Pristis, Torpedo, Chimaera, Mystus, Heteropneustes, Labeo, Exocoetus, Echeneis, Anguilla, Hippocampus, Tetrodon/ Diodon, Anabas,* Flat fish

4. Amphibia: *Ichthyophis/Ureotyphlus, Necturus, Bufo, Hyla, Alytes, Salamandra*

5. Reptilia: *Chelone, Trionyx, Hemidactylus, Varanus, Uromastix, Chamaeleon, Ophiosaurus, Draco, Bungarus, Vipera, Naja, Hydrophis, Zamenis, Crocodylus,* Key for Identification of poisonous and non-poisonous snakes

6. Aves: Study of six common birds from different orders. Types of beaks and claws

7. Mammalia: *Sorex*, Bat (Insectivorous and Frugivorous), *Funambulus, Loris, Herpestes, Erinaceous.* Study of weberian ossicles of *Mystus,* pecten from fowl head and brain of fowl, Power point presentation on study of any two animals from two different classes by students

References

· Young, J. Z. (2004). The Life of Vertebrates. III Edition. Oxford university press.

· Parker T.J. and Haswell W.A. Textbook of Zoology, Vertebrate 7th Edition, Volume II

- Pough H. Vertebrate life, VIII Edition, Pearson International.

Suggested Readings**:**

- Darlington P.J. The Geographical Distribution of Animals, R.E. Krieger Pub. Co.
- Hall B.K. and Hallgrimsson B. (2008). Strickberger's Evolution. IV Edition. Jones and Bartlett Publishers Inc.

Additional Resources:

SUGGESTED ADDITIONAL MATERIALS

- https://www.khanacademy.org/science/biology/crash-course-bio-ecology/crash-course-biology-science/v/crash-course-biology-123

Teaching Learning Process

Animal pictures and models; Related videos,Powerpoint presentations, Maximizing interaction with students, Mentoring, Analysis of scientific articles

Assessment Methods

Assignments, Class test,Viva voce, MCQs,Paper presentations,Continuous assessment

Keywords

Chordata, Origin,General characteristics,Classification

Evolutionary Biology
(32231602)
Core Course - (CC) Credit:6

Course Objective(2-3)

The study of evolutionary biology is essential for anyone who seeks to obtain an understanding of life and natural world. It is a unifying thread which joins all organisms from prokaryotes to highest of eukaryotes. This course emphasizes on the development of evolutionary thought by dealing in general with the process and pattern of biological evolution. On one hand it offers a chance to students to learn about deciphering of evidences ranging from fossil records to molecular data and arrange them to establish phylogenetic relationships of species, while on the other it provides a platform to understand various forces which bring about variations between populations of a species and cause them to diversify into new species.

Course Learning Outcomes

Problem solving and high order analytical skills will be developed by attempting numerical problems as well as performing simulation studies of various evolutionary forces in action.

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Application of knowledge gained, on populations in real time, while studying speciation, behavior and susceptibility to diseases will be possible.

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Students will gain knowledge about the relationship of the evolution of various species and the environment they live in. They will be motivated to work towards mitigating climate change so that well adapted species do not face extinction as a result of sudden drastic changes in environment

.

The knowledge gained from study of variations, genetic drift can be applied to ensure that conservation efforts for small threatened populations are focused in right direction

.

The course would allow the students to predict the practical implication of various evolutionary forces acting on the human population in the field of human health, agriculture and wildlife conservation. Use of various softwares can generate an interest in the mind of learners towards the field of bioinformatics and coding used in programming language.

Unit 1

Unit:1	Life's Beginning Chemogeny, RNA World, Biogeny, Origin of photosynthesis, ~~Evolution of eukaryotes~~, Endosymbiotic theory	7 hrs

Unit 2

Unit:2	Historical Review of Evolutionary Concepts Lamarckism, Darwinism, Neo-Darwinism	4 hrs

Unit 3

Unit: 3	Evidences of Evolution Palaeontological: ~~Fossil record~~ Fossils : formation, ~~(~~types ~~of fossils,~~ and dating; ~~transitional forms~~, geological time scale; study of horse phylogeny ~~evolution of horse~~ Molecular: ~~(universality of genetic code and protein synthesising machinery, three domains of life,~~ neutral theory of molecular evolution, molecular clock ,example of globin gene family, rRNA/cyt c; phylogenetic trees: types, interpretation and applications	~~10~~ 12 hrs

Unit 4

Unit:4	~~Sources of Variations~~ Raw material for Evolution: Variations Heritable variations and their role in evolution	~~8~~ 6 hrs

Unit 5

Unit: 5	~~Population genetics~~: Forces of Evolution: Qualitative studies ~~Hardy-Weinberg Law (statement and derivation of equation, application of law to human Population);Evolutionary forces upsetting H-W equilibrium.~~ Natural selection: ~~(: concept of fitness, selection coefficient~~, ~~derivation of one unit of selection for a dominant allele, genetic load, mechanism of working,~~ types of selection; ~~density-dependent selection~~, ~~heterozygous superiority,~~ kin selection, adaptive resemblances, sexual selection. ~~Genetic Drift (mechanism, founder's effect, bottleneck phenomenon; Role of Migration and Mutation in changing allele frequencies~~ frequency dependent selection	~~13~~ 6 hrs

Unit 6

Unit:6	~~Product of evolution~~	~~7~~ 8 hrs

	~~Micro-evolutionary changes (inter-population variations, clines, races, Species concept, Isolating mechanisms, modes of speciation - allopatric, sympatric, Adaptive radiation / macroevolution (exemplified by Galapagos finches~~ Forces of Evolution: Quantitative studies Hardy-Weinberg Equilibrium: statement, assumptions, derivation of the equation; derivation of equations for change in allelic frequencies in a population by evolutionary forces upsetting H-W equilibrium: natural selection (concept of fitness, selection coefficient), genetic drift (founder's effect, bottleneck phenomenon), migration and mutation (genetic load).	
Unit:7	~~Extinctions, Back-ground and mass extinctions (causes and effects), detailed example of K-T extinction~~ Product of Evolution: Speciation Microevolutionary changes (inter-population variations, clines, Ring species, races), species concept, isolating mechanisms, modes of speciation, adaptive radiation/macroevolution, phyletic gradualism and punctuated equilibrium	~~2~~ 8 hrs
	-	-
Unit:8	~~Origin and evolution of man, Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular analysis of human origin~~ Loss of Biodiversity: Mass extinctions (events, causes and effects); detailed explanation of K-T extinction	~~6~~ 3 hrs
	-	-
Unit:9	~~Phylogenetic trees, Multiple sequence alignment, construction of phylogenetic trees, interpretation of trees~~ Origin and Evolution of Man: Unique hominin characteristics contrasted with primate characteristics, primate phylogeny from *Dryopithecus* leading to *Homo sapiens*, molecular evidences in human evolution.	~~2~~ 6 hrs

Practical

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~~

Construction of cladograms based on morphological characters.

4. ~~Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies~~ Construction of phylogenetic tree with the help of bioinformatics tools (Clustal X, Phylip,

~~NJ~~, MLK) and its interpretation.

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

Study of variations in a sample human population.

Continuous variation: Height/Weight in relation to age and sex.

Discontinuous variation: Ability/Inability to taste Phenylthiocarbamide.

6. ~~Construction of phylogenetic trees with the help of bioinformatics tools (Clustal X, Phylip, NJ) and its interpretation.~~

Study and verification of Hardy-Weinberg Law by chi square analysis.

7. Demonstration of role of natural selection and genetic drift in changing allele frequencies using simulation studies.

References

Recommended:

- Ridley,M (2004) Evolution III Edition Blackwell publishing
- Hall, B.K. and Hallgrimson, B (2013). Evolution V Edition. Jones and Barlett Publishers.
- Douglas, J. Futuyma (1997).Evolutionary Biology. Sinauer Associates.

Additional Resources:

Suggested reading:

- Pevsner, J (2009). Bioinformatics and Functional Genomics. II Edition Wiley- Blackwell
- Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.

Online Resources

- https://www.coursera.org/learn/molecular-evolution
- https://www.coursera.org/learn/genetics-evolution
- https://swayam.gov.in/courses/4062-environmental-biology-genetics-and-evolution

Teaching Learning Process

Teaching and learning Process:

The traditional pedagogical methods employed in the field of evolutionary biology, while building up on the information base of the students do little to invoke a deep understanding of the various forces, mechanisms and results of evolutionary process. To inculcate a pattern of thinking which is inquisitive, scientific and focuses on seeking relationships between various cause and effects, a constructive methodology o teaching is required.

- While traditional lectures will be the foundation stone and walls of the teaching process, the learning process will be accentuated by providing visual stimulus through presentations which show pictorial evidence of evolution (fossils) and wildlife movies which focus on topics like sexual selection and kin selection.
- Regular group discussions amongst the students will enhance the learning to a great extent.
- Organising of workshops and seminars, where eminent scientists working in the field of evolution are invited, will be a major step to draw attention of students towards the various possibilities in this field of biological science.
- Visits to lab working in the field of evolution (e.g. microbial evolution) can be very fruitful for the young learners.
- The saying "Nature is the best teacher" holds truest for the science of Evolutionary biology. One of the most important aspects of learning will be covered when field visits are organised for students to observe and study phenomenon like adaptive mimicry.
- Also, a field visit to any Natural History Museum or any Geology lab having a collection of fossils is a must to inculcate a deeper understanding of the subject.
- While, field visits will definitely benefit the students, equal, if not more benefit will be accrued by the use of Information and Communication Technology. On one hand, students will be able to gain information about all the studies being done in this field, while on the other, they can learn to use a number of programs for establishing phylogenetic relationship between organisms.
- Various computer programs which offer simulation of evolutionary forces like genetic drift, natural section etc. can be used to enhance the learning in laboratory exercises.

Assessment Methods

Assessment methods:

Assessment of Theory and Practical is done as per University guidelines as follows:

a. Theory: Total marks: 100

- Internal assessment: 25 marks:

Mid-term test: 10 marks

Written Assignment or presentation: 10 marks

Attendance: 5 Marks

- Semester end exam: 75 marks

b. Practicals: Total 50 marks

- Continuous Evaluation: 25 marks:

Practical class attendance: 5 marks

Performance in Practicals: 5 marks

Practical records: 10 marks

Viva: 5 marks

- Semester end exam: 25 marks

Keywords

Keywords: Chemogeny, RNA World, Darwinism, Neo Darwinism, Fossils, Molecular Evolution, Phylogenetic Trees, Variations, Natural Selection, Mutation, Migration, Genetic Drift, Speciation, Isolating Mechanisms, Mass Extinctions, Human Evolution

Fundamentals of Biochemistry (32231303) Core Course - (CC) Credit:6

Course Objective(2-3)

Biochemistry is understanding the core biological phenomena at the molecular level. Its aim is to comprehend the fundamental principles of chemistry that govern complex biological systems. The program is designed to enable a student acquire sound knowledge of Biochemistry and its practicable applicability. To make the study relevant, interesting, encouraging to the students to join the industry or to prepare them for higher studies including research. The new and updated syllabus is based on a basic and applied approach to ensure that students develop problem solving skills, laboratory skills, chemistry communication skills, team skills as well as ethics.

Course Learning Outcomes

- Students gain knowledge and skill in the fundamentals of biochemical sciences, Interactions and interdependence of physiological and biochemical processes.
- To expose the students to various processes used in industries and allow them to gain skills in techniques of chromatography and spectroscopy.
- Be able to demonstrate foundation knowledge biochemistry: synthesis of proteins, lipids, nucleic acids, and carbohydrates and their role in metabolic pathways along with their regulation.
- Be knowledgeable in classical laboratory techniques and be able to use modern instrumentation. Be able to design and conduct scientific experiments and analyze the resulting data.
- Be knowledgeable in proper procedures and regulations in handling and disposal of chemicals.

Unit 1

Unit 1: Carbohydrates **8**

Structure and Biological importance: ~~Monosaccharides, Disaccharides,Polysaccharides~~

~~and Glycoconjugates~~ with emphasis on aldose, ketose, chiral centre, polarised light and Fischer nomenclature, cyclization reaction of glucose, anomers, pyranose, furanose, glycosidic linkage, reducing and non-reducing sugars: monosaccharides, disaccharides , polysaccharides and Glycoconjugates

Unit 2

Unit 2: Lipids **8**

Structure and Significance: Physiologically important saturated and

unsaturated fatty acids, Tri-acyl glycerols, Phospholipids, Glycolipids, Steroids

Unit 3

Unit 3: Proteins **14**

Amino acids: Structure, Classification and General properties of α-amino acids; Physiological importance of essential and non-essential α-amino acids Proteins: Bonds stabilizing protein structure; Levels of organization in proteins motifs, folds and domains; Denaturation; Introduction to simple and conjugate proteins. Immunoglobulins: Basic Structure.

Unit 4

Unit 4: Nucleic Acids **12**

Structure: Purines and pyrimidines, Nucleosides, Nucleotides, Nucleic acids

Cot Curves: Base pairing, Denaturation and Renaturation of DNA

Types of DNA and RNA, Complementarity of DNA, Hpyo-Hyperchromaticity of DNA

Unit 5

Unit 5: Enzymes **18**

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; Multi-substrate reactions;

Enzyme inhibition; Allosteric enzymes and their kinetics; Regulation of enzyme

action

Practical

1. To understand the preparation and roles of two important biological buffer systems: phosphate and bicarbonate. Or Preparation of Buffers and determination of pH

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

3. Quantitative Tests: Determination of Ascorbic acid – DCPIP method OR Estimation of Calcium–Titrimetric method.

4. Paper chromatography of amino acids.

5. Action of salivary amylase under optimum conditions.

6. Effect of pH, temperature and inhibitors on the action of salivary amylase.

7. Demonstration of proteins separation by SDS-PAGE

References

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, 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.

5. 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.

Additional Resources:

1. Hames, B.D. and Hooper, N.M. (2000). Instant Notes in Biochemistry, II Edition, BIOS Scientific Publishers Ltd., U.K.

2. 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.

e-Resources & e-Learning Websites:

1. The Consortium for Educational Communication (CEC) is one of the Inter University Centres set up by the University Grants Commission of India to address the needs of Higher Education through the use of powerful medium of Television along with the appropriate use of emerging Information Communication Technology (ICT). *CEC* Gurukul (www.cec.nic.in) provides regular live transmission of educational lectures delivered by eminent academicians/subject experts. The lectures are also available in their YouTube webpage (https://www.youtube.com/user/cecedusat/featured).

2. National Institute of Science Communication and Information Resources (NISCAIR) (http://www.niscair.res.in/) and National Science *Digital Library* (NSDL) (www.nsdl.niscair.res.in) aims at providing comprehensive S&T information to students of science, engineering and technology in the country.

3. National Digital Library of India (NDL India; https://ndl.iitkgp.ac.in/), Ministry of Human Resource Development under its National Mission on Education through ICT has initiated the pilot project to develop a framework of virtual repository of learning resources with a single-window search facility.

Teaching Learning Process

At the end of the IV Semester, the UG student is expected :

· To demonstrate clear understanding of general concepts and fundamental biochemical principles such as structure/function of biomolecules metabolic pathways, regulation of biological and biochemical processes through class room lectures and encourage interactive learning with simulation studies including animations, presentations.

· To describe the principles of various biochemical techniques and advanced instrumentations and analyse and interpret the data with computer assisted softwares.

Project based studies will help students devise experiments independently

Assessment Methods

· Continuous Assessment by regular class tests; Projects and Assignments both individual/group projects to inculcate independent thinking as well as team work among the students. Regular Presentations to be assessed based on the content, novelty, explanation and response to queries.

· Online Assignment/Project Submission; Self-assessment through Quizm.

· Concept maps (Diagram with hierarchical nodes, labeled with concepts), ConcepTest (The instructor presents one or more questions during class along with several possible answers), Oral/Poster Presentation.

· Use of free video recording tool and online video platform (such as PresentationTube; http://presentationtube.com/). It helps to connect and train teachers and students to record, publish, and share quality video tutorials.

Keywords

: biomolecules: , carbohydrates, proteins, lipids, nucleic acids, Hypo-Hypercheomacity, Enzymes

Molecular Biology
(32231501)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course aims to provide students with an introduction of the underlying molecular mechanisms of various biological processes in cells and organisms. The study primarily involves learning about structure and synthesis of deoxyribo- and ribo-nucleic acids (DNA & RNA, respectively), formation of proteins, and regulation of gene expression.The course aims to develop basic understanding of structure-function relationships of nucleic acids and proteins.

Course Learning Outcomes

Some examples of course-level learning outcomes that a student of this course is required to demonstrate are indicated below: ● Describe the basic structure and chemistry of nucleic acids, DNA and RNA; ● Compare and contrast DNA replication machinery and mechanisms in prokaryotes and eukaryotes. ● Elucidate the molecular machinery and mechanism of information transfer processes–transcription (formation of RNA from DNA) and translation (formation of proteins from RNA) - in prokaryotes and eukaryotes; ● Explain post-transcriptional modification mechanisms for the processing of eukaryotic RNAs; ● Discuss general principles of transcription regulation in prokaryotes by exploring the structure and function of lactose and tryptophan metabolism operons; ● Give an overview of gene expression regulation in eukaryotes; ● Explain the significance of DNA repair mechanisms in controlling DNA damage; ● Recognise role of RNAs (riboswitches, siRNA and miRNA) in gene expression regulation. ● Demonstrate practical knowledge of raising, handling, maintenance and special features such as antibiotic resistance of a simple prokaryotic model organism, Escherichiacoli. ● Quantitatively estimate concentration of DNA and RNA by colorimetric methods.

Unit 1

Nucleic Acids : (6 hrs) Salient features of DNA and types ofRNA(mRNA, rRNA and tRNA) Watson and Crick model of DNA

Unit 2

DNA Replication: (12 hrs) DNA replication in prokaryotes and eukaryotes – replication machinery and mechanisms, , semi-conservative, bidirectional and semi-discontinuous replication, , Replication of circular and linear double stranded DNA, replication of telomeres.

Unit 3

Transcription: (10 hrs) Machinery and mechanism of transcription in prokaryotes and eukaryotes-RNA polymerases,transcription unit, transcription factors, synthesis of rRNA.

Unit 4

Translation: (12 hrs) Genetic code, Degeneracy of the genetic code and Wobble hypothesis; Process of protein synthesis in prokaryotes: Ribosome structure, fidelity of protein synthesis, aminoacyl-tRNA synthetases and charging of tRNA; Proteins involved in initiation, elongation and termination of polypeptide chain, Inhibitors of protein synthesis. Difference between prokaryotic and eukaryotic translation.

Unit 5

Post Transcriptional Modifications and Processing of Eukaryotic RNA: (4 hrs) Split genes: concept of introns and exons, splicing mechanism, alternative splicing, exon shuffling, and RNA editing.

Unit 6

Unit 6.1: Gene Regulation (10 hrs) Transcription regulation in prokaryotes: Principles of transcriptional regulation with examples from lac operon and trpoperon; Overview of transcription regulation in eukaryotes: Activators, repressors,

enhancers, silencer elements; Gene silencing and Genetic imprinting. Unit 6.2: DNA Repair Mechanisms (2 hrs) Pyrimidine dimerization and mismatch repair. Unit 6.3: Regulatory RNAs (4 hrs) Ribo-switches; RNA interference: miRNA and siRNA.

Practical

1. Study of Polytene chromosomes from Chironomous/ Drosophila larvae. 2. Preparation of liquid culture medium (LB) and raise culture of E. coli. 3. Preparation of solid culture medium (LB) and growth of E. coli by spreading and streaking. 4. Estimation of the growth kinetics of E. coli by turbidity method. 5. Demonstration of antibiotic sensitivity/resistance of E. coli to antibiotic pressure and interpretation of results. 6. Quantitative estimation of salmon sperm/calf thymus DNA using colorimeter (Diphenylamine reagent) or spectrophotometer (A260 measurement). 7. To understand working of the lac operon in the presence/absence of lactose and/or glucose by using simulations. 8. Study and interpretation of electron micrographs/ photograph showing a) DNA replication b) Transcription c) Split genes.

References

• Watson, J. D., Baker T.A., Bell, S. P., Gann, A., Levine, M., and Losick, R., (2008) Molecular Biology of the Gene 6th edition. Cold Spring Harbour Lab. Press, Pearson Pub. • 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. • Karp, G. (2010) Cell and Molecular Biology: Concepts and Experiments. VI Edition. John Wiley and Sons. Inc. • Cooper G. M. and Robert E. Hausman R. E. The Cell: A Molecular Approach, V Edition, ASM Press and Sinauer Associates. Additional Readings • Lewin B. (2008). Gene XI, Jones and Bartlett. • Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter: Molecular Biology of the Cell, IV Edition.

Additional Resources: Additional Resources: Online Resources • https://swayam.gov.in/courses/5065-molecular-biology • https://swayam.gov.in/courses/4916-molecular-biology • https://www.youtube.com/user/cecedusat

Teaching Learning Process

It is important for any course to enhance conceptual understanding of the subject content in the students, provide related hands-on training as well as aid in developing required skill-set for making them advance towards a field of choice. Molecular Biology course is designed in a manner to equip students with a strong foundation in molecular mechanisms of biological processes which instigates a plethora of ideas in them that will motivate them to pursue advance research. Practical exercise further provide them with required basic molecular microbiology laboratory training that will build in them confidence and make them competent to pursue advance research in this field in India or abroad. Apart from the enriched content, use of teaching learning methodologies such as active learning, inquiry-based learning, project learning, peer learning etc. in the classrooms will help in developing higher order thinking skills of analysing, evaluating and creating knowledge. Further usage of general and specific information & communications technology (ICT) and digital tools such as projectors, simulations, scientific games, mind maps, wikis etc, will make the teaching learning process most rewarding an experience.

Assessment Methods

Any teaching method needs to be matched by an appropriate assessment that relates to the objectives of the teaching. Thus i is important to ensure that our molecular biology curriculum matches the teaching that occurs and the assessments we make Students may or may not learn what is in the curriculum or what we teach, but they will learn what we assess them. Assessment based on project work, quiz, problem solving exercise, practical assignment, laboratory reports, presentation, viva-voce, computerized adaptive testing, and literature surveys by end-semester examination etcare reliable and valid measure of a student's performance, and can be relatively easily used to assess the final cumulative performance. It is also important to Identifies the focus areas required for individual student study and ranks student performance. Present Method of assessment: The students will be assessed on basis of their performance inTheory - 100 marks • End semester exam- 75 marks • Internal Assessment- 25 marks (Assignment-10; Test-10 and Attendance-5) Practical -50 marks • Classroom exam- 25 marks • Continuous Evaluation- 25 (record- 10, project/viva- 5, attendance-5, total number of practical units performed- 5)

Keywords

DNA, RNA, nucleic acids, replication, transcription, translation, RNA processing, regulation of gene expression, lac operon, attenuation, splicing, RNA interference, riboswitches.

Non Chordata-1
(32231101)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course would provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. It will help the student to understand the features of Kingdom Animalia and systematic organisation o the animals based on their evolutionary relationships, and structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; economic, ecological and

medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

Course Learning Outcomes

Upon completion of the course, students should be able to:

- **Learn about the importance of systematics, taxonomy and structural organization of animals.**
- **Appreciate the diversity of non-chordates living in diverse habit and habitats.**
- **Understand evolutionary history, relationships of non-chordates and affinities between groups through functional and structural similarities.**
- **Critically think about the organization, complexity and characteristic features of non-chordates.**
- **Getting familiarized with the morphology and anatomy of representatives of various animal phyla.**
- **Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.**
- **Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.**

Unit 1

Unit 1: Introduction to Animalia
3 hrs

General Characteristics of Kingdom Animalia and Basis of Classification

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Unit 2

Unit 2: Protista
17 hrs

General characteristics and Classification up to classes

Study of *Euglena* and *Paramecium*

Life cycle and pathogenicity of *Plasmodium vivax*

Locomotion and Reproduction in Protista

Unit 3

Unit 3: Porifera
8 hrs

Introduction to Parazoa

General characteristics and Classification up to classes

Study of *Sycon*

Canal system in sponges

Unit 4

Unit 4: Cnidaria
12 hrs

Introduction to Metazoa

General characteristics and Classification up to classes

Metagenesis in *Obelia*

Polymorphism in Cnidaria

Corals and coral reefs

Unit 5

Unit 5:Ctenophora 3 hrs

General characteristics and Evolutionary significance

Unit 6

Unit 6: Platyhelminthes 10 hrs

General characteristics and Classification up to classes

Life cycle, and pathogenicity of *Fasciola hepatica* and *Taenia solium*

Parasitic adaptations in Platyhelminthes

Unit 7: Nemathelminthes 7 hrs

General characteristics and Classification up to classes

Life cycle, and pathogenicity of *Ascaris lumbricoides*

Parasitic adaptations in Nemathelminthes

Practical

PRACTICAL (Credits 2)

1. Study of whole mount of *Euglena*, *Amoeba, Noctiluca, Paramecium,* Binary fission in *Paramecium,* Conjugation in *Paramecium*

2. Examination of pond water collected from different places to observe diversity in protista

3. Study of *Sycon, Hyalonema, Euplectella, Spongilla,* T.S. of *Sycon,* L.S. of *Sycon*

4. Study of *Obelia, Physalia, Millepora, Aurelia, Tubipora, Corallium, Alcyonium, Gorgonia, Metridium/Adamsia, Pennatula, Fungia, Meandrina, Madrepora,* T.S. of *Metridium/Adamsia*

5. One specimen/slide of any ctenophore

6. Study of adult *Fasciola hepatica*, *Taenia solium* and their life stages (Slides/micro-photographs)

7. Study of adult *Ascaris lumbricoides* and its life stages (Slides/micro-photographs), T.S. of female *Ascaris,* T.S. of male *Ascaris*

8. Submit a Project Report on life cycle of any one parasite or pathogen/corals/ coral reefs.

Note: Classification to be followed from "Barnes, R.D. (2006). *Invertebrate Zoology*, 7th Edition, Cengage Learning, India"

References

- **Barnes, R.D. (2006). *Invertebrate Zoology*, 7th Edition, Cengage Learning, India.**
- **Pechenik, J. A. (2015) *Biology of the Invertebrates.* 7th Edition, McGraw-Hill Education**

Additional Resources:

- **Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). *Invertebrate Zoology: A Functional Evolutionary Approach*. 7thEdition, Cengage Learning, India**
- **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**
- **Barrington, E.J.W. (2012). *Invertebrate Structure and Functions*. II Edition, EWP Publishers**

- **Swayam (MHRD) Portal**
  - **Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity)**
  - **Advances in Animal Diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology)**
- **ePg Pathshala (MHRD)**
  - **Module 10, 18, 19 of the paper P-08 (Biology of Parasitism) https://epgp.inflibnet.ac.in/ahl.php?csrno=35**

Teaching Learning Process

Information and concepts about morphology, anatomy and physiology of non-chordates will be imparted not only through classroom lectures to inculcate a conceptual base among the students about the subject but also through observations in nature and through real animals/preserved specimens/models which will create interest among students and enhance their understanding. Hands-on exposure would be provided to the students leading to more comprehensive learning. Blended learning using chalk-n-talk method and e-learning using presentations, animations, simple animal model systems, etc. would be used to enhance their conceptual understanding. Inquiry-based collaborative learning environment through presentations debates, group discussions, and roundtables on the various aspects of non-chordate biology would be created to not only ensure effective learning and understanding of the concepts, but also inculcate confidence in the students. Field-based projec activities have been included to create interest among the students to study and explore the biology and behaviour of non-chordates inculcating research aptitude. In addition, study of animals in their natural habitat will improve the observation skills, data collection skills, critical thinking and analytical skills of students. Furthermore, museology will give them a comprehensive idea of structural features of non-chordates and the basis of classification. Curriculum-related assignments would improve the reading, writing and abstracting skills; and enhance the critical thinking of the students.

Assessment Methods

Various measures adopted will be as follows.

- **Regularity and Discipline:Assessment of the students based on their regularity and behaviour in the class plays a significant role. Monitoring their attendanceis important to ensure concept clarity and grasp of the subject as missing links during the course of study can affect the comprehension of the subject.**
- **Class Tests:Regular class tests will judge the grasp of the topics by the students. It includes practice sessions as well as the ones during which students will be evaluated.**
- **Projects and Assignments:Individual/group projects will inculcate independent thinking as well as the team work skills among the students. Assessment on the participation of each student, analytical skills and project outcome will be held**
- **Regular Presentations:Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.**
- ***Viva-voce:Viva-voce* is another critical component ofassessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.**
- **Semester-end Examination:Semester-end examination and grading of students based on their performance in the exam is an indicator of student's learning throughout the semester. Assessment of students through final exams analyses comprehensive knowledge gained by each student comparatively.**

Keywords

Acoelomates, Classification, Cnidaria, Ctenophora, Diploblastic, Helminths, Metazoa, Parazoa, Porifera, Protista, Protostomia, Pseudocoelomates, Structural organization, Symmetry, Triploblastic

Non Chordata-II
(32231201)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course would provide an insight to the learner about the existence of different life forms on the Earth, and appreciate the diversity of animal life. It will help the student to understand the features of Kingdom Animalia and systematic organisation o the animals based on their evolutionary relationships, and structural and functional affinities. The course will also make the students aware about the characteristic morphological and anatomical features of diverse animals; economic, ecological and medical significance of various animals in human life; and will create interest among them to explore the animal diversity in nature.

Course Learning Outcomes

Upon completion of the course, students should be able to:

- **Learn about the importance of systematics, taxonomy and structural organization of animals.**
- **Appreciate the diversity of non-chordates living in diverse habit and habitats.**
- **Understand evolutionary history, relationships of non-chordates and affinities between groups through functional and structural similarities.**
- **Critically think about the organization, complexity and characteristic features of non-chordates.**
- **Getting familiarized with the morphology and anatomy of representatives of various animal phyla.**
- **Comprehend the economic importance of non-chordates, their interaction with the environment and role in the ecosystem.**
- **Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.**

Unit 1

Unit 1: Introduction to Coelomates
2 hrs

Evolution of coelom and metamerism

Unit 2

Unit 2: Annelida
14 hrs

General characteristics and Classification up to classes

Digestion, Excretion and Reproduction in Annelida

Unit 3

Unit 3: Arthropoda
17 hrs

General characteristics and Classification up to classes, Classification of Insecta up to orders

Vision and Respiration in Arthropoda

Metamorphosis in Insects

Social life in bees and termites

Unit 4

Unit 4: Onychophora
2 hrs

General characteristics and Evolutionary significance

Unit 5

Unit 5: Mollusca
14 hrs

General characteristics and Classification up to classes

Respiration in Mollusca

Torsion and detorsion in Gastropoda

Pearl formation in bivalves

Unit 6

Unit 6: Echinodermata
11 hrs

General characteristics and Classification up to classes

Protective mechanisms in echinoderms (Dermal skeleton, evisceration, autotomy)

Water-vascular system in Asteroidea

Practical

PRACTICAL
(Credits 2)

1. Study of *Aphrodite, Nereis, Heteronereis, Sabella, Serpula, Chaetopterus, Pheretima, Hirudinaria*, Trochophore larva

2. Study of T.S. through pharynx, gizzard, and typhlosolar intestine of earthworm

3. Study of *Limulus*, *Palamnaeus, Palaemon, Daphnia*, *Balanus*, *Sacculina*, *Cancer*, *Eupagurus*, *Scolopendra*, *Julus*, *Bombyx*, *Periplaneta, Apis, Musca,* termites, Crustacean larvae (Any three)

4. Study of *Peripatus* or any other Onychophora

5. Study of *Chiton, Dentalium, Pila, Doris, Helix, Unio, Mytilus, Patella, Ostrea, Pinctada, Sepia, Octopus, Nautilus,* Glochidium larva

6. Study of *Pentaceros/Asterias, Ophiura, Clypeaster, Echinus, Cucumaria/Holothuria, Antedon,* Echinoderm larvae (Any three from three different classes)

7. Study of digestive system, ovary, septal nephridia and pharyngeal nephridia of earthworm

8. Study of mouth parts, digestive system and nervous system of *Periplaneta*

9. Submit a Project Report on field study of the social behaviour of any insect (bees/termites/ants/wasps) OR behavioural pattern of earthworm in nature

Note: Classification to be followed from "Barnes, R.D. (2006). *Invertebrate Zoology*, 7th Edition, Cengage Learning, India"

References

- **Barnes, R.D. (2006). *Invertebrate Zoology*, 7th Edition, Cengage Learning, India.**
- **Pechenik, J. A. (2015) *Biology of the Invertebrates.* 7th Edition, McGraw-Hill Education**

Additional Resources:

- **Ruppert, E.E., Fox, R.S., Barnes, R. D. (2003). *Invertebrate Zoology: A Functional Evolutionary Approach*. 7thEdition, Cengage Learning, India**
- **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**
- **Barrington, E.J.W. (2012). *Invertebrate Structure and Functions*. II Edition, EWP Publishers**
- **Swayam (MHRD) Portal**

  - Animal Diversity (https://swayam.gov.in/courses/5686-animal-diversity)
  - Advances in Animal Diversity, Systematics and Evolution (https://swayam.gov.in/courses/5300-zoology)

Teaching Learning Process

Information and concepts about morphology, anatomy and physiology of non-chordates will be imparted not only through classroom lectures to inculcate a conceptual base among the students about the subject but also through observations in nature and through real animals/preserved specimens/models which will create interest among students and enhance their understanding. Hands-on exposure would be provided to the students leading to more comprehensive learning. Blended learning using chalk-n-talk method and e-learning using presentations, animations, simple animal model systems, etc. would be used to enhance their conceptual understanding. Inquiry-based collaborative learning environment through presentations debates, group discussions, and roundtables on the various aspects of non-chordate biology would be created to not only ensure effective learning and understanding of the concepts, but also inculcate confidence in the students. Field-based projec activities have been included to create interest among the students to study and explore the biology and behaviour of non-chordates inculcating research aptitude. In addition, study of animals in their natural habitat will improve the observation skills, data collection skills, critical thinking and analytical skills of students. Furthermore, museology will give them a comprehensive idea of structural features of non-chordates and the basis of classification. Curriculum-related assignments would improve the reading, writing and abstracting skills; and enhance the critical thinking of the students.

Assessment Methods

Various measures adopted will be as follows.

- **Regularity and Discipline:Assessment of the students based on their regularity and behaviour in the class plays a significant role. Monitoring their attendanceis important to ensure concept clarity and grasp of the subject as missing links during the course of study can affect the comprehension of the subject.**
- **Class Tests:Regular class tests will judge the grasp of the topics by the students. It includes practice sessions as well as the ones during which students will be evaluated.**
- **Projects and Assignments:Individual/group projects will inculcate independent thinking as well as the team work skills among the students. Assessment on the participation of each student, analytical skills and project outcome will be held**
- **Regular Presentations:Presentations by the students on a particular topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries raised by peers.**
- ***Viva-voce:Viva-voce* is another critical component ofassessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.**
- **Semester-end Examination:Semester-end examination and grading of students based on their performance in the exam is an indicator of student's learning throughout the semester. Assessment of students through final exams analyses comprehensive knowledge gained by each student comparatively.**

Keywords

Annelida, Arthropoda, Coelomates, Classification, Deuterostomia, Echinodermata, Insecta, Metamerism, Metazoa, Mollusca, Onychophora, Structural organization, Symmetry, Triploblastic

Physiology: Life Sustaining Systems (32231402) Core Course - (CC) Credit:6

Course Objective(2-3)

Physiology is the study of life, specifically, how cells, tissues and organisms function. It is important because it is the foundation upon which we build our knowledge of what "life" is, how to treat diseases and how to cope with the stresses imposed upon our bodies by different environments.

It is a core and fundamental scientific discipline that underpins the health and well being of living organisms.

Besides satisfying a natural curiosity about how our body systems function, it gives us knowledge about the functions of literally all the parts and systems of the body. It is also of central importance in medicine and related health sciences, psychological and philosophical view points. Hence it also helps us to understand the nervous system and behaviour as well a learning.

This paper is intended for the second year undergraduate students pursuing B.Sc(H) course in Zoology. In third semester, the students are introduced to controlling and coordinating systems and the fourth semester aims to introduce the students to physiological concepts of homeostasis and life sustaining systems.

Purpose of this paper is

(a) To standardize and achieve uniformity in teaching of physiology at the undergraduate level in the universities.

(b) To develop a holistic understanding of the complex physiological systems of the body , through lectures, practical and laboratory exercises, assignments, seminars and occasional field trips, visits to hospitals and research Institutes.

(c) To acquire the knowledge to introspect and understand the core concepts of physiology.

To provide in-depth knowledge of physiological phenomena.

1. To provide a course of study aimed on building knowledge of basic physiological principles.

2. To introduce latest concepts in line with the research developments in physiological sciences.

3. To apply the theoretical concepts to the laboratory exercises for acquiring skills of assessment and analysis

4. To extend the fundamental or coherent understanding of the subject to related disciplinary areas/subjects. e.g. through understanding of normal body functions, enables more effective treatment of abnormal or diseased states.

5. To equip students with skill based knowledge enabling them to undertake further studies in physiology and related area as well as in multidisciplinary subjects.

Course Learning Outcomes

· The students should have a clear knowledge of basic fundamentals as well as understanding of advanced concepts so as to develop a strong foundation that will help them to acquire skills and knowledge to pursue advanced degree courses .

· Should be able to comprehend and analyze problem based questions

· Should be able to recognize and explain how all physiological systems work in unison to maintain homeostasis in the body and use of feedback loops to control the same i.e., should learn about an integrative approach to understand the interactions of various organ systems resulting in the complex overall functioning of the body. e.g. Cardiovascular and Respiratory systems to meet the oxygen demand of the body.

· Synthesize ideas to make connection between knowledge of physiology and real world situations, including healthy life style decisions and homeostatic imbalances i.e. how physiological mechanisms adapt in response to various external and internal stimuli in order to maintain health.

· Knowledge of role of regulatory systems viz. endocrine and nervous systems and their amalgamation in maintaining various physiological processes.

In general, to develop investigative, communication, analytical and personal skills of the students w.r.t. the subject.

Unit 1

Unit 1: Physiology of Digestion 16

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.

Unit 2

Unit 2: Physiology of Respiration 12

Histology of Respiratory tract; 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; Control of respiration

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Unit 3

Unit 3: Renal Physiology 12

Structure of kidney and its functional unit; Mechanism of urine formation; Regulation of water balance; Regulation of acid-base balance

Unit 4

Unit 4: Blood **8**

Components of blood and their functions; Structure and functions of haemoglobin

Haemostasis: Blood clotting system, ~~Kallikrein-Kinninogen system, Complement system&~~ Fibrinolytic system~~, Haemopoiesis~~

~~Blood groups: Rh factor, ABO and MN~~

Unit 5

Unit 5: Physiology of Heart

12

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, Frank-Starling Law of the heart, nervous and chemical regulation of heart rate. Electrocardiogram, Blood pressure and its regulation

Unit 6

Practical

.~~ 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 frog's heart beat under *in situ* and perfused conditions*~~

5. Interpretation of recording of frog's heart beat (in *situ*) under normal and experimental conditions.

6. Recording of blood pressure using a sphygmomanometer

7. Examination of sections of mammalian oesophagus, stomach, duodenum, ileum, rectum liver, trachea, lung, kidney

8. Study of lung volumes and capacities by Spirometry; Comparison of normal physiological and one pathological condition.

(*Subject to UGC guidelines)

SUGGESTED READINGS:

1. Victor P. Eroschenko. (2008). diFiore's Atlas of Histology with Functional correlations. XII Edition. Lippincott W. & Wilkins.

2. Arey, L.B. (1974). Human Histology. IV Edition. W.B. Saunders.

3. Zao,P.Stabler, T.Smith, L.Lokuta, A. and Griff, E., Physio Ex9.1 Laboratory Simulations in Physiology (with CD) USA: Pearson Education Inc. 2014.

References

Recommended 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, Mc Graw Hills.

Additional Resources:

Suggested Readings

1. Ganong WF: Review of Medical Physiology 26th ed Mc Graw-Hill,2019

2.Guyton, A.C & Hall,J.E (2006).Textbook of Medical Physiology, XI Edition.Hercourt Asia PTE Ltd/W.B.Saunders Company

3. Marieb E.N. (1998) Human Anatomy and Physiology, Fourth Edition, Addison Wesley Longman,Inc.

4. E-portals like Swayam or MOOCs

Journals

1. Journal of Applied Physiology

2. Physiology

3. The Journal of Physiology

4. American Journal of Physiology

5. Physiological Reviews

6. Experimental Physiology

Teaching Learning Process

Teaching – Learning Process

Teaching and learning Process:

The Learning Outcomes-Based Approach to curriculum planning and execution requires that the teaching learning processes are oriented towards enabling students to attain the defined learning outcomes relating to the courses within a programme. This, particularly in the context of undergraduate studies, requires a significant shift from teacher centric to learner/ student centric, pedagogies and from passive to active /participatory pedagogies. Therefore Planning for teaching becomes critical. The underlined suggestions can be incorporated:

1. Practical skills, including an appreciation of the link between theory and experiment , will constitute an important aspect o the teaching-learning process in this regard, as this subject involves learning of functioning of the body systems.

2.Teaching methods guided by such a framework, may include:

(a) Lectures supported by group tutorial work; invited lectures

(b) Practical and field based learning;

(c) The use of prescribed textbooks and e-learning resources and other self-study materials;

(d) Open-ended project work, some of which may be team based;

(e) Assignments, seminars, oral presentations

(f) Activities designed to promote the development of generic/transferable and subject specific skills;

(g) Internships and visits to field sites and hospitals or other research facilities

(h) Guidance by the 'mentors' and specialists in the field etc.

Assessment Methods

Assessment Methods

A variety of assessment methods for this will be used to assess progress towards the course learning outcomes. Priority will be accorded to formative assessment. Progress towards achievements of learning outcomes will be assessed using the following :

(1) Time-constrained examinations - both theory and practical

(2) Closed-book and open-book tests;

(3) Problem based assignments;

(4) Practical assignment, laboratory exercises and reports; observation of practical skills; (5) Individual project reports (case study reports); team project reports;

(6) Oral presentations, including seminar presentations; viva voce interviews;

(7) Peer and self assessment, literature survey evaluations etc.

Keywords

Gastrointestinal Tract, Absorption, Respiratory Volumes and Capacities, Oxy-haemoglobin curve, Nephron, Countercurrent mechanism, Acid -base Balance, Haemostasis, Coronary circulation, Pacemaker, ECG, Cardiac cycle, Heart sounds, Frank-Starling Law, Blood pressure.

Principles of Ecology
(32231102)
Core Course - (CC) Credit:6

Course Objective(2-3)

The Primary aim of the syllabus is to sensitize the students about the paramount role and importance of Nature. Nature has provided us enormous benefits, which is known as Ecosystem services. The study of Ecology imparts us the knowledge about the judicious use of existing ecological resources for sustainable development. Ecology is the only branch of science which briefs us on the ways and means of living with nature for mutual benefit. Ecology also provides us opportunity to understand its practical aspects and helps the students to solve many contemporary ecological issues such as Global warming, land degradation, habitat loss, desertification and pollution etc. The hands on experiences of laboratory also enable students to understand the ecosystem and ecology in a better way.

Course Learning Outcomes

After completion of this course students will be expected to: • Demonstrate an understanding of key concepts in ecology with emphasis on historical perspective, role of physical factors and concept of limiting factors. • Demonstrate an understanding of populations: characteristics, dynamics, growth models and interactions. • Understand the community characteristics, ecosystem development and climax theories. • Knowledge about the types of ecosystems, food chains, food webs, energy models, and ecological efficiencies. • Capability to apply the basic principles of ecology in wildlife conservation and management. • Demonstrate scientific quantitative skills, such as the ability to evaluate experimental design, read graphs, and analyse and use information available in scientific literature. • Demonstrate effective communication skills in writing and in oral presentations.

Unit 1

Unit 1: Introduction to Ecology 6 5 periods History and Scope of ecology, Autecology and synecology, Levels of organization, Laws of limiting factors, Study of physical factors: Temperature and Light

Unit 2

Unit 2: Population 24 periods Unitary and Modular populations Unique and group attributes of population: Density, natality, mortality, life tables, fecundity 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 Population interactions, Gause's Principle with laboratory and field examples, Lotka-Volterra equation for competition and Predation, functional and numerical Responses

Unit 3

Unit 3: Community 12 periods Community characteristics: species richness, dominance, diversity, abundance, Guilds, Ecotone and edge effect; Ecological succession; with one example, Types, Theories pertaining to climax community.

Unit 4

Unit 4: Ecosystem 14 periods Types of ecosystems with detailed study of; any one forest Ecosystem, Pond or lake Ecosystem, Mangrove and Coral reef Ecosystem. Vertical stratification in Forest & Aquatic ecosystem, 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 with one example of Nitrogen cycle Human modified ecosystem

Unit 5

Unit 5: Applied Ecology 4 5 periods Ecology in Wildlife Conservation and Management, Biodiversity; types, Importance & threats, Protected areas; National Parks, Bio reserves & Sanctuaries. Restoration ecology, Global Climate Change and its mitigation

Practical

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 quadrate method and calculation of Shannon-Weiner diversity index for the same community 3. Study of an aquatic ecosystem: Phytoplankton and zooplankton, Measurement of area, temperature, turbidity/penetration of light, determination of pH, and Dissolved Oxygen content (Winkler's method), Chemical Oxygen Demand and free CO_2, Alkalinity 4. Report on a visit to National Park/Biodiversity Park/Wild life sanctuary

References

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

Teaching Learning Process

• The course involves four hours each of classroom teaching and laboratory activity per week. • Classroom work would incluc lectures based on textbook and scientific journal readings. • Lectures consist of traditional board teaching as well as power point presentations. • Learning process will also include participatory activities like focused group discussions, presentations by students, experience sharing, brainstorming and project writing. • Field trip activities to National parks and Eco-parks complement and enhance understanding of the theory content of the course. • Laboratory work provides students the first hands on experience for better understanding of the subject.

Assessment Methods

• Evaluation is carried out to determine the extent to which the students demonstrate desired learning outcomes. • Multiple assessment methods will be used as evaluation criteria which include continuous assessment, assignments, tests, class presentations & mock tests. • Project writing based on leanings from field trips.

Keywords

• Ecology, Community Ecology, Population Ecology, Biodiversity

Principles of Genetics
(32231502)
Core Course - (CC) Credit:6

Course Objective(2-3)

Unknown to them, human beings had been applying the principles of genetics by engaging in selective breeding of domesticated animals for many centuries. However, it was only with the work of Mendel and advent of 20thcentury, that basi principles of the science of genetics were formulated. In about a century of its existence, this field has generated tremendous amount of knowledge through observational and experimental research. The information amassed in the last century has laid the foundation for more discoveries in this important field of life science. This course aims to provide an overview of genetics starting from the work of Mendel to the current understanding of various phenomena like recombination, transposition, sex determination and mutations. The course will help in building sound fundamental knowledge of the principles of genetics, to be used as a stepping stone for higher studies and research in this field.

Course Learning Outcomes

Course Learning Outcome: **· Knowledge of the principles of genetics is essential for a deeper understanding of the varied branches of the biological sciences like microbiology, evolutionary biology, genomics and metagenomics.** **· The primary outcome of studying this course will be the gaining of knowledge of the basic principles of inheritance.** **· Analysis of pedigree will lead to development of analytical skills and critical thinking enabling the students to present the conclusion of their findings in a scientific manner. Field studies can be conducted and case histories of families can be collected. This will not only help the students in hypothesis formulating and testing but will also teach them an essential skill of data collection. Students can prepare reports and present their findings in posters or oral presentations. This will help them to upgrade their data presentation and communication skills.** **· Knowledge of the mechanisms of mutations and the causative agents will lead to an increase in an awareness of the students about the harmful impact of various chemicals and drugs being used in day to day life. These students will in turn make people aware of the impact of indiscriminate use of such compounds.** **· Students can work to find out the effects of indiscriminate use of various chemicals, drugs or insecticides in nature by studying their effect on various bacterial species in soil and water samples from different industrial or polluted areas. This will help to enhance the organisational and experimental skills of the students.**

Unit 1

Unit:1	**Mendelian Genetics and its Extension**	**10-hrs**
Principles of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, penetrance and expressivity, Epistasis, Pleiotropy, Sex-linked, sex- influenced and sex-limited characters inheritance and concept of gene.		

Unit 2

Unit:2	**Linkage, Crossing Over and Chromosomal Mapping**	**10-hrs**
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, Linkage map, coefficient of coincidence and Interference, Gene mapping by Somatic cell hybridization.		

Unit 3

Unit: 3	**Mutations**	**10-hrs**
Types of gene mutations ~~(Classification)~~, Detection of mutations in Drosophila: CLB method, attached X method. Mutagens: Physical and Chemical. Molecular basis of spontaneous and induced mutations. ~~Types of~~ Chromosomal aberrations ~~(Classification, figures and with one suitable example of each~~) :Variations in number and structure .		

Unit 4

Unit:4	**Sex Determination**	**5-hrs**
Genetic and environmental basis of sex determination; Chromosomal mechanisms of sex determination in *Drosophila* and Man; Mechanism of Dosage compensation		

Unit 5

Unit: 5	**Extra-chromosomal Inheritance**	**6-hrs**

Comparison of nuclear and extra nuclear inheritance; Organelle inheritance: ~~Criteria for extra-chromosomal inheritance~~, Antibiotic resistance in Chlamydomonas, Mitochondrial mutations in *Saccharomyces*, mitochondrial mutations and human disorders, Infective heredity in Paramecium. Maternal effects: Shell coiling in *Limnaea*, pigmentations in *Ephestia*		

Unit 6

Unit:6	**Polygenic Inheritance**	**3-hrs**
Polygenic inheritance with suitable examples and ~~simple~~ numericals.		
Unit:7	**Recombination in Bacteria and viruses**	**9-hrs**
Conjugation, Transformation, Transduction in bacteria. Complementation test in Bacteriophage		
Unit:8	**Transposable Genetic Elements**	**8-hrs**
Transposons in bacteria, Ty elements in yeast, Ac-Ds elements in maize and P elements in Drosophila, Transposons in humans. Transposons as mutagens.		

Practical

Practicals **[Credits: 2]**
1. ~~To study the Mendelian laws and gene interactions.~~ **Simulation exercises using beads or seeds to study the Mendel's laws and gene interactions.** **2. ~~Chi-square analyses using seeds/beads/*Drosophila*.~~** **Verification of Mendelian ratios using Chi-square analysis /test** **3. ~~Linkage maps based on data from conjugation, transformation and transduction.~~** **Pedigree analysis** **4. ~~Linkage maps based on data from *Drosophila* crosses.~~** **Use of probability in solving problems in genetics.** **5. ~~Study of human karyotype (normal and abnormal).~~** **Linkage maps based on data from conjugation.** **6. ~~Pedigree analysis of some human inherited traits.~~** **Linkage maps based on data from Drosophila crosses.** **7. Study of human karyotype (normal and abnormal).**

References

Recommended books:

- **Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons In.**
- **Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). Concepts of Genetics. X Edition. Benjamin Cumming**
- **Pierce B. A. (2012). *Genetics-A conceptual approach.* IV Edition. W. H. Freeman and Company**

Suggested reading:

- **Russell, P. J. (2009). *Genetics- A Molecular Approach.*III Edition. Benjamin Cummings**
- **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.**
- **Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). Principles of Genetics. VIII Edition. Wiley India**

On line tools and Web resources:

- **https://swayam.gov.in/courses/4922-genetics-and-genomics**
- **https://swayam.gov.in/course/96-genetics**
- **https://www.coursera.org/learn/genetics-evolution**
- **https://onlinelearning.hms.harvard.edu/hmx/courses/hmx-genetics/**
- **https://learn.genetics.utah.edu/**

Teaching Learning Process

Teaching and learning Process:

1. Lectures, using blackboard and power-point presentations will be delivered by the teachers and the queries of students will be addressed after they have revised the topic.

2. Students are given assignments e.g. Constructing linkage maps, pedigree analysis, probability calculation etc.

3. As a part of peer learning, regular group discussions will be held amongst the students to enhance their knowledge.

4. To develop a scientific temper and hone communication skills of students, power point presentations, paper presentations and debates can be organised on various themes as prescribed in the syllabus while focusing on the latest development in them.

5. An essential part of learning is through observation and experimentation. Towards this end visit of students to labs working in the field of genetics (e.g. Drosophila, Microbial genetics) can be organized. Also, students can be encouraged to undertake internships in these labs so as to deepen their interest in this field.

6. Another essential way of learning is through the experience of others. Lectures of researchers working in the field of Genetics can be organized to update students about the latest developments in this field, so that they get motivation to make a career in this highly versatile field of Biological sciences.

Assessment Methods

Assessment methods: Students can be assessed by following methods for proper understanding of the subject:

1. **Problem solving assignments can be given to students.**
2. **Assessment of Case history projects to prepare pedigrees and find out the probabilities of occurrence of diseases in next generations.**
3. **Power point presentation evaluation on different topics.**
4. **Debates can be held and students can be assessed for understanding of the subject.**
5. **Multiple choice questions (Test) can be taken and students are assessed for their grasping of the topics.**
6. **Laboratory visits to understand the research going on in the field of Genetics and to submit reports.**

Keywords

Keywords:

Mendelian inheritance, Multiple alleles, Penetrance, Epistasis, Pleiotropy, Gene, Chromosomal mapping, Recombination, Interference, Mutations, mutagens, chromosomal aberrations, Sex determination, Dosage compensation, Nuclear inheritance, Mitochondrial inheritance, Infective heredity, shell coiling, polygenic inheritance, conjugation, transformation, transduction, complementation, Transposons, Ty elements, Ac-Ds elements, transposons as mutagens.

Animal Behavior and Chronobiology
(32237901)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Animal Behaviour is the scientific study of the wild and wonderful ways in which animals interact with each other, with other living beings, and with the environment in which they live in. One important aspect pertaining to the studies on Animal Behaviour is that it can be conducted anywhere and at any time, depending on the interest of the researcher. Moreover, it is not confined to the four walls of the classroom or the laboratory. The behavioural biology has high applied value and currently linked to conservation biology, molecular biology, behavioural ecology and integrated pest management. The chronobiology addresses some periodic and cyclic nature of various life phenomenon occurring in living beings in nature. They often correlate with the external environmental factors. Chronopharmacology, chronomedicine, chronotherapy are some of the direct applications of chronobiology in human health. This course aims to provide an overview of animal behaviour and chronobiology starting from historical prospective to types of behaviours and their evolutionary significance. The course also highlights types, mechanisms and importance of the biological rhythms and biological clocks operating in the living organisms. This course will help the learners to understand and appreciate different types of animal behaviours, their adaptive, evolutionary and practical significance.

Course Learning Outcomes

- **The learners can understand types of animal behaviour and their importance to the organisms.**
- **The student will enhance their observation, analysis, interpretation and documentation skills by taking short projects pertaining to Animal behaviour and chronobiology.**
- **They will relate animal behaviour with other subjects such as Animal biodiversity, Evolutionary biology, Ecology, Conservation biology and Genetic basis of the behaviour.**
- **They will understand various process of chronobiology in their daily life such as jet lag.**
- **They will also learn about the biological rhythm and their application in pharmacology and modern medicine.**
- **The course will help the students to understand, appreciate and develop passion to biodiversity. They will respect the nature and environment.**

Unit 1

Introduction to Animal Behaviour **8-hrs**

Origin and history of Ethology; Pioneers of Modern Ethology: Karl von Frish, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen; Proximate and ultimate causes of behaviour; Tools, Techniques and Methods used in studying animal behaviour

Unit 2

Patterns of Behaviour **10-hrs**

Stereotyped behaviours (Orientation, Reflexes); Individual behavioural patterns; Instinct *versus* Learned behaviour; Associative learning, Classical and Operant conditioning, Habituation, Imprinting

Unit 3

Social and Sexual Behaviour **15-hrs**

Social Behaviour: Concept of Society; Communication and the senses (Chemical, Tactile, Auditory, Visual); Altruism, Inclusive fitness, Hamilton's rule; Insects' society (Example: Honey bee); Foraging in honey bee and advantages of the waggle dance.

Sexual Behaviour: Asymmetry of sex, Sexual dimorphism, Mate choice, Intra-sexual selection (male rivalry), Inter-sexual selection (female choice), Courtship behaviour; Parental care, sexual conflict in parental care.

Unit 4

Introduction to Chronobiology **6-hrs**

Historical developments in chronobiology; Biological oscillation: the concept of Average, amplitude, phase and period. Adaptive significance of biological clocks

Unit 5

Biological Rhythm **13-hrs**

Characteristics of biological rhythms; Short- and Long- term rhythms; Circadian rhythms; Tidal rhythms and Lunar rhythms; Concept of synchronization and masking; Photic and non-photic zeitgebers; Circannual rhythms; Photoperiod and regulation of seasonal reproduction of vertebrates; Role of melatonin.

Unit 6

Biological Clocks **8-hrs**

Relevance of biological clocks; Chronopharmacology, Chronomedicine, Chronotherapy.

Practical

[Credits: 2]

1. **To study nests and nesting behaviour of the birds and social insects.**
2. **To study the behavioural responses of wood lice to dry and humid conditions.**
3. **To study geotaxis behaviour in earthworm/ phototaxis behaviour in insect larvae.**
4. **Study of courtship behaviour in birds and insects from short videos/films.**
5. **Visit to Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park to study and record the behavioural activities of animals and prepare a short report.**
6. **Study and actogram construction of locomotor activity of suitable animal models.**
7. **To study circadian functions in humans (daily eating, sleep and temperature patterns).**

References

- **Alcock J. Animal Behaviour, Sinauer Associate Inc., USA.**
- **McFarland D. Animal Behaviour, Pitman Publishing Limited, London, UK.**
- **Vinod Kumar 2002, Biological Rhythms, Narosa Publishing House, Delhi/ Springer-Verlag, Germany**
- **Dunlap J. C, Loros J. J, DeCoursey P. J. Chronobiology Biological Timekeeping: (ed). 2004, Sinauer Associates, Inc. Publishers, Sunderland, MA, USA**

Additional Resources:

- **Manning, A. and Dawkins, M. S, An Introduction to Animal Behaviour, Cambridge, University Press, UK.**
- **Paul W. Sherman and Alcock J., Exploring Animal Behaviour, Sinauer Associate Inc., Massachusetts, USA.**
- **Saunders D. S. Insect Clocks (3rd Ed) 2002 Barens and Noble Inc. New York, USA**

Teaching Learning Process

Teaching learning methods for the Animal behaviour and chronobiology paper should include conventional black board teaching coupled with power point presentations and smart board. The animal behaviour in wild life can be shown to the student with the help of videos and short films. The classroom teaching should be inclusive and have opportunities for the students to participate in the class discussion. The students should be encouraged to observe various live animal behaviours in their immediate surrounding environment and interpret them. There should be ample scope for field visits and visit to the research laboratories. Seminar should be arranged at the departmental level for the student, where student can have paper presentation on various themes of animal behaviour and chronobiology. Quizzes and debates can be arranged to make the teaching learning more innovative. Students should be advised to use e resources along with standard text books and reference books. They should take short project work and case study on the animal behaviour. They should relate various concepts in chronobiology taught in the classroom with their daily life. The students should be regularly assessed.

Assessment Methods

Scheme for the assessment of students would have two components. The first component will include continuous evaluation of the student throughout the course work by assessing assignments, project works, presentations, quiz, class tests and regularity in attending the classes. The second component will carry examination carried by the University at the end of semester.

A. Theory (4 credits): Total marks: 100

1. Continuous evaluation: 25 marks

- **Class tests/Quiz: 10 marks**
- **Assignments/Projects/Presentations: 10 marks**
- **Attendance: 5 Marks**

2. University end semester examination: 75 marks

B. Practicals (2 credits): Total 50 marks

1. Continuous Evaluation: 25 marks

- **No. of practical performed: 5 marks**
- **Project work: 5 marks**
- **Practical records: 10 marks**
- **Viva voce: 5 marks**

2. University end semester examination: 25 marks

Keywords

Animal behaviour, Types of behaviour, Social behaviour, Reproductive behaviour, Altruism, Courtship behaviour, Communication, Chronobiology, Biological rhythm, Biology Clocks

Animal Biotechnology
(31137903)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Course Objective: Biotechnology is the advanced branch of biological sciences which mostly deals with technological application on biological systems. It is basically the management of biological processes for industrial and other human welfare purposes.

- **The present paper on biotechnology attempts to give a wholesome idea of biotechnology at a basic level.**
- **It provides a toolkit in the form of a number of various techniques and processes developed over time to solve problems involving primarily human welfare with focus on health and medicine.**
- **Equips students with basic tools of biotechnology which are a must for everyone interested in pursuing a career in biotechnology.**
- **It makes one aware of the scope of this field which encompasses almost every field of science like engineering, research, commercialization and academics.**

Course Learning Outcomes

Course Learning Outcome:

· The student will be able to use or demonstrate the basic techniques of biotechnology like DNA isolation, PCR, transformation, restriction digestion etc.

· Will be able to make a strategy to manipulate genetic structure of an organism for the improvement in any trait or its well being based on the techniques learned during this course.

· Will understand better the ethical and social issues raised regarding GMOs.

· Can use the knowledge for designing a project for research and execute it.

Unit 1

Unit 1 **3hrs**
Introduction

Concept and scope of biotechnology

Unit 2

Unit 2 **12 hrs.**

Basic Tools for Gene Manipulation

Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics).

Restriction enzymes: Nomenclature, detailed study of Type II, DNA modifying enzymes.

Transformation techniques: Calcium chloride method, electroporation and biolistic method.

Construction of genomic and cDNA libraries and screening by colony and plaque hybridization

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Unit 3

Unit 3 **18 hrs.**

Advance Tools and Techniques

Southern, Northern and Western blotting

DNA sequencing: Sanger method, Next generation sequencing (Illumina)

Polymerase Chain Reaction, DNA Finger Printing and DNA micro array,

Gene Editing Tools : Zinc finger nucleases (ZFNs), transcription activator-like effector-based nucleases (TALEN) and the clustered regularly interspaced short palindromic repeats (CRISPR/Cas9) system

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Unit 4

Unit 4 **18hrs.**

Genetically Modified Organisms

Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection

Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knock out mice.

Production of transgenic plants: Agrobacterium mediated transformation.

Applications of transgenic plants: insect and herbicide resistant plants

Unit 5

Unit 5 **9 hrs.**

Applications of Genetic Engineering

Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia), Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy

Practical

Practicals

[Credits: 2]

1. Genomic DNA isolation from *E.coli*

2. Plasmid DNA isolation (pUC 18/19) from *E.coli*

3. Demonstration of Restriction digestion of plasmid/ Lambda DNA.

4. Construction of circular and linear restriction map from the data provided.

5. Calculation of transformation efficiency from calcium chloride method.

6. To demonstrate following techniques: (Optional)

a. Southern/ Northern/Western blotting (Any one)

b. PCR

c. DNA fingerprinting

7. Project report on a visit to any biotechnology institute / Advance techniques in biotechnology

References

Gene Cloning and DNA Analysis (2010) 6th ed., Brown, T.A., Wiley-Blackwell publishing (Oxford, UK), ISBN: 978-1-4051-8173-0.

Glick, B.R., Pasternak, J.J. and Patten, C.L., (2010). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA. ISBN: 978-1- 55581-498-4 (HC).

Primrose, S.B., and Twyman, R. M.,(2006). Principles of Gene Manipulation and Genomics 7th ed., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544

Additional Resources:

Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA- Genes and Genomes- A Short Course. III Edition, Freeman and Co., N.Y.,USA.

Biotechnology (2012) update ed., Clark, D. P., Pazdernik, N.J. ,Academic Press ISBN :978-0-12-385063-8

Additional Online References

https://swayam.gov.in/courses/5178-molecular-biology-genetic-engineering-and-plant-tissue-culture Module no. :14,to 21,23&24

https://nptel.ac.in/courses/102103041/2 Gene Therapy

https://nptel.ac.in/courses/102103013/49 Genetic Engineering & Applications(Web)

https://nptel.ac.in/courses/102107028/40 Analytical Technologies in Biotechnology (Video) Electrophoresis , PCR, DNA sequencing methods

https://www.edx.org/course?search_query=biotechnology

https://www.coursera.org/courses?query=biotechnology&

Teaching Learning Process

Teaching and learning Process:

1. The students can have hands on experience of basic biotechnology tools and can acquire jobs and internships in pharmaceutical companies directly after graduation and can also execute research in biotechnology.

2. A problem solving methodology should be employed in biotechnology education, which consists of four phases: design, production, evaluation and presentation.

3. Various methods will be employed to make learning effective like tutorials, workshops, seminar, online assignments, questionnaires, simulation excercises and presentations.

4. Evaluation elements in these methods will also serve to direct student learning.

5. Evaluation question sets will alert students about teacher's expectations.

6. Introductory activities will be employed to promote the decision making process.

Assessment Methods

Assessment methods:

- **PowerPoint presentation on any aspect of biotechnology instead of regular assignments.**
- **There should be a project work, which would be assessed by the visiting examiner approved by the University.**
- **Students should execute one project of their choice or teacher may assign the project.**
- **The project report should be scanned for plagiarism check by freely available softwares like Viper etc. A soft copy of report should be mandatory.**
- **A list of suggested projects is as follows:**

1. **Nanotechnology**
2. **Instrumentation/ Advance techniques in biotechnology**
3. **Process of drug development and drug targeting**
4. **Isolation and characterization of microbes**
5. **Project based on visit to any biotechnology institute or pharmaceutical company**

Keywords

Biotechnology, Gene manipulation, Vectors, Restriction Enzyme, Transformation, Blotting, Sequencing, Gene Editing, Trans-genesis, Recombinant DNA medicines, Gene Therapy

Basics of Neuroscience
(32237902)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

'Neuroscience' is the branch of biology that deals with the scientific study of the nervous system- its anatomy, physiology and pathology. It deals with how the brain works and how the cells interact to control behaviour, physiology and psychology of a person. Neuroscience has become a buzz word in recent times, frequently making the headline for all manner of discoveries. The buzz is justified. Tremendous advances in neuroscience have occurred in the past two decades, with the 2010s being called 'the decade of the brain'. Let's take a look at some of the reasons why this emerging and happening field is genuinely amazing. The human brain is the 'most complex structure in the known universe'. We have around 100 billion nerve cells, or neurons in our brain. What's more, a single neuron can be directly connected with up to 10,000 others. This gives rise to a staggering 100 trillion or more nerve connections. Even though computer intelligence is rising rapidly, it still pales in comparison to complexity of our grey matter. It's also an entity which can structurally rewire and adapt according to environmental or physiological stimuli – all on its own. The present course content is designed to give the learner a better understanding of the structure of the nervous system, as to how it works, how we sense, feel, get motivated, behave, learn and remember things/ events. In this course, you will learn various aspects of neural phenomena such as cellular, molecular and neural basis of brain rhythms, behaviour, cognition, sensation, and motivation; mechanisms and functions of emotions, behaviour; learning and memory; and aspects of synaptic plasticity. This undergraduate course also covers aspects of clinical neuroscience with the aim of educating the learner in the breadth of

the subject and to encourage critical thinking and evaluation of evidence. This will help undergraduates to decide whether they would wish to pursue higher studies and research in the field of neuroscience This course also covers the finer details of neurotransmitter release, synaptic plasticity, activation of ligand-gated ion channels, receptor-mediated modulation of neuronal excitability, neurotransmitter clearance etc. This will equip the learner with a detailed insight into how the membrane excitability elicits functional effects in individual neurons and in neuronal networks as a whole. In the same manner, abnormal transmitter release/clearance, altered ion channel properties etc. will also be studied to understand their role in diseases of the nervous system.

Course Learning Outcomes

On completion of this course, the learner shall be able to- 1. understand major advances in neuroscience, neural basis of emotions, behaviour, learning and memory, and how brain and behaviour can be trained/ modified by experience ever since its emergence as a major field of science, understand the, 2. discuss how the hypothalamus controls various behavioural patterns by releasing neurohormones/ neuropeptides in brain and periphery in response to various signals, 3. construe neural mechanisms of learning and memory (spatial and episodic memory etc.) and how specific circuits contribute to learning and memory, 4. develop an understanding as to what is cognition and how it enables us to react to various situations appropriately and how neurological diseases affect cognition, 5. understand cellular and molecular mechanisms that underlie cognition such as synaptic plasticity and organisation of memory, memory persistence and forgetfulness, the role of sleep in cognition etc., 6. gain knowledge as to how prion-like mechanisms are responsible for the pathogenesis of common neurodegenerative diseases such as Alzheimer's, Parkinson's diseases etc.

Unit 1

The Nervous system- An Introduction: --4Hrs

Origins of Neuroscience; Neuron doctrine; Classification of nervous system.

Unit 2

Development and Anatomical Organization of the Nervous System: -- 12Hrs

Neural tube induction, neurulation and embryonic brain development; Gross anatomy of human brain, Meninges, Ventricular System, Blood Brain Barrier, Cranial nerves; Spinal cord; Overview of peripheral nervous system (PNS).

Unit 3

Cellular and Molecular Neurobiology: --14Hrs

The prototypical neuron and classification of neurons; Electrophysiology of membrane potentials- resting and action potentials, generation and propagation; Types of Synapses, synaptic transmission and integration; EPSPs and IPSPs. Ion channels; Concept of neural coding.

Unit 4

Neurotransmitters and Rhythms of Brain: -- 9Hrs

Types of neurotransmitters; Transmitter gated channels; G-protein coupled receptors and effectors, neurotransmitter receptors; Ionotropic and metabotropic receptors. Electroencephalogram (EEG); Sleep neurophysiology, neural mechanisms of sleep; Neurophysiology of affection and depression.

Unit 5

Behavioural Neuroscience: --14 Hrs

Neurobiology of Behaviour (Example: Language, Sexual Orientation); Neurobiology of Perception (Example: Visual perception); Molecular basis of Learning and Memory: Classification of memory, amnesia, case of H.M., synaptic plasticity, long-term potentiation (LTP), long-term depression (LTD), memory consolidation.

Unit 6

Neurobiology of Neurodegenerative Diseases: --7Hrs

Molecular pathogenesis of Parkinson's, Alzheimer's, and Schizophrenia. Molecular mechanism (pathogenesis) of Pain including Placebo effect and Phantom limbs. Dopamine and alcohol addiction. Use of PET, CT and MRI imaging for disease diagnosis.

Practical

PRACTICALS (2 CREDITS)
1. Dissection and study of Drosophila nervous system using GFP reporter.
2. Observation and quantitation of Drosophila photoreceptor neurons in healthy and diseased condition.
3. Study of Anatomy of Mammalian Brain (from slaughter house or) by using brain models (plastic or clay medical anatomical teaching models, graphics, videos etc. can used).

4. Histological study of neurons and myelin sheath (Nissl, Giemsa or Luxol Fast Blue staining.)
5. Study of olfaction in Drosophila.
6. 6.Stu of novelty, anxiety and spatial learning in mice.
7. Histological study of cerebellum and spinal cord by H&E stain and cerebral cortex by Nissl stain.

References

1. Neuroscience: Exploring the Brain, 4th Ed, Mark F. Bear, Barry W. Connors, Michael A. Paradiso. Publisher: Wolters Kluwer, 2015.

2. Principles of Neural Science, 4th Ed., ER Kandel, JH Schwartz and TM Jessell. Publisher: McGraw-Hill Companies, 2000.

Additional Resources:

1. Essential Psychopharamacology- Neuroscientific Basis and Practical Applications- 2nd Edn.-Stephan M. Stahl-CUP-2000

2. Phantoms in the Brain - Vilayanur S. Ramachandran and Sandra Blakeslee-1998
3. The Human Brain Book - Rita Carter-2009.

Online tools and web resources:
1. Introduction to Neuroanatomy. Coursera online course https://www.coursera.org/lecture/neurobiology/introduction-to-neuroanatomy-22nRY • General principles of sensory system part 1 and
2. Coursera online courses 1. www.coursera.org%2Flecture%2Fmedical-neuroscience%2Fgeneral-principles-of-sensory-systems-part-1-nwfLG, 2. www.coursera.org%2Flecture%2Fmedical-neuroscience%2Fgeneral-principles-of-sensory-systems-part-2-g7uLG

Online lectures on SWAYAM (MHRD) Portal: (free signup is required)

1. Demystifying The Brain. https://swayam.gov.in/courses/5361-jan-2019-demystifying-the-brain
2. How The Brain Creates Mind. https://swayam.gov.in/courses/4451-how-the-brain-creates-mind
3. Learning about Learning: A Course on Neurobiology of Learning and Memory. https://swayam.gov.in/courses/5375-jan-2019-learning-about-learning-a-course-on-neurobiology-of-learnin
4. Cognitive Science. https://swayam.gov.in/courses/267-cognitive-science

Teaching Learning Process

'Teaching and learning' involves the process of channelizing the knowledge from the one who is beholding to the one who is obtaining. Student-centric teaching-learning process shall be the sine qua non of any course. To move in that direction, • students will be exposed to problem solving exercises, brain puzzles, elaborative quiz-based learning, • smart classes and ICT-based teaching, including animation clips and videos, and attractive detailed pictures, • incorporating online learning courses and practical exercises relevant to the subject, • organizing conferences and seminars where the students can participate in group based learning and poster presentations, • organizing visits to brain research institutes to have a glimpse of current research and techniques in neuroscience, and • they will be motivated to take up mini-project works, group discussions etc.

Assessment Methods

The learners/ students can be assessed in many different ways- such as • formative feedback throughout the course and summative feedback as mid semester and semester end evaluation, • students would be presenting the topics in the class via blackboard teaching/ presentations, group discussions etc., • students would be provided feedback on their work with a view to improve their academic performance, • from time to time learners will be given practical problems and neuroimages to test their theoretical skills and promote practical knowledge, and • they would be provided feedback on their work with a view to improve their academic performance.

Keywords

Neuroscience, neurobiology, action potentials, learning & memory, synaptic plasticity, neurotransmitters, cognitive, neurodegenerative diseases, Alzheimer's disease, Parkinson's disease

Bio. of Insecta
(32237904)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Insect diversity society and evolution attempts to introduce students to the various orders and some of the most important families of insects so that they can distinguish between harmful and beneficial insects, which form the basis of entomology. This is followed by understanding the unique morphological characters of the insects and also their biology, natural history and succinct features. Students would also be introduced to the classification. Understanding insect societies would empower the student to appreciate their societal implications. Besides many social insects are good candidate biocontrol agents.

Insect Physiology is the study of the properties, processes, and functions of insect systems. As a component of this course we study some major biochemical molecules and their physiological actions to examine and understand the structure–function correlates within the various physiological systems functioning in insects.

Course Learning Outcomes

• Following completion of this course, they would acknowledge the value and importance of insects and the students would be able to sight identify most of the 29 orders of insects.
• They will also know the basic biology and the significant identification characters of the insects. T
• They would also learn the latest ideas of comparing these insects in an evolutionary perspective. Studying insect societies, students would develop an ability to appreciate their implications on societal impacts. They would also be able to identify and use various insects as biocontrol agents.

Unit 1

Introduction: (4 hrs)
General Features of Insects Distribution and Success of Insects on the Earth

Insect Taxonomy: (4 hrs)
Basis of insect classification; Classification of insects up to orders

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Unit 2

General Morphology of Insects : (8 hrs)
External Features; Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits Thorax: Wings and wing articulation, Types of Legs adapted to diverse habitat Abdominal appendages and genitalia .

Unit 3

Physiology of Insects : (28 hrs)
Structure and physiology of Insect body systems - Integumentary, digestive, excretory, circulatory, respiratory, endocrine, reproductive, and nervous system Sensory receptors Growth and metamorphosis

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Unit 4

Insect Society: (6 hrs)
Group of social insects and their social life Social organization and social behaviour (w.r.t. any one example)

Unit 5

Insect Plant Interaction: (4 hrs)
Theory of co-evolution, role of allelochemicals in host plant mediation Host-plant selection by phytophagous insects, Insects as plant pests

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Unit 6

Insects as Vectors: (6 hrs)
Insects as mechanical and Biological vectors, Brief discussion on houseflies and mosquitoes as important insect vectors

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Practical

Study of one specimen from each insect order
2. Study of different kinds of antennae, legs and mouth parts of insects
3. Study of head and sclerites of any one insect
4. Study of insect wings and their venation.
5. Study of insect spiracles
6. Methodology of collection, preservation and identification of insects.
7. Morphological studies of various castes of Apis, Camponotus and Odontotermes

8. Study of any three insect pests and their damages
9. Study of any three beneficial insects and their products
Field study of insects and submission of a project report on the insect diversity

References

SUGGESTED READINGS
- **A general text book of entomology, Imms , A. D., Chapman & Hall, UK**
- **The Insects: Structure and function, Chapman, R. F., Cambridge University Press, UK**
- **Principles of Insect Morphology, Snodgrass, R. E., Cornell Univ. Press, USA**
- **Introduction to the study of insects, Borror, D. J., Triplehorn, C. A., and Johnson, N. F., M Saunders College Publication, USA**
- **The Insect Societies, Wilson, E. O., Harward Univ. Press, UK**
- **Host Selection by Phytophagous insects, Bernays, E. A., and Chapman, R. F., Chapman and Hall, New York, USA**
- **Physiological system in Insects, Klowden, M. J., Academic Press, USA**
- **The Insects, An outline of Entomology, Gullan, P. J. , and Cranston, P. S., Wiley Blackwell, UK**
- **Insect Physiology and Biochemistry, Nation, J. L., CRC Press, USA**

Teaching Learning Process

- **Classroom teaching using Power point presentations enabled with related photographs of insect vectors, their life stages and disease diagnosis.**
- **Case studies of epidemics caused by insects as vectors.**
- **Visit to local diagnostic centre to have an overview of various medical tests conducted to detect and confirm vector transmitted diseases.**

Assessment Methods

1. Continuous and Comprehensive Formative assessment (attendance+ assignment+ test)
2. Summative Assessment
3. Term end theory exam
4. Term end practical exam (no. of practicals attended+ project + exam+ record book)

Keywords

Insect, Vector, Diseases, Mosquito, host, parasite

Computational Biology
(32237905)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course offers an overview of fundamental concepts of Bioinformatics and Biostatistics. An interdisciplinary program, it emphasizes integration of Computer Science with Biology and introduces the students to various computational methods and software tools for understanding biological databases, gene sequence alignments, gene annotation, protein structure predictions, drug discovery, molecular phylogeny, metagenomics, etc. The broad aim of this course is to make students get basic hands-on training and develop skill-set required for computational analysis of biological data. Recently many interest groups, such as governments, universities, research institutes and industries find Bioinformatics as a crucial area of research and development due to generation of large-scale genome sequencing data. In view of above, this course is designed to motivate the undergraduate students to pursue postgraduate program in Bioinformatics and Biostatistics.

Course Learning Outcomes

Course- level learning outcomes that a student of this course is required to demonstrate are • Explain the basic concepts of Bioinformatics and Biostatistics and its various applications in different fields of biological sciences, • Describe theoretically sources of biological data, and list various biological databases –nucleic acids, protein sequence, metabolic pathways and small molecule, • Identify various file formats of sequence data and tools for submission of data in databases as well as retrieval of gene and protein data from databases • Annotation of gene sequence and protein structure prediction, • Perform and explain the underlying mechanisms of pair-wise and multiple sequence alignments and determine phylogenetic relationships • Describe various computational tools and methodologies and their application in structural bioinformatics, functional genomics and in silico drug discovery • Measure variability (standard deviation, standard error, co-efficient of variance) and hypothesis testing (Z-test, t-Test, chi-square test)

Unit 1

Introduction to Bioinformatics Goal and Scope; Genomics, Transcriptomics, Systems Biology, Functional Genomics, Metabolomics, Molecular Phylogeny; Applications and Limitations of Bioinformatics

Unit 2

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 databases (KEGG, EcoCyc, and MetaCyc); Small molecule databases (PubChem, Drug Bank, ZINC, CSD)

Unit 3

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)

Unit 4

Basic Concepts of Sequence Alignment Scoring Matrices (PAM, BLOSUM), Methods of Alignment (Dot matrix, Dynamic Programming, BLAST and FASTA); Local and global alignment, pair wise and multiple sequence alignments; Similarity, identity and homology of sequences

Unit 5

Applications of Bioinformatics Structural Bioinformatics (3-D protein, PDB), Functional genomics (genome-wide and high-throughput approaches to gene and protein functions), Human genome and genome wide association studies (GWAS – basic concepts), Drug discovery method (basic concepts). Machine Learning in Bioinformatics (basic concepts)

Unit 6

Biostatistics Introduction: Measures of Variability, calculation of standard deviation, standard error and Co-efficient of Variance, Statistical errors, Confidence Intervals, Chi-square test, Z test, t-Test

Practical

1. Accessing different 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. Translate a nucleotide sequence and select the correct reading frame of the polypeptide from the output sequences 5. Predict the structure of protein from its amino acid sequence. 6. To perform a "two-sample t- test" for a given set of data 7. To learn graphical representations of statistical data with the help of computers (e.g. MS Excel).

References

• Ghosh, Z. and Mallick, B. (2008). Bioinformatics: Principles and Applications, Oxford University Press. • Lesk M. Arthur (2014). Introduction to Bioinformatics. Oxford University Press. • Pevsner, J. (2009). Bioinformatics and Functional Genomics, II Edition, Wiley Blackwell. • Zar, Jerrold H. (1999). Biostatistical Analysis, IV Edition, Pearson Education Inc and Dorling Kindersley Publishing Inc. USA
Additional Resources:• Attwood Teressa K. and David Parry- Smith (2007). Introduction to Bioinformatics. Pearson Education. • Mount, D. W. (2005).Bioinformatics: Sequence and Genome Analysis; CBS Publishers and Distributers Pvt. Ltd., Delhi. • Zvelebil, Marketa and Baum O. Jeremy (2008). Understanding Bioinformatics, Garland Science, Taylor and Francis Group, USA. • Antonisamy, B., Christopher S. and Samuel, P. P. (2010). Biostatistics: Principles and Practice. Tata McGraw Hill Education Private Limited, India. • Pagana, M. and Gavreau, K. (2000). Principles of Biostatistics, Duxberry Press, USA • R. Durbin, S. Eddy, A. Krogh, and G. Mitchson (1998) Biological sequence analysis: Probablistic models of proteins and nucleic acids, Cambridge University Press Online tools and web resources • https://www.my-mooc.com/en/categorie/bioinformatics • https://swayam.gov.in/course/4573-bioinformatics-algorithms-and-applications • https://www.ncbi.nlm.nih.gov/ • https://www.ebi.ac.uk/ • https://www.expasy.org/ • https://www.edx.org/course/dna-sequences-alignments-and-analysis

Teaching Learning Process

• The students will be taught theory units of this course in classrooms while practical units in Computer Laboratory/ Centers in the College. • In addition to blackboard, ICT-based teaching tools, videos, animation clips, handouts, flow charts will be also adopted for class room teaching • Computers/laptops with high speed internet facilities will be used for practical classes • Online demonstration of each practical units will be given by the Instructor. • Students will save sequence data/ snapshots of the steps followed for each practical unit. • Laboratory record files will be prepared for each practical units • Students will be encouraged to participate in group discussion, seminar presentation as well as visit to

Institutes of Bioinformatics or joining Research Internship program. • Students will be trained by problem solving exercises with their computational skills.

Assessment Methods

The students will be assessed for their performance by different means: • Both continuous and summative assessment will be made during entire semester. Continuous assessment of students will be based on their performance in class tests, assignments. • Students will be also assessed on the basis of power-point presentation/black-board presentation on different units of theory paper • Summative assessment will be based on semester end examinations of theory and practical papers. Theory - 100 marks • End semester exam- 75 marks • Internal Assessment- 25 marks (Assignment-10; Test-10 and Attendance-5) Practical - 50 marks • Classroom exam-25 marks • Continuous Evaluation- 25 (record- 10, project/viva- 5, attendance-5, total number of practical units performed- 5)

Keywords

Bioinformatics, Computation, Genomics, Proteomics, System Biology, Biological database, Sequence alignment, BLAST, FASTA, NCBI, EMBL, EBI, Phylogenetic tree, Drug designing, Machine Learning.

Endocrinology
(32237907)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Course Objective:

The main goal of this Discipline specific elective (DSE) paper is to provide students with a basic understanding of human endocrine glands, neuroendocrine glands and their structure, function and signaling pathways. Students will also study the influence of biological rhythm on hormones secretion. In addition, the course will facilitate the understanding of the biosynthesis and biochemistry of hormones. Also emphasis would be laid on understanding the maintenance of homeostasis by the hormones. The course will also try to integrate the basic and clinical aspects of endocrinology to enhance the understanding of students about the consequences due to hyposecretion, hypersecretion and absence of hormones leading to various diseases and metabolic disorders.

Course Learning Outcomes

Course Learning Outcome:

· understanding of endocrine system and the basic properties of hormones.

· understand and appreciate the importance of endocrine system and the crucial role it plays along with the nervous system in maintenance of homeostasis.

· insight into the molecular mechanism of hormone action and its regulation.

· understand the regulation of physiological process by the endocrine system and its implication in diseases.

· gain knowledge about the prevalent endocrine disorders and critically analyze their own and their family`s health issues.

Unit 1

Introduction to Endocrinology8h

Overview of the endocrine system, Classification of hormones and their synthesis, Transport of Hormones, Metabolism of hormones and their half lives

Unit 2

Neuroendocrinology15h

Structure of pineal gland, Secretions and their functions in biological rhythms and reproduction.

Structure of hypothalamus, Hypothalamic nuclei and their functions, Regulation of neuroendocrine glands, Feedback mechanisms, Structure of pituitary gland, Hormones and their functions, Hypothalamo-hypophysial portal system, Disorders of pituitary gland

Unit 3

Peripheral Endocrine Glands 25 h

Functional histology and Regulation of Thyroid, Parathyroid, Adrenal, Endocrine Pancreas, Gonads

Disorders related to hypersecretion and hyposecretion of hormones

Unit 4

Molecular Endocrinology12h

Hormone receptors , transduction and regulation Hormone action at Molecular level: Molecular mediators (GPCR Family; DAG-Calcium Signaling Systems; RTKs, Protein Kinases and Phosphatases in Cellular Signaling); Steroid Hormone Receptor Families

Practical

ENDOCRINOLOGY

PRACTICAL

(Credits 2)

1. Dissect and Display of Endocrine glands in laboratory bred rat* /Human model

2.Study of the permanent slides of all the endocrine glands

3.Compensatory ovarian/ adrenal hypertrophy *in vivo* bioassay in laboratory bred rat*

4.Demonstration of Castration/ ovariectomy in laboratory bred rat*

5.Estimation of plasma level of any hormone using ELISA

6.Paper chromatographic separation of steroid hormones

7. Survey based project on any prevalent endocrine disorder

References

1. Endocrinology byJ. Larry Jameson Leslie De Groot, 6th ed., 2010.

2. Vertebrate Endocrinology by David O. Norris Elsevier Academic press, 5th edition.

3. Franklin F. Bolander, Molecular endocrinology, 3rd edition, Academic Press, USA.

Additional Resources:

Suggested Reading

1. Hand Book of Physiology published by American Physiological Society by Oxford University Press, Section 7: Multiple volumes set, 1998.

2. General Endocrinology 6th edition by C. DonnellTurner Published by SaundersToppan.

3. Endocrinology: An Integrated Approach; Stephen Nussey and Saffron Whitehead. BIOS Scientific Publishers; 2001. (https://www.ncbi.nlm.nih.gov/books/NBK22/)

4. Endocrinology by Hadley, M.E. and Levine J.E. 2009., 6th Edition. Pearson PrenticeHall, Pearson Education Inc., New Jersey.

5. Strauss and Barbieri, 7th Edition, 2013. Yen & Jaffe's-Reproductive Endocrinology- Physiology, Pathophysiology and Clinical Management. ELSEVIER.

6. https://sites.google.com/site/openmeded/specialties/endocrinology

7. https://www.endocrine.org/topics

Teaching Learning Process

1. **Lecture using PowerPoint and chalk-blackboard method**
2. **Use of ICT facility**
3. **Survey based short projects as assignments**
4. **Visit to Prominent endocrinology laboratory to learn about basic techniques**
5. **Theory-related practicals**

Assessment Methods

1. **Formative assessment in the form of Quizzes, multiple choice questions, fill in the blanks and short answers**
2. **Student presentation**
3. **Take-home Assignments**
4. **Summative assessment in the form of End of term theory and Practical examination**

Keywords

Endocrinology

Endocrine glands
Neuroendocrinology
Hormones
Steroids
Glycoproteins
Receptors
Second Messenger
Signal Transduction
HYPO and HYPER secretion
Endocrine Disorder
Homeostasis

Fish and Fisheries
(32237908)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Fisheries involves study of both, capturing and culturing of fish. India is a peninsular country with a huge coastline and large inland water bodies. Assisted with such ideal geographical location our nation has outstanding accomplishments in

Fish and fisheries. Globally, India is ranked second in Aquaculture and 3

rd

in Fisheries.

In an evolutionary sense, the most successful of the larger aquatic animals are the fishes that are hunted commercially. About 64% of the global marine catch comes from the Pacific Ocean, 28% comes from the Atlantic and 8% from the Indian Ocean. Marine fisheries is a multibillion-dollar industry that is able to fulfil about 20% of the total animal protein requirement of humans, and also produce animal feeds for domestic livestock and poultry, fish oils (for paints and drugs, pet foods) and some food additives. For the increasing human population, there is continuous increase in the demand for high-quality protein. To meet these demands, it is necessary to focus attention on the current stocks from marine as well as freshwater species and create opportunities to increase or at least maintain the amount of harvest. It has become apparent that fisheries management has not always been successful in maintaining fish yields and conserving stocks. So, this course has been designed to equip the student with a balanced and complete scientific understanding of fisheries concepts.

Course Learning Outcomes

- **Students acquire knowledge of physiology, reproduction of fishes, analyse different kinds of water and identify/differentiate between different kinds of fishes.**
- **Procurement of pure fish seed by artificial procedures such as artificial and induced breeding which can learn by visiting any fish farm or demonstrated in research labs in college/Departments**
- **Awareness and knowledge of Inland and marine Fisheries in India and how it contributes to Indian economy.**
- **Knowledge of different kinds of fishing methods and fish preservation which can be employed for export and storage of commercial fishes.**
- **Students able to find the reasons behind the depletion of fisheries resources.Aspirants can go for entrepreneurship or self-employed in their own fisheries-related business. The students can educate others or work to conserve our natural resources.**

Unit 1

Credits: 4

Introduction and Classification **6 Hrs**

General description of fish; Account of systematic classification of fishes (upto classes); Classification based on feeding habit, habitat and manner of reproduction.

Unit 2

Morphology and Physiology **18 Hrs**

Types of fins and their modifications; Locomotion in fishes; Hydrodynamics; Types of Scales, Gills and gas exchange; Swim Bladder: Types and role in Respiration, buoyancy; Osmoregulation in Elasmobranchs; Reproductive strategies (special reference to Indian fishes); Electric organs; Bioluminiscience; Mechanoreceptors; Schooling; Parental care; Migration

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Unit 3

Fisheries **12 Hrs**

Inland Fisheries; Marine Fisheries; Environmental factors influencing the seasonal variations in fish catches in the Arabian Sea and the Bay of Bengal; Fishing crafts and Gears; Depletion of fisheries resources; Application of remote sensing and GIS in fisheries; Fisheries law and regulations

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Unit 4

Aquaculture **20 Hrs**

Sustainable Aquaculture; Extensive, semi-intensive and intensive culture of fish; Pen and cage culture; Polyculture; Composite fish culture; Brood stock management; Induced breeding of fish; Management of finfish hatcheries; Preparation

and maintenance of fish aquarium; Preparation of compound diets for fish; Role of water quality in aquaculture; Fish diseases: Bacterial, viral and parasitic; Preservation and processing of harvested fish, Fishery by-products.

Unit 5

Fish in research

Transgenic fish, Zebrafish as a model organism in research.

Practical

Credits: 2

1. **Study of *Petromyzon*, *Myxine*, *Pristis*, *Chimaera, Exocoetus*, *Hippocampus*, *Gambusia, Labeo, Heteropneustes, Anabas* (at least one fish from each class).**
2. **Study of different types of scales (procure scales from market and prepare permanent slides).**
3. **Study of crafts and gears used in Fisheries.**
4. **Water quality criteria for Aquaculture: Assessment of pH, conductivity, Total solids, Total dissolved solids.**
5. **Fish seed production through Artificial/induced breeding in Fishes (demonstration/video).**
6. **Demonstration of parental care in fishes (video).**
7. **Determination of fish density in a pond by Peterson's mark recapture method.**
8. **Breeding of ovoviviparous fishes in Aquarium.**
9. **Project Report on a visit to any fish farm/ pisciculture unit/Zebrafish rearing Lab**

References

- **C.B.L. Srivastava, Fish Biology, Narendra Publishing House.**
- **Jhingran, V.G. (1982) Fish and Fisheries in India: Hindustan publication Cooperation, India.**
- **Pandey, K and J.P. Shukla (2013). Fish and Fisheries: Rastogi publication, India**
- **J.R. Norman, A history of Fishes, Hill and Wang Publishers.**
- **S.S. Khanna and H.R. Singh, A text book of Fish Biology and Fisheries, Narendra Publishing House.**

Teaching Learning Process

There would be a teacher-centered lecture sessions, where students can take notes or absorb information and interact with the teacher. The teacher/student based lessons would be supported by multimedia presentations (videos/animations). Visit to Field, Fisheries institutes, laboratory or Aquatic research institutes would be useful to students for better understanding of the subject.

Assessment Methods

Formative assessment is an important assessment method, where teacher analyze a student's performance during instruction, and usually occurs regularly throughout the instruction process (continuous evaluation). Summative Assessment involves measurement of a student's achievement at the end of instruction. Written tests to analyze their intake on taught lectures. Inspiring the students give talks through power point presentations/submit assignments with emphasis on recent studies in Fish and Fisheries.

Keywords

Fish Classification, Fish physiology, reproduction, Fisheries, Aquaculture, Transgenic fishes.

Immunology
(32237909)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The aim of the course in immunology is to apprise the student with the working of the immune system in normal health and how it fights the disease and may sometimes contributes to disease. The immune system is incredibly complex. This course is hence designed to enable understanding the molecular and cellular basis of the development and function of the immune system and identification of its biological, clinical and therapeutic implications.

Course Learning Outcomes

A student should be able to demonstrate the following-

- **Describe the basic mechanisms, distinctions and functional interplay of innate and adaptive immunity**
- **Define the cellular/molecular pathways of humoral/cell-mediated adaptive responses including the role of Major Histocompatibility Complex**
- **Explain the cellular and molecular aspects of lymphocyte activation, homeostasis, differentiation, and memory**
- **Understand the molecular basis of complex, humoral (Cytokines, Complement)and cellular processes involved in inflammation and immunity, in states of health and disease**
- **Describe basic and state-of-the-art experimental methods and technologies**
- **Integrate knowledge of each subsystem to see their contribution to the functioning of higher-level systems in health and disease including basis of vaccination, autoimmunity, immunodeficiency, hypersensitivity and tolerance**

Unit 1

Overview of Immune System (12 Hrs):

Historical perspective of Immunology, Early theories of Immunology, Clonal Selection Theory, Cardinal features of vertebrate immune system, Hematopoiesis, Cells and organs of the Immune system.

Unit 2

Innate and Adaptive Immunity (7 Hrs):

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, Immunological Tolerance

Unit 3

Antigens (8 Hrs) :

Antigenicity and immunogenicity, Immunogens, Adjuvants and haptens, Factors influencing immunogenicity, B and T-Cell epitopes

Unit 4

Immunoglobulins (10 Hrs):

Structure and functions of different classes of immunoglobulins, Antigenic determinants on Immunoglobulins, Antigen-antibody interactions (Precipitation reactions, Agglutination reactions, Immunofluorescence and ELISA), Polyclonal sera, Hybridoma technology: Monoclonal antibodies in therapeutics and diagnosis

Unit 5

Major Histocompatibility Complex (6 Hrs):

Structure and functions of MHC molecules (MHC I and II). Endogenous and exogenous pathways of antigen processing and presentation

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Unit 6

Unit 6 Cytokines (3 Hrs):
Properties and functions of cytokines

Unit 7 Complement System (4 Hrs):
Components and pathways of complement activation. Biological consequences of complement activation

Unit 8 Vaccines (3 Hrs):
Various types of vaccines

Unit 9 Immune Dysfunction (7 Hrs) :

- **Hypersensitivity: Gell and Coombs classification and various types of hypersensitivities**
- **Autoimmunity: Brief account with reference to Hashimoto's Thyroiditis (Organ Specific) and Rheumatoid arthritis (Systemic)**
- **Immunodeficiency: Brief account with reference to SCID (Primary) and AIDS (Secondary)**

Practical

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. Study of basic patterns of precipitation by Ouchterlony's double immuno-diffusion method.

5. ABO Blood group antigen determination by heamagglutination

6. Cell counting and viability test from splenocytes of farm bred animals/cell lines.

7. Demonstration of:

a. ELISA

b. Immunoelectrophoresis

8. Purification of IgG Antibodies using affinity chromatography.

References

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.**

Additional Resources:

1. **Abbas, K. Abul and Lechtman H. Andrew (2003.) Cellular and Molecular Immunology, V Edition, Saunders Publication.**
2. **Janeway's Immunobiology 9th Edition, by Kenneth Murphy, Casey Weaver, Garland Science**
3. **E-content on e-PG Pathshala portal of Government of Indiahttps://epgp.inflibnet.ac.in**
4. **Fundamentals of Immunology https://www.coursera.org/specializations/immunology**

Teaching Learning Process

- **The course on immunology has been structured to develop the requisite knowledge, skills and learning attitude of the student.**
- **The process is extremely student-oriented and includes details of cells and organs of the system, antigens, antibodies, autoimmunity, immunodeficiency, hypersensitivity and other important aspects.**
- **The practical exercises are accordingly designed to enhance the interest of the students.**
- **A variety of approaches to teaching-learning process, including lectures, seminars, power point presentations, workshops, peer teaching/learning, assignments, problem based learning, project based learning, simulation videos, group or co-operative learning, book reviews, research colloquium will be adopted to achieve this.**
- **Problem based learning skills and higher-order skills of reasoning and analysis will be encouraged through research based pedagogical tools.**
- **The students must be given sufficient support by faculty to apply their learning and acquire knowledge from real life situations.**

Assessment Methods

The assessment of students' achievement in immunology will be aligned with the course/program learning outcomes.

- **Continuous evaluation of learning by formative and diagnostic evaluation should be followed at the University.**
- **Efforts should be made to measure cognitive as well as applied learning.**
- **Project work, quiz, problem solving exercise, classroom assessment methods, closed-book and open-book tests, problem-solving exercises, practical assignment, laboratory reports, seminar presentation, *viva-voce* interviews, computerized adaptive testing, literature surveys and summative evaluations by end-semester examination *etc.* constitute the different components of the overall assessment.**
- **Moreover, students should be provided with feedback on their work with the aim of improving their academic performance.**

Theory-100 marks (4 Credits)

End Semester exam- 75 marks; Internal Assessment- 25 marks (Assignment-10, Test-10, Attendance-5)

Practicals-50 marks (2 Credits)

Exam-25 marks; Continuous Evaluation- 25 marks (Records-10, Viva/Project-5, Attendance-5, Total no. of practical units performed-5).

Keywords

Adaptive Immunity, Innate Immunity, cytokines, complement, hypersensitivity, autoimmunity, immunodeficiency, Vaccines

Parasitology
(32237906)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Course Objective: Parasites are vast menagerie. They can cause diseases without pardon. They can slip into a person's brain wrecking the biological clock turning the day into nights. They can cause livers of cattle useless and roots of plants functionless. They may cause a tourist spot an epicenter of epidemic disease. Parasitology is the study of the parasites. They affect almost every organism. There is an enormous diversity of parasites in nature and knowing and understanding them well becomes very important in the light of controlling and managing the parasites effectively. The economic impact of these organisms is often huge and that makes it even more important to study them. Parasitology will enable us diagnose parasites correctly, understand their life cycle and control them effectively and use some of them as bio control agents. For so long parasites have lived in nightmares and have been occupying the darkest shadows of science. They have also been shaping the history of a nation and human societies. Parasitology especially the study life cycles of parasites have helped in defying the stigmas and religious taboos for many societies making free many of the people from superstition and ill health. Parasites have health and economic importance. Developing countries like our country where majority of the people are engaged in agricultural activities and living in poor conditions have advantages to be harvested from the study of parasitology. The course shall surely skill the students to see, appreciate and understand the diversities of parasites in the whole spectrum of the study of life. The course shall also make the students aware about the possible scopes of the subject which include research and applied aspects including entrepreneurial works.

Course Learning Outcomes

The course shall help building up among the learners the variation amongst parasites, parasitic invasion in both plants and animals thus applicable to medical and agriculture aspects. It will help in understanding the stages of the life cycles of the parasites and the respective infective stages. Ecology of parasitism as an interspecific interaction shall also help in developing ecological model. Population dynamics of parasite and establishment of parasite population in host body, adaptive radiations and methods adopted by parasite in order to combat with the host immune system (innate and adaptive immunity), evolution and co-evolution of parasite with respect to host strategy, pathogenesis caused in tissues of the host due parasitic invasion will be known. Skills and significance of diagnosis (microscopic examination, biochemical tests) of parasitic attack, treatment of patient or host (animal/ plant) to get rid-off parasite which includes prophylactic,

preventive and medication measures shall be learnt. Important case studies to highlight interesting researches, serendipities towards the advancement and enrichment of knowledge in the field of Parasitology shall surely give necessary spark to further promote the study. Studying parasitology is closely related with the productivity in agriculture, maintenance of health and hygiene to humans and non-human animals.

Unit 1

Introduction to Parasitology 5period Brief introduction of Parasitism, Parasite, Parasitoid and Vectors (mechanical andbiological vector) Host parasite relationship. Ecology of parasites, Population dynamics of parasite and establishment of parasite population in host body, evolution of parasitism, evolution and co-evolution of parasite with respect to host strategy, important case studies to highlight interesting researches, serendipities towards the advancement and enrichment of knowledge in the field of Parasitology including some historical events such as the role of the mosquito control and the successful completion of the construction of the Panama canal.

Unit 2

Parasitic Protists 14 periods Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity,Diagnosis, Prophylaxis and Treatment of Entamoeba histolytica, Giardiaintestinalis, Trypanosoma gambiense, Leishmaniadonovani, Plasmodium vivax.

Unit 3

Parasitic Platyhelminthes 14 periods Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity,Diagnosis,Prophylaxis and Treatment of Fasciolopsis buski, Schistosomahaematobium, Taenia solium and Hymenolepis nana.

Unit 4

Parasitic Nematodes (15 Periods) Study of Morphology, Life Cycle, Prevalence, Epidemiology, Pathogenicity,Diagnosis,Prophylaxis and Treatment of Ascaris lumbricoides, Ancylostomaduodenale, Wuchereriabancrofti and Trichinella spiralis. Study of structure, lifecycle and importance of Meloidogyne (root knot nematode),Pratylencus (lesionnematode) Parasitic Arthropoda (10 periods) Biology, importance and control of ticks, mites, Pediculus humanus (head andbody louse), Xenopsylla cheopis and Cimex lectularius

Unit 5

Parasitic Vertebrates (2 Periods) A brief account of parasitic vertebrates; Cookicutter Shark, Candiru, HoodMockingbird and Vampire bat.

Practical

1. Study of life stages of Entamoeba histolytica, Giardia intestinalis,Trypanosoma gambiense, Leishmania donovani and Plasmodium vivaxthrough permanentslides/micro photographs. 2. Study of adult and life stages of Fasciolopsis buski, Schistosomahaematobium, Taenia solium and Hymenolepis nana through permanentslides/micro photographs. 3. Study of adult and life stages of Ascaris lumbricoides, Ancylostomaduodenale, Wuchereria bancrofti and Trichinella spiralis throughpermanent slides/micro photographs. 4. Study of plant parasitic root knot nematode, Meloidogyne from the soilsample. 5. Study of Pediculus humanus (Head louse and Body louse), Xenopsyllacheopis and Cimex lectularius through permanent slides/ photographs. 6. Study of monogenea from the gills of fresh/marine fish [Gills can beprocured from fish market as by product of the industry] 7. Study of nematode/cestode parasites from the intestines of Poultry bird [Intestine can be procured from poultry/market as a by product] 8. Submission of a brief report on parasitic vertebrates. 9. To study natural history of parasite visit to rural area/ hospital near rural area/ NCDC/ MRC/ NICD 10. Parasite album, photograph collection: Tissue invasion, Life cycle 11. Culturing root parasites in laboratory, field 12. DNA extraction of parasite/s and molecular identification using universal and specific markers

Reproductive Biology
(32237910)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

This course is meant for making the students learn about the various aspects of reproduction in humans. It includes a detailed study of the male and female reproductive systems as well as factors that are important in maintaining reproductive health. The students are also made aware of new technologies in assisted reproduction as well as contraceptive methods. They are taught about social and public health issues related to family planning.

Course Learning Outcomes

Learning outcomes The learner must be able to demonstrate the following:

1) In-depth understanding of morphology, anatomy and histology of male and female reproductive organs.

2) Knowledge of the different processes in reproduction starting from germ cell formation to fertilization and consequent pregnancy, parturition and lactation.
3) Comparison of estrous and menstrual cycles and their hormonal regulation.
4) Comprehension of the interplay of various hormones in the functioning and regulation of the male and female reproductive systems.
5) Knowledge of the diagnosis and management of infertility, including latest methods, technologies and infrastructure in assisted reproduction.
6) Practical understanding of modern methods in contraception and their use in family planning strategies.

7) Ability to translate this understanding into:

i) development of products like non-hormonal contraceptives

ii) contributing to drug discovery programmes as well as neonatal and maternal health programmes.

iii) working with family planning teams to understand the needs and preferences of individuals belonging to lower socioeconomic groups.

Unit 1

Unit 1: Reproductive Endocrinology
(12 Hrs)

Reproductive Endocrinology

~~Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, h~~Hypothalamo–hypophyseal–gonadal axis.~~, r~~Regulation of gonadotroph~~in~~s and gonadal steroids~~secretion in male and female~~ ~~; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.~~ Steroidogenesis. Puberty. Mechanism of action of hormones related to reproduction.

Unit 2

Unit 2: Male reproductive system **10 Hrs**

~~Functional anatomy of male reproduction~~

Male reproductive system

~~Outline and histological of male reproductive system in rat and human;~~ Functional histology and anatomy of male reproductive system: Testis, epididymis, vas deferens, prostate gland, seminal vesicle.~~Testis: Cellular functions, germ cell, system cell renewal;~~ Spermatogenesis and its regulation. Sperm transport and maturation in male genital tract

~~: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions;~~

Unit 3

Unit 3: Female reproductive system
(28 Hrs)

Female reproductive system

~~Functional anatomy of female reproduction Outline and histological of~~ Functional histology and anatomy of~~female~~ reproductive system: ~~in rat and human;~~ Ovary~~:~~, fallopian tubes/oviducts, uterus, cervix and vagina. ~~f~~Folliculogenesis~~,~~. Oocyte maturation and ovulation.~~, c~~Corpus luteum formation and regression. ~~; Steroidogenesis and secretion of ovarian hormones;~~ Reproductive cycles (estrous and menstrual~~rat and human~~) and their regulation~~,~~; changes in the female tract during these cycles.~~;~~ ~~Ovum transport in the fallopian tubes; Sperm transport in the female tract, f~~Fertilization.~~;~~ Implantation; Maternal recognition of pregnancy; Feto-placental unit~~Hormonal control of implantation~~; Hormonal regulation of gestation; gestational adaptations.~~,~~ ~~pregnancy diagnosis, foeto – maternal relationship; Mechanism of p~~Parturition and its hormonal regulation; Lactation and its regulation

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Unit 4

Unit 4: Reproductive Health and family planning
(10 Hrs)

Reproductive Health and family planning

Contraceptive methods. Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technologies~~y~~: ~~sex selection,~~ sperm banks, frozen embryos, ~~in vitro fertilization~~ IVF, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST.~~; Modern contraceptive technologies; Demographic terminology used in family planning~~

Practical

Practicals*

[Credits: 2]

1. Study of animal house: set up and maintenance of animal house, breeding techniques, care of normal and experimental animals.

2. Examination of vaginal smear of rats (from live animals).

3. Surgical techniques: principles of surgery in endocrinology. Ovarectomy, hysterectorny, castration and vasectomy in rats.

4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.

5. Human vaginal exfoliate cytology through micrographs.

6. Sperm count and sperm motility in rat

7.To study the effect of cryptorchidism on sperm count and motility in rats

8. Study of modern contraceptive devices

9. Mini projects involving survey, data collection, statistical analysis and submission of a project report on reproductive health of a small human community

***All exercises requiring live animals are, at present, being performed with the help of photomicrographs/pictures. They would be meaningful only if these are performed on live animals.**

References

REFERENCES:

a) Jones, R.E. and Lopez, KH. *Human Reproductive Biology.* Fourth Edn, Elsevier, 2014.

b) Johnson, M.H. Everitt, B.J. *Essential reproduction*. Fourth edn. London: Blackwell Science; 1995. (Eighth ed. by Johnson, MH. 2018)

Additional Resources:

SUGGESTED READINGS

1. Austin, C.R. and Short R.V. (Eds). *Reproduction in Mammals*. Cambridge University Press. 2012 (online edition)

2. De-Groot, L.J. and Jameson, J.L. (eds). *Endocrinology*. W.B. Saunders and Company. 2001

3. Franklyn F. Bolander. *Molecular Endocrinology*. Third Edn. USA: Academic Press; 2012.

4. Knobil, E. and Neil, JD (eds). *The Physiology of Reproduction*. Elsevier. Fourth edn. 2014

5. Hatcher, R.A. et al. *The Essentials of Contraceptive Technology*. Population Information Programme, John Hopkins school of public health.1997

6. Robert Martin. *How We Do It: The Evolution and Future of Human Reproduction,* Basic Books, 2013.

7. Peter T. Ellison. *On Fertile Ground: A Natural History of Human Reproduction,* Harvard University Press 2001.

ONLINE TOOLS AND WEB RESOURCES:

1.Introduction to reproduction: https://www.classcentral.com/course/coursera-introduction-to-reproduction-4252

2.Anatomy & Physiology: Sexual Reproduction in Humans: https://www.classcentral.com/tag/reproductive-health?subject=health

Teaching Learning Process

Teaching-learning processes

The programme of study in reproductive biology is designed to enable students to acquire extensive subject knowledge and skills required for related professions and jobs in national and international agencies. It would be taught in a learner-centric mode with emphasis on active participation. This mode of teaching increases thinking and problem solving capacities which would be highly useful in a work scenario and also research.

A variety of approaches will be used in the teaching-learning process, including:

1. **lecture-based learning - that are aided with diagrams, flow charts and models. These will be interactive with simple questions for students to learn and derive logically and think analytically. Examples where possible will be given from day-to-day activities to explain the concept and make the basics clear, relevant and interesting. After every lecture students will be posed with questions to help them summarise the topic.**
2. **practical-based learning- regular practical classes will be held to develop the practical skills of students. The topics for practicals will include detailed explanations of organ systems using hands-on and digital means. Histological slides will be shown to explain the microscopic structure of various tissues. The students will be assessed on their performance after each practical class.**
3. **seminar-based learning - for some topics students will be expected to deliver a seminar followed by a discussion to assess their understanding and grasp of the topics.**
4. **project-based learning - students will undertake projects for certain topics to sharpen their understanding, enhance critical thinking, reasoning and analysis, and hone their presentation skills.**
5. **field-based learning - students will attend in-college workshops on topics related to their study. Experts in the field will be invited to hold workshops. Students will also be taken on field trips to subject-related locations/agencies for a practical understanding of skills required for their potential future workplace.**
6. **simulation-based learning - mock practical/theory examinations will be held before the university examination. The pattern of questions would match the university question paper to better equip the students to perform with confidence in the final examination.**

Assessment Methods

Assessment methods

Students of the reproductive biology study programme will be assessed on the basis of their course learning outcomes as well as relevant skills. A variety of assessment methods will be used:

- **time-constrained oral and written examinations**
- **problem-based assignments, individual project reports**
- **practical file reports**
- ***viva-voce* and**
- **class assessments via observation of practical skills and regular class tests.**

Keywords

Reproduction, Hormones, Steroids, Gonadotropins, Gonads, Pituitary, Hypothalamus, Ovaries, Testes, Testosterone, Estrogens, Corpus luteum, Cervix, Vagina, Progesterone, Inhibin, Placenta, Fertilisation, Oviducts, Vas deferens, Epididymis, Spermiation, Maturation, hCG, Pregnancy, Menstrual cycle, Estrous cycle, Oogenesis, Spermatogenesis, Prostate glands, Seminal vescicles Uterus, Endometrium, Parturition, Lactation, Prolactin, Oxytocin, Contraception, Fertility, Infertility, Assisted Reproduction, Reproductive health

Wildlife Conservation and Management (32237911) Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The Discipline Specific Paper on Wildlife Conservation and Management is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, management of their habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. This course will motivate students to pursue career in the field of wildlife conservation and management.

Course Learning Outcomes

- **Awareness about the importance of wildlife in general, and its conservation and management in particular.**
- **Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.**
- **Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.**
- **Understand the key factors for loss of wildlife and important strategies for their in situ and ex situ conservation.**
- **Understand the techniques for estimation, remote sensing and Global Position Tracking for wildlife.**
- **Awareness about the wildlife diseases and the quarantine policies.**
- **Knowledge about the Protected Area Networks in India, Ecotourism, Ecology of perturbation and Climax persistence.**
- **Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.**

Unit 1

Introduction to Wild Life

Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21.

Unit 2

Evaluation and management of wild life

Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

Unit 3

Management of habitats

Setting back succession: Grazing logging; Mechanical treatment; Advancing the successional process: Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats.

Unit 4

Population estimation

Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods.

Unit 5

Management planning of wild life in protected areas

Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories; Ecology of purterbance.

Unit 6

Management of excess population

Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (Ebola and Salmonellosis), Rabies, Foot and Mouth Disease, Mycobacterium TB, Bovine and Avian Flu.

Protected areas
National parks and sanctuaries; Biosphere reserves; Conservation and Community reserve; Important features of protected areas in India; Tiger conservation - Tiger reserves in India and Management challenges in Tiger reserve.

Practical

1. Identification of flora, mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site.

2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System,Various types of Cameras and lenses).

3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats,

pellet groups, nests and antlers. etc.

4. Demonstration of different field techniques for flora and fauna: PCQM, Circular, Square & rectangular plots.

5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird

(direct and indirect evidences).

6. Identification of big cats: Lion, tiger, panther, cheetah, leopard and jaguar.

7. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

References

- **Saha, G.K. and Mazumdar, S. (2017). Wildlife Biology: An Indian Perspective. PHI learning Pvt. Ltd. ISBN: 8120353137, 978-812035313**
- **A.R.E. Sinclair, J.M. Fryxell and G. Caughley (2006). Wildlife Ecology, Conservation and Management. Wiley-Blackwell, Oxford, UK.**
- **S.K. Singh (2005). Text Book of Wildlife Management. IBDC, Lucknow.**

Additional Resources:

- **P.J. Hudson, Annapaola Rizzoli, Bryan T. Grenfell, Hans Heestrbeek and Andy P. Dobson (2002). The Ecology of Wildlife Diseases. Oxford University Press, Oxford.**
- **K. Banerjee (2002). Biodiversity conservation in managed and protected areas. Agrobios, India.**
- **B.D. Sharma (1999). Indian Wildlife Resources Ecology and Development. Daya Publishing House, Delhi.**
- **R.B. Primack (1998). Essentials of Conservation Biology. Sinauer Associates, Inc. Sunderland, MA.**
- **B. B. Hossetti (1997). Concepts in wild life management. Daya Publishing House, Delhi**
- **https://swayam.gov.in/courses/4687-july-2018-wildlife-conservation**
- **https://swayam.gov.in/courses/5364-jan-2019-wild-life-ecology**
- **https://papaco.org/mooc-on-species-conservation/**
- **https://www.iucn.org/theme/protected-areas/our-work/capacity-development/moocs**
- **https://www.zsl.org/united-for-wildlife-free-conservation-courses**
- **https://wildlife.org/next-generation/career-development/online-courses/**
- **https://www.openlearning.com/umtmooc/courses/wildlife-management**

Teaching Learning Process

- **Case studies: The case study approach with real-life examples from the field to get a better understanding of the subject and its applications.**
- **Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system and use of visualizer for theory classes. Projection of videos or short movies available on the subject will enhance the understanding of the subject.**
- **E-Museum: Digital collection of pictures of pugmarks, hoof marks, birds nests, wild fauna and flora will facilitate observation of their characteristic features with ease.**
- **Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching. Project based reports, assignments and E-posters can also form an important part of learning regime.**
- **Research projects: Field based research projects develop interest in the subject and also motivate students to peruse research as a career in future.**
- **Educational Visits: Laboratory visits to renowned institutions like WII, Dehradun and Field visits to various conservation sites like Jim Corbett National Park, Aravali Biodiversity Park and National Zoological Park will provide students a practical or hands on knowledge of the subject.**
- **Citizen Science Initiatives: Students should participate in citizen science initiatives related to wildlife such as bird counts and uploading of the data on E-bird.org.**

Assessment Methods

Learning outcomes will be assessed using the following assessment methods:

- **Formative/ Continuous assessment: This will be done through problem solving exercises, oral and written examinations, closed-book and open book tests, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation, viva voce interviews, computerized adaptive testing, literature surveys and evaluations, outputs from collaborative work etc. to assess the retention abilities of students.**
- **Summative assessment: Semester-end written and practical examinations will be an indicator of student's learning throughout the semester and analyses comprehensive knowledge gained by the students.**

Keywords

Wildlife, Conservation, Management, Population, Habitat, Succession, Climax, Quarantine, Tiger Project, National Park, Wildlife Sanctuaries, Biodiversity Reserves, Wildlife Diseases, Protected Areas

Wildlife Conservaation and Management
(DSE 11)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

: The Discipline Specific Paper on Wildlife Conservation and Management is designed to acquaint students with varied aspects of wildlife conservation, including its importance, major threats, management of their habitats and populations. The emphasis will be on developing interest and invoking a sense of responsibility among students towards wildlife conservation. The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals. This course will motivate students to pursue career in the field of wildlife conservation and management.

Course Learning Outcomes

● Awareness about the importance of wildlife in general, and its conservation and management in particular. ● Comprehend the application of the principles of ecology and animal behaviour to formulate strategies for the management of wildlife populations and their habitats. ● Understand the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration. ● Understand the key factors for loss of wildlife and important strategies for their in situ and ex situ conservation. ● Understand the techniques for estimation, remote sensing and Global Position Tracking for wildlife. ● Awareness about the wildlife diseases and the quarantine policies. ● Knowledge about the Protected Area Networks in India, Ecotourism, Ecology of perturbation and Climax persistence. ● Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.---

Unit 1

Introduction to Wild Life Values of wild life - positive and negative; Conservation ethics; Importance of conservation; Causes of depletion; World conservation strategies: WCS, CBD, Agenda 21.

Unit 2

Evaluation and management of wild life Habitat analysis: a) Physical parameters: Topography, Geology, Soil and water; b) Biological Parameters: food, cover, forage, browse and cover estimation; Standard evaluation procedures: remote sensing and GIS.

Unit 3

Management of habitats Setting back succession: Grazing logging; Mechanical treatment; Advancing the successional process: Cover construction; Preservation of general genetic diversity; Restoration of degraded habitats.

Unit 4

Population estimation Population density, Natality, Birth rate, Mortality, fertility schedules and sex ratio computation; Faecal analysis of ungulates and carnivores: Faecal samples, slide preparation, and Hair identification; Pug marks and Census methods.

Unit 5

Management planning of wild life in protected areas Estimation of carrying capacity; Human-wildlife conflict; Eco tourism / wild life tourism in forests; Climax communities: characteristics and theories; Concept of climax persistence; Ecology of purterbance.

Unit 6

Management of excess population Bio- telemetry; Care of injured and diseased animal; Quarantine; Common diseases of wild animals: Zoonosis (Ebola and Salmonellosis), Rabies, Foot and Mouth Disease, Mycobacterium TB, Bovine and Avian Flu.

Practical

1. Identification of mammalian fauna, avian fauna, herpeto-fauna through direct and indirect evidences seen on a field trip to a wildlife conservation site. 2. Demonstration of basic equipment needed in wildlife studies use, care and maintenance (Compass, Binoculars, Spotting scope, Range Finders, Global Positioning System,Various types of Cameras and lenses). 3. Familiarization and study of animal evidences in the field: Identification of animals through pug marks, hoof marks, scats,, nests and antlers. 4. Demonstration of different field techniques for flora and fauna: PCQM,Circular, Square & rectangular plots. 5. Trail / transect monitoring for abundance and diversity estimation of mammals and bird (direct and indirect evidences). 6. Identification of big cats: Lion, tiger, panther, cheetah, leopard and jaguar. 7. A report based on a visit to National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

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Teaching Learning Process

• Case studies: The case study approach with real-life examples from the field to get a better understanding of the subject and its applications. • Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system and use of visualizer for theory classes. Projection of videos or short movies available on the subject will enhance the understanding of the subject. • E-Museum: Digital collection of pictures of pugmarks, hoof marks, birds nests, wild fauna and flora will facilitate observation of their characteristic features with ease. • Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching. Project based reports, assignments and E-posters can also form an important part of learning regime. • Research projects: Field based research projects develop interest in the subject and also motivate students to peruse research as a career in future. • Educational Visits: Laboratory visits to renowned institutions like WII, Dehradun and Field visits to various conservation sites like Jim Corbett National Park, Aravali Biodiversity Park and National Zoological Park will provide students a practical or hands on knowledge of the subject. • Citizen Science Initiatives: Students should participate in citizen science initiatives related to wildlife such as bird counts and uploading of the data on E-bird.org.

Assessment Methods

Learning outcomes will be assessed using the following assessment methods: • Formative/ Continuous assessment: This will be done through problem solving exercises, oral and written examinations, closed-book and open book tests, practical assignment laboratory reports, observation of practical skills, individual project reports, seminar presentation, viva voce interviews, computerized adaptive testing, literature surveys and evaluations, outputs from collaborative work etc. to assess the retention abilities of students. • Summative assessment: Semester-end written and practical examinations will be an indicator of student's learning throughout the semester and analyses comprehensive knowledge gained by the students.

Keywords

Wildlife, Conservation, Management, Population, Habitat, Succession, Climax, Quarantine, Tiger Project, National Park, Wildlife Sanctuaries, Biodiversity Reserves, Wildlife Diseases, Protected Areas

Apiculture
(32239902)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The course will make the student aware about the significance of beekeeping as the economically viable industry. It will help the students to understand the biology and behaviour of bees. The course would clarify the techniques of honey bee rearing, optimization of techniques based on climate and the geographical regions, and various measures to be taken to maximize the benefits. It would also help the students to develop entrepreneurial skills required for self-employment in beekeeping sector.

Course Learning Outcomes

Upon completion of the course, students should be able to: Learn about the various species of honey bees in India, their social organization and importance. Be aware about the opportunities and employment in apiculture – in public, private and government sector. Gain thorough knowledge about the techniques involved in bee keeping and honey production. Know about various products obtained from beekeeping sector and their importance. Getting familiarized with the skills necessary for self-employment in beekeeping sector. Develop entrepreneurial skills in beekeeping. Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.

Unit 1

Unit 1: Biology of Bees 4 hrs History, Classification and Biology of Honey Bees Different species of honey bees – Apis dorsata, Apis cerana indica, Apis florea, Apis mellifera, Melipona sp. Social Organization of Bee Colony, Behavioural patterns (Bee dance, swarming)

Unit 2

Unit 2: Rearing of Bees 14 hrs Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth Bee Pasturage Selection of Bee Species for Apiculture - Apis cerana indica, Apis mellifera Bee Keeping Equipment Methods of Extraction of Honey (Indigenous and Modern) & processing Apiary management – Honey flow period and Lean period

Unit 3

Unit 3: Diseases and Enemies (5) Bee Diseases, control and preventive measures Enemies of bees and their control

Unit 4

Unit 4: Bee Economy 3 hrs Products of Apiculture Industry (Honey, Bees Wax, Propolis, Royal jelly, Pollen etc.) and their uses Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

Practical

PRACTICAL (Credits 2) 1. Study of the life stages of honey bee, Apis cerana indica and Apis mellifera - Egg, larva, pupa, adult (queen, drone, worker) from specimen/ photographs 2. Study of natural bee hive and identification of queen cells, drone cells and brood 3. Study of morphological structures of honey bee through permanent slides/ photographs – mouth part, antenna, wings, legs (antenna cleaner, mid leg, pollen basket), sting apparatus. 4. Permanent/temporary mount of antenna cleaner, mid leg and pollen basket OR mount of pollen grains from flowers 5. Study of artificial hive (Langstroth/Newton), its various parts and beekeeping equipment. 6. Analysis of honey – purity, biochemical analysis (Any two constituents) 7. Visit to an apiary/honey processing unit/institute and submission of a report. 8. Study of bee pasturage – Visit to fields/gardens/orchards for studying the bee activity (role in pollination and nectar collection). Making of herbarium of nectar and pollen yielding flowering plants 9. Submission of a few products obtained from apiculture industry.

References

Singh S. (1962) Beekeeping in India, Indian Council of Agricultural Research, New Delhi. Mishra, R. C. (1995). Honeybees and their management in India. Indian Council of Agricultural Research, New Delhi. Additional Resources: Prost, P. J. (1962). Apiculture. Oxford and IBH, New Delhi. Rahman, A. (2017) Beekeeping in India. Indian Council of Agricultural Research, New Delhi Gupta, J. K. (2016). Apiculture, Indian Council of Agricultural Research, New Delhi Master Beekeeping (https://www.ecornell.com/certificates/beekeeping/master-beekeeping/) Beekeeping (https://nios.ac.in/media/documents/nsqf/beekeeping%20theory.pdf) Swayam (MHRD) Portal -Vocational Beekeeping (https://swayam.gov.in/courses/5844-vocational-beekeeping

Teaching Learning Process

Information and concepts about benefits of honey bees in human life and how these benefits can be reaped, will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject. Learning through observations of bees in nature and study of rearing technology will be assisted through visits to various apiculture institutes which will create interest, enhance their understanding and inculcate entrepreneurial skills among students to set up SMEs. Blended learning including chalk-n-talk method and e-learning will be encouraged to make student's learning more dynamic. Inquiry-based collaborative learning environment through presentations, debates, group discussions, and roundtables on the various aspects of bee biology will be promoted to not only ensure effective learning and understanding of the concepts, but also to inculcate confidence in the students. Field-based project activities and hands-on exposure have been added to make students aware about handling of bees and their rearing methods. Collection of plants and bee products will also help students to know the benefits of apiculture. Visit to various apiculture institutes will clarify their concepts about the bees and their rearing technology.

Assessment Methods

Various measures adopted will be as follows. Regularity and Discipline: Assessment of the students based on their regularity and behavior in the class plays a significant role. Monitoring their attendance is important to ensure concept clarity and grasp of the subject. Missing links during the course of study can affect the comprehension of the subject. Class Tests: Regular class tests will judge the grasp of the topics by the students. It includes practice sessions as well as the ones in which evaluation is held. Projects and Assignments: Individual/group projects will inculcate independent thinking as well as the team work skills among the students. Assessment on the participation of each student, analytical skills and project outcome will be held. Regular Presentations: Presentations by the students on a topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries. Viva-voce: Viva-voce is a critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students. Semester-end Examination: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. Assessment of students through final exams analyses comprehensive knowledge gained by each student comparatively.

Keywords

Apiculture, Bee, Bee hive, Beekeeping, Bees' wax, Brood, Comb sheets, Drones, Entrepreneurship, Honey, Langstroth's hive, Newton's hive, Propolis, Queen bee, Royal jelly

Aquarium Fish Keeping
(32239904)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

.

To impart basic knowledge of ornamental fish Industry and inculcate its scope as an avenue for career development in Entrepreneurship or as an Aquariculturist.

.

To impart a clear understanding the basics of habits and biology of aquarium fishes so as to facilitate taking up ornamental fish keeping even at a household level.

.

To promote skill capacity building of students by teaching the techniques of aquarium constructions, feed formulation and preparation, transportation, maintenance and management of the system.

.

To facilitate the students to have first hands on experience by exposure to technology, production, functioning or operation of an institution through visits to public aquariums in the markets, ornamental fish farms, hatcheries, and fish feed production plant as study tours or field visits.

Course Learning Outcomes

.

Knowledge of different kinds of fishes, their compatibility in aquarium.

.

Awareness of Aquarium as commercial, decorative and of scientific studies.

.

Personal Skill development - Maintenance of Aquarium.

.

Basic needs of an aquarium, i.e dechlorinated water, reflector, filters, scavenger, aquatic plants etc. Knowledge of setting an Aquarium and how to make it cost effective.

Unit 1

Introduction to Aquarium Fish Keeping

The potential scope of Aquarium Fish Industry as a Cottage Industry Exotic and Endemic species of Aquarium Fishes

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Unit 2

Biology of Aquarium Fishes

.

Study of different species of Aquarium fishes and their biology (Breeding, Feeding economic importance etc) of exotic and endemic fish.

Common characters and sexual dimorphism of Fresh water and Marine Aquarium fishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

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Unit 3

Food and feeding of Aquarium fishes **· Use of live fish feed organisms.** **(Advantages and Disadvantages of live food)** **· Use of formulated Feeds** **Types of Formulated feed, Formulation and preparation of feed, Advantages and Disadvantages of formulated feed)**	**8-hrs**

Unit 4

Fish Transportation **· Live fish transport**

(Capture and Pre-transport Maintenance, Capture and Handling techniques)

- **Fish Packing and Transport**

(Closed and Open Transport System, Preparation for Packaging, Procedure for Packaging, Precautions, Post Transport Maintenance)

- **General Handling techniques**

Unit 5

Maintenance of Aquarium .

General Aquarium maintenance — budget for setting up an Aquarium Fish Farm as a Cottage Industry.

Practical

1.

Study of different species of Aquarium fishes and their biology (Breeding, Feeding economic importance etc) of exotic and endemic fish.

2.

Study of Sexual Dimorphism of Fresh water and Marine Aquarium Fish.(Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish, Butterfly fish)

3.

Type, compostion and Formulation of Fish feed (using Pearson Square Methods)

4.

Construction and maintenance of Glass Aquarium and Filter System Using Indigenous Locally available materials.

5.

Monitoring of Aquarium Water Quality (Temperature, pH, Dissolved Oxygen, Carbon dioxide, Ammonical N-Load) through titrimetry methods.

To write a project proposal for setting up a small aquarium fish keeping as a cottage industry to a funding agency for self employment of youths or for helping poor farmers.after visiting any farm/enterprise

References

.

Dawes, J. A(1984). The freshwater Aquarium, Roberts Royee Ltd.London.

.

Gunther, A. (1980). An introduction to the study of fishes. A and C. Black Edinburgh.

.

Jhingran, V.G.(1982) Fish and Fishries in India: Hindustan publ.Corp – India.

.

Pandey, K and J.P. Shukla (2013) Fish and fisheries: Rastogi publication

Additional Resources:

Best Management Practices for freshwater Ornamental Fish Production. NFDB, Hyderabad

Teaching Learning Process

Teaching Learning must include the videos, surveys, presentation to show the significance of the course - its commercial, scientific and aesthetic prospects.

.

Learning must inculcate in students with the visit of any farm or lab.

.

Practical exercise with the set- up of an aquarium and its maintenance develop skill development.

.

Hands on training for the formation of feeds.

.

Students should be assigned for subject related surveys, presentation, reports so that they can be rewarded on this basis.

Assessment Methods

Assessment of student for Skill Enhancement course in Aquarium Fish Keeping would be done in conformity with the aims and objectives of the course/ programme from which the syllabus was designed to achieve the learning outcomes of the course.

For skill enhancement course the Learning outcomes will be assessed using the following

Both the formative and summative assessment can be done for the papers. Formative assessment can be done throughout the assigned exercises. At the end of any assigned exercise based on the report, presentation students can be rewarded.

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Reports

.

Presentation

.

Individual project reports

.

Problem-solving exercises

.

Observation of practical skills

.

Viva voce

Keywords

Ornamental Fishes, Cottage Industry, Endemic fish, Feed Formulation, Transporatation techniques.

Medical Diagnostics
(32239901)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Course Objective:

Medical diagnostics paper is aimed to provide students a unique opportunity to study how doctors or clinicians come to a conclusion regarding disease prediction, prevention, diagnosis, and optimal treatment regimens. Students will learn about multiple diagnostic tools, techniques and technologies use in medical practices. The emphasis is on how to select an appropriate diagnostic technique, methods and technologies to conduct analyses to understand the results and their implications in patient diagnoses. The medical diagnostic paper is primarily focused on, clinical chemistry, hematology, diagnostic microbiology, histopathology, molecular diagnostics and diagnostic medical imaging.

Course Learning Outcomes

Course Learning Outcome: The course essentially aims to impart training to students in:

.

Gaining knowledge about various infectious, non-infectious and lifestyle diseases, tumors and their diagnosis

.

Students will understand the use of histology and biochemistry of clinical diagnostics and will learn about the molecular diagnostic tools and their relation to precision medicine.

.

They will develop their skills in various types of tests and staining procedure involved in hematology, clinical biochemistry and will know the basics of instrument handling.

.

Students will learn scientific approaches/techniques that are used in the clinical laboratories to investigate various diseases and will be skilled to work in research laboratories.

.

They will gain knowledge about common imaging technologies and their utility in the clinic to diagnose a specific disease.

Unit 1

Unit:1

Introduction to Medical Diagnostics and its Importance

4hrs

Unit 2

Unit:2	
Diagnostics Methods Used for Analysis of Blood **Medical diagnostics of body fluids 20hrs** **Blood composition, blood bank, transfusion of blood,** **Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman's stain** **, RBC, WBC and platelet count using haemocytometer, erythrocyte sedimentary rate (E.S.R), packed cell volume (P.C.V.), Analysis of urine, sputum, feces and semen(sperm count)**	

Unit 3

~~**Diagnostic Methods Used for Urine Analysis**~~	~~**6hrs**~~	
~~**Urine analysis: physical characteristics; abnormal constituents.**~~ -		
-Medical diagnostics of Non-infectious Diseases	**20 hrs**	
Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Diagnosis and detection of types of tumors (Benign/Malignant) and metastasis, FNAC.		

Unit 4

Infectious Diseasesand Tumors

Diagnostics Microbiology

10hrs

Causes, types, symptoms,

Methods to diagnose and isolate infectious agents of diseases like Tuberculosis, Hepatitis and AIDS.

Unit 5

~~Tumours~~ **DiagnosticMedical Imaging**	**6hrs**	
~~Types (Benign/Malignant), Detection and metastasis;~~ **Principle of Medical imaging techniques like X-Ray of Bone fracture, PET, MRI and CT Scan** ~~(using photographs)~~ _		

Practical

Practicals	**Credits: 2**
1. ABO blood group typing. **2. Estimation of haemoglobin content using Sahli's haemoglobinometer.** **3. Analysis of urine for abnormal constituents.** **4.** ~~**Differential**~~ **Total leucocytes count from blood.** **5. Measurement of** ~~**temperature**~~ **and blood pressure under normal and stress condition.** **6. Estimation of blood glucose/ cholesterol by kit.** **7. Determination of bleeding time/clotting time** **8. Detecting defects of colour vision by Ishihara Charts.** **9. Interpretation of ECG.** **10. Medical Imaging techniques: X-Ray of bone fracture, MRI, CT scan.**	

References

Recommended Readings:*2-3 text books*

.

Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers

.

Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition,Bhalani Publishing House

.

Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chandand Co. Ltd.

· Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis forTraining Courses* · Guyton A.C. and Hall J.E. T*extbook of Medical Physiology*, Saunders · Robbins and Cortan, *Pathologic Basis of Disease*, VIIIEdition, Saunders

Additional Resources:

WEB RESOURCES:

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https://www.skillstat.com/tools/ecg-simulator

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https://www.youtube.com/watch?v=ZoGfQM5JCnI

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https://www.youtube.com/watch?v=Qbnz4_qed9Q&t=276s

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https://www.youtube.com/watch?v=djAxjtN_7VE

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https://www.youtube.com/watch?v=9SUHgtREWQc&t=188s

.

https://www.youtube.com/watch?v=fHUzVqoDnts

Teaching Learning Process

Teaching and learning Process:

.

Different instructing strategies including: Lectures, interactive lectures, classroom discussions and practical based on a theory paper by analyzing body fluids, tissues, blood typing, chemical analyses, cell counts of human body etc.

.

Use of digital technologies to enable students to get a better understanding of the concepts.

.

Hands-on experience, including diagnostic analysis in the diagnostic laboratory and student presentations will provide supplement to conventional text books.

.

Field studies which will include visits to diagnostic laboratory or a visit to a hospital having diagnostic facilities.

Assessment Methods

Assessment methods:

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In class, closed-book tests to evaluate the students' knowledge and understanding of material covered in the class.

.

The Internal evaluation would also be done by the Internal Examiner based on the experiment performed during the internal examination or class tests conducted by the internal examiners.

.

Dimension of comprehension and capacity to respond to inquiries as a piece of viva-voce can be carried out.

.

Involvement in class and group discussions of individual research and contribution to fruitful discussions.

.

Assignments based on the text prescribed in the syllabus.

.

Power Point presentation on any aspect of medical diagnostics.

.

Hospital visit/ medical institute visit.

.

Project work (Students should execute one project of their choice or teacher may assign the project. Project report should be scanned for plagiarism through freely available software and a soft copy of the report should be mandatory).

Keywords

Keywords: Diagnostic methods for body fluids, Infectious and Non-Infectious Diseases And Imaging Techniques

Research Methodology (32239905) Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

This course offers overview of Research Methodology including quantitative and qualitative research in basic as well as applied aspects of Biological Sciences. It is designed to provide hands-on experience with collection, analysis and interpretation of data and also writing a report/thesis. Moreover, this course focusses on developing the skills necessary for pursuing a career in research. The students will be motivated to learn scientific investigation to solve problems, test hypothesis, develop or invent new products for the benefit of society.

Course Learning Outcomes

After completing this course, the students should be able to • Describe basic concepts of research and its methodologies • Identify appropriate research topics and set up hypothesis • Perform literature review using library (print) and internet (online) resources • Design experiments/surveys, collect data and represent data in tables/figures • Analyze data with appropriate software tools, interpret results and draw conclusion • Write scientific report/ review/ thesis and prepare seminar/ conference presentations - oral as well as poster • Understand the methods of citation and referencing styles, check plagiarism and get insight of intellectual property right

Unit 1

Foundations of Research: Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied.

Unit 2

Research Design: Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

Unit 3

Data Collection, Analysis and Report Writing: Observation and Collection of Data - Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies; Preparation of Tables and Figures; Technical Reports and Thesis writing; Bibliography/References; Data Presentation using digital tools. Seminar presentation (oral/poster)

Unit 4

Ethical Issues: Intellectual Property Rights, Copy Right, Royalty, Patent laws, Commercialization, Plagiarism, Citations, Acknowledgement, Research Grants/ Fellowships

Practical

1. Usage of search engine tools for retrieving research/review papers 2. To generate a hypothesis and design an experiment 3. Collection of data, interpretation and writing a report 4. Graphical representation and interpretation of the data provided 5. Title and abstract writing for a given research paper 6. Preparation of bibliography in different formats as per journal requirements 7. To find the impact factors of journals 8. Usage of software tools for checking plagiarism 9. Visit to Research Laboratory and/or Research Internship

References

• Anthony, M, Graziano, A.M. and Raulin, M.L. (2009). Research Methods: A Process of Inquiry, Allyn and Bacon. • Walliman, N. (2011). Research Methods- The Basics. Taylor and Francis, London, New York.
Additional Resources:• Wadhera, B.L.(2002). Law Relating to Patents, Trade Marks, Copyright Designs and Geographical

Indications, Universal Law publishing ● Kothari, C.R. (2009). Research Methodology, New Age International. ● Coley, S.M. and Scheinberg, C.A. (1990). "Proposal writing". Stage Publications. Online tools and web resources https://swayam.gov.in/course/292-introduction-to-research https://explorable.com/research-methodology https://www.coursera.org/learn/research-methods https://www.coursera.org/learn/sciwrite

Teaching Learning Process

● Survey based data collection, graphical representation of data and compilation of report as assignments ● Visit to Research Laboratories to introduce usage of instruments and techniques in the research work to students. ● Participation in Research Internships/ Conferences/Seminar

Assessment Methods

The students will be assessed on the basis of their performance in class room presentations as well as semester end examination. ● Paper presentations (Oral and Poster). ● Paper or Abstract/Report/Dissertation writing. ● Semester End Examination- 100 marks (4 credits): 1. Practical Examination – 50 marks 2. Continuous Evaluation – 50 marks (Record-20, Viva-5, Thesis-15, Minimum Number of practical units performed- 5, continuous assessment- 5)

Keywords

Research, Methodology, Research Methods, Data Analysis, Experimental design, Sampling, Research paper, Abstracts, Dissertation, Thesis, Citation, IPR, Plagiarism, Patent, Research Grants, Fellowships

Sericulture
(32239903)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The course will make the student aware about the significance of sericulture as the profit-making enterprise. It will help the students to understand the biology of silkworms and its nutritional requirement to secrete quality silk. The course would clarify the techniques of silkworm rearing, reeling of silk and various measures to be taken to maximize the benefits. It would also help the students to know about various uses of silk and develop entrepreneurial skills required for self-employment in sericulture and silk production sector.

Course Learning Outcomes

Upon completion of the course, students should be able to:

- **Learn about the history of sericulture and silk route.**
- **Recognize various species of silk moths in India, and Exotic and indigenous races.**
- **Be aware about the opportunities and employment in sericulture industry – in public, private and government sector.**
- **Gain thorough knowledge about the techniques involved in silkworm rearing and silk reeling.**
- **Getting familiarized with the skills necessary for self-employment in mulberry and seed production.**
- **Develop entrepreneurial skills in sericulture and be apprised about practicing sericulture as a profit-making enterprise.**
- **Enhance collaborative learning and communication skills through practical sessions, team work, group discussions, assignments and projects.**

Unit 1

Unit 1: Introduction 4 hrs

Sericulture: Definition, history and present status; Silk route

Types of silkworms, Distribution and Races in India; Exotic and indigenous races

Mulberry sericulture; Non-mulberry Sericulture – Eri, Muga, Tasar

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Unit 2

Unit 2: Biology of Silkworm 3 hrs

Life cycle of *Bombyx mori;* Structure of silk gland and secretion of silk

Composition and properties of silk

Unit 3

Unit 3: Rearing of Silkworms 14 hrs

Selection of mulberry variety and establishment of mulberry garden

Rearing house and rearing appliances

Disinfectants: Formalin, bleaching powder, RKO

Silkworm rearing technology: Early age and Late age rearing

Types of mountage

Harvesting and storage of cocoons

Post-harvest technology – Silk reeling, Dyeing and Weaving, Ahimsa silk

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Unit 4

Unit 4: Pests and Diseases 4 hrs

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates

Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial

Control and prevention of pests and diseases

Unit 5

Unit 5: Silk Industry and Its Importance 2 hrs

Silk usage and application in Textile and non-textile industry

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Unit 6

Unit 5: Entrepreneurship in Sericulture 3 hrs

Prospects of Sericulture in India: Sericulture industry in different states, Employment opportunities in mulberry and non-mulberry sericulture sector, Economics in small scale and large scale silkworm rearing, Scope for women entrepreneurs in sericulture sector.

Practical

PRACTICAL (Credits 2)

1. Study of the life cycle of different species of silk moths - *Bombyx mori, Philosamia ricini, Antheraea paphia/Antheraea mylitta, Antheraea assama* and silk secreted by them.

2. Study of the sexual dimorphism in caterpillar, pupae and adults of *Bombyx mori.*

3. **Study of the structure of silk gland of mulberry silk worms.**
4. **Study of rearing house and different appliances used in rearing of mulberry silk worms.**
5. **Study of the different disinfectants used in silkworm rearing houses.**
6. **Study of different types of mountages from specimen/photographs.**
7. **Analysis of silk fibre quality – Visual examination, thickness, purity.**
8. **Study of the parasites and predators of silk worms and their control - Uzi fly, Dermestid beetle, Vertebrates.**
9. **Study of silkworm diseases and their control – Pebrine, Flacherie, Grasserie, Muscardine.**
10. **Submission of a report on visit to 'Sericulture Institute'/ 'Various Sericulture Centres in India'.**

References

- ***Manual on Sericulture*** **(1976); Food and Agriculture Organisation, Rome**
- **Ullal, S.R. and Narasimhanna M.N. (1987) *Handbook of Practical Sericulture*; 3rd Edition, CSB, Bangalore**

Additional Resources:

· **Yonemura, M. and Rama Rao, N. (1951) *A Handbook of sericulture. I. Rearing of silk-worms*. Government Branch Press, Mysore.**

· **Ananthanarayanan, S. K. (2008). *Silkworm rearing.* Daya Publishing House**

- **Aruga, H. (1994). *Principles of sericulture.* CRC Press**
- **Sathe, T. V. and Jadhav, A. (2002) *Sericulture and Pest Management.* Daya Publishing House**
- **Yup-Lian, L. (1991) *Silkworm diseases.* Food and Agricultural Organization.**
- **Silkworm crop protection (https://swayam.gov.in/courses/152-silkworm-crop-protection)**
- **Sericulture (http://csb.gov.in/silk-sericulture/sericulture/)**
- **http://csb.gov.in/publications/videos/**
- **http://www.fao.org/3/x2099e/x2099e02.htm**

Teaching Learning Process

Information and concepts about benefits of silkworms in human life and how these benefits can be reaped, will be imparted through classroom lectures to inculcate a conceptual base among the students about the subject. Learning through observations of silkworms in nature and study of rearing technology will be assisted through visits to various sericulture institutes which will create interest, enhance their understanding and inculcate entrepreneurial skills among students to set up SMEs. Blended learning including chalk-n-talk method and e-learning will be encouraged to make student's learning more dynamic. Inquiry-based collaborative learning environment through presentations, debates, group discussions, and roundtables on the various aspects of silkworm biology will be promoted to not only ensure effective learning and understanding of the concepts, but also to inculcate confidence in the students. Field-based project activities and hands-on exposure have been added to make students aware about handling of worms and their rearing methods. Visit to various sericulture institutes will clarify their concepts about the bees and their rearing technology.

Assessment Methods

Various measures adopted will be as follows.

- **Regularity and Discipline: Assessment of the students based on their regularity and behavior in the class plays a significant role. Monitoring their attendance is important to ensure concept clarity and grasp of the subject. Missing links during the course of study can affect the comprehension of the subject.**
- **Class Tests: Regular class tests will judge the grasp of the topics by the students. It includes practice sessions as well as the ones in which evaluation is held.**
- **Projects and Assignments: Individual/group projects will inculcate independent thinking as well as the team work skills among the students. Assessment on the participation of each student, analytical skills and project outcome will be held.**
- **Regular Presentations: Presentations by the students on a topic will enhance student's learning and confidence. The presentations will be assessed based on the content, novelty, explanation and response to queries.**

- ***Viva-voce: Viva-voce*** **is a critical component of assessment of the practical component of a course. Inquiry-based learning blended with hands-on learning will develop critical thinking and competencies among students.**
- **Semester-end Examination: Semester-end examination and grading of students based on their performance in the exams is an indicator of student's learning throughout the semester. Assessment of students through final exams analyses comprehensive knowledge gained by each student comparatively.**

Keywords

Cocoon, Disinfectant, Eri, Flacherie, Grasserie, Moriculture, Mountages, Muga, Mulberry, Muscardine, Pebrine, Rearing, Reeling, Sericulture, Silk moth, Tasar, Textile, Uzi fly, Weaving

Animal Cell Biotechnology
(32235901)
Generic Elective - (GE) Credit:6

Course Objective(2-3)

The syllabus of Generic elective course/ paper on "Animal Cell Biotechnology" is revised to cater to the needs of Choice Based Credit System (CBCS). The changing scenario of higher education in India and abroad is taken into consideration to make this syllabus more oriented towards current need of modern research and industrial sectors. The revised and updated syllabus is based on a basic and applied approach with vigor and depth. Empowerment of students to face research and industrial outlets by nurturing independent thinking, initiating scientific enquiry and developing their entrepreneurship skills is at the centre of this syllabus. The units of the syllabus are well defined, taking into consideration the level and capacity of students.

Course Learning Outcomes

This is a Generic elective course chosen by students from unrelated discipline with an intention to seek exposure to the concept of genetic engineering and recombinant DNA technology. Therefore, the course structure is designed in such a way that to start with, students get a clear concept of the basic principles and then end up with applications of biotechnology in detail.

- **Students will get complete knowledge of all the basic techniques used in genetic manipulation and thus help them continue with higher studies in this field.Students will acquire thorough knowledge of the basic principles, preparations and handling required for animal cell culture, which is an indispensable technique for understanding the structure and function of cells and in recent times it has very good implications in biotechnology.**
- **They will be able to understand principles underlying the design of fermentor and fermentation process and its immense use in the industry.**
- **After completion of the course, graduates will be able to design small experiments for successful implementation of the ideas and develop solutions to solve problems related to biotechnology while keeping in mind safety factor for environment and society.**
- **They can apply the knowledge and skills gained in the course to develop new diagnostic kits and to innovate new technologies further in their career. Hence, students will develop skills required in various industries, research labs and in the field of human health.**

By the end of the course students will be able to enhance the understanding of the various aspects and applications of biotechnology as well as the importance of bio-safety and ethical issues related to it.

Unit 1

Unit: 1 Introduction 2-hrs

Concept and Scope of Biotechnology

Unit 2

Unit: 2 Techniques in Gene manipulation 20-hrs

Outline process of genetic engineering and recombinant DNA technology, Isolation of genes, Concept of restriction and modification: Restriction endonucleases, DNA modifying enzymes, Cloning Vectors: Plasmids, Phage vectors, Cosmids, Phagemids (lambda & M13), BAC, YAC, HAC. Shuttle and Expression Vectors. Construction and Screening of Genomic libraries and cDNA libraries. Transformation techniques: Electroporation and Calcium Chloride method.

Aagrose and Polyacrylamide Gel Electrophoresis, Southern, Northern and Western blotting, DNA sequencing: Sanger method, Polymerase chain reaction, DNA Fingerprinting and DNA microarrays.

Unit 3

Unit: 3 Fermentation 15-hrs

Different types of Fermentation: Submerged & Solid state; batch, Fed batch & Continuous; Stirred tank, Air Lift. Downstream Processing: Filtration, Centrifugation, Extraction, Chromatography (Only Principles: Adsorption, Ion exchange, gel filtration, hydrophobic, affinity and size exclusion) and Lyophilization.

Unit 4

Unit 4: Transgenic Animal Technology
5-hrs

Production of transgenic animals: Retroviral method, DNA microinjection method, Nuclear Transplantation: Dolly and Polly.

Unit 5

Unit 5: Animal Cell Culture and rDNA Application in Health
15-hrs

Basic techniques in animal cell culture, Primary Culture and Cell lines, Culture media- Natural and Synthetic, Cryopreservation of cultures.

Recombinant Vaccines, Gene Therapy (*in-vivo* and *ex-vivo*). Production of recombinant Proteins: Monoclonal Antibodies, Insulin and growth hormones.

Bio safety: Physical and Biological containment.

Practical

1. Packing and sterilization of glass and plastic wares for cell culture.

2. Preparation and sterilization of culture media.

3. Preparation of genomic DNA from *E. coli*.

4. Plasmid DNA isolation (pUC 18/19) and its detection on Agarose Gel Electrophoresis.

5. Calculation of transformation efficiency from the data provided

6. Restriction digestion of lambda (λ) DNA using *Eco*R1 and *Hind* III.

7. Techniques:

a) Western Blot

b) Southern Hybridization

c) DNA Fingerprinting

d) PCR

e) DNA Microarrays

References

- **Jennie P. Mathur and David Barnes, Methods in Cell Biology. (1998). Animal Cell Culture Methods Academic Press.**
- **Brown, T.A. (1998). Molecular Biology Labfax II: Gene Cloning and DNA Analysis. II Edition, Academic Press, California, USA.**
- **Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology- Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.**

Additional Resources:

Suggested Reading

- **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.**
- **Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). Recombinant DNA-Genes and Genomes-A Short Course. III Edition, Freeman and Co., N.Y.,USA.**

Online Tools and Web Resources

- **e-PG Pathshala: an initiative of the MHRD under its National Mission on Education through ICT (NME-ICT) being executed by the UGC. *https://epgp.inflibnet.ac.in/***
- **SwAYAM is a programme initiated by Government of India and designed to achieve the three cardinal principles of Education Policy viz., access, equity and quality.*https://swayam.gov.in/Home***

Teaching Learning Process

As the students of Generic Elective papers are from different and unrelated discipline (s) the revised syllabus is framed with a basic introduction to the concept of genetic engineering, scientific techniques and applications. Effective teaching involves aligning the three major components of instruction: learning objectives, assessments, and instructional activities. The following measures are required for an impactful teaching learning process:

- **Students Participation: To increase the participation of students and in turn develop their interest in the topic more discussions/ Quiz to be included.**
- **Brain Storming sessions: To help students march towards scientific excellence, the recent research activities/trends are to be discussed in form of brain storming sessions (twice a month).**
- **Open Learning Resources: To clear the concept (s) relevant videos from various Open Learning Resources like SWAYAM, MOOC etc. to be shown.**
- **Field trips/visits to Institute/Industry: To provide better exposure and more practical view of studying science and applying it judiciously various visits to research institutes and industries are to be planned for students.**
- **Theory and practical are linked together: To develop a better understanding on the respective topic, the theory classes are immediately followed up by the practicals.**
- **Continuous Evaluation: Students understanding will be assessed at frequent intervals throughout the learning process. Continuous evaluation of learning will be carried out and efforts will be made to measure cognitive as well as applied learning. Project work, quiz, problem solving exercise, classroom assessment methods, end-semester examination, etc. will constitute the different components of the overall assessment.**
- **Personal Attention: Extra efforts and time slots will be given to students facing difficulty in understanding any topic/concept etc.**

Assessment Methods

- **Regular class tests with objective/subjective questions.**
- **Oral presentation on regular basis by students.**
- **Group discussion: Dividing the class into groups and assign each group a topic or latest development/scientific finding in the field of biotechnology.**
- **Small projects can be designed by students (a group of 3 students) to enhance their critical thinking, improving scientific writing and honing their skills.**
- **Assignment work.**

Keywords

Restriction enzymes, Vector, Cloning, Transformation, Fermentation, Transgenic, Cell culture, Gene Therapy

Animal Diversity
(32235902)
Generic Elective - (GE) Credit:6

Course Objective(2-3)

Zoology is the scientific study of animal life and builds on centuries of human inquiry into the animal world, its origins and relationships. Animals are the most diverse creatures on this planet. This course gives a framework for understanding the way they all fit together; the diversity within different groups, and the things that are common between different species and genera within each group.

The aim of this course is to understand the importance of animal kingdom in context to hierarchy, body plan and their role in ecological development. This course provides an overview of the invertebrate and vertebrate animals, including sponges, cnidarians, flatworms, nematodes, annelids, molluscs, arthropods, echinoderms, invertebrate chordates, fishes, amphibians, reptiles, birds, and mammals. This paper comprises of 15 units of Non-Chordata and Chordata both. First nine units provide knowledge of coelom formation, different level of organization, different modes of living, evolutionary changes of Non-chordates and their salient features. Whereas, remaining units will impart knowledge on different classes of chordates.

After completion of this course, the learners will have a framework for understanding all of the different types of animals, and the characteristics of each.

Course Learning Outcomes

Learning Outcomes

- **To distinguish between major phyla of animals through a demonstrated understanding of their taxonomic classification and diversity.**
- **To describe the distinguishing characteristics of all major phyla.**
- **To describe the fundamental differences among animal body plans and relate them to function, taxonomic classification, and evolutionary relationships among phyla.**
- **To illustrate lifecycles, structure, function and reasons for importance of few representative organisms from different groups of animals.**
- **To identify anatomical structures from prepared tissues.**
- **To observe living animals in the environment and relate observations to theory from the course.**

Skill Based Outcomes

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To identify major animal phyla and animals on the basis of their external characteristics.

Unit 1

Unit 1. Protista **4 periods**

General characters of Protozoa; Life cycle of Plasmodium

Unit 2

Unit 2. Porifera **4 periods**

General characters and canal system in Porifera

Unit 3. Radiata **3 periods**

General characters of Cnidarians and polymorphism

Unit 4. Aceolomates **3 periods**

General characters of Helminthes; Life cycle of Taenia solium

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Unit 3

Unit 5. Pseudocoelomates **3 lectures**

General characters of Nemathelminthes; Parasitic adaptations

Unit 6. Coelomate Protostomes **3 lectures**

General characters of Annelida ; Metamerism.

Unit 7. Arthropoda **5 lectures**

General characters. Social life in insects.

Unit 4

Unit 8. Mollusca **4 lectures**

General characters of mollusca; Pearl Formation

Unit 9. Coelomate Deuterostomes **5 lectures**

General characters of Echinodermata, Water Vascular system in Starfish.

Unit 10. Protochordata **3**

Salient features

Unit 5

Unit 11. Pisces **5 lectures**

General characters of Pisces, Osmoregulation in Fishes

Unit 12. Amphibia **5 lectures**

General characters, Adaptations for terrestrial life, parental care in Amphibia.

Unit 13. Reptilia **4 lectures**

General Characters, Poisonous and Non-poisonous snakes

Unit 6

Unit 14. Aves: **4 periods**

General Characters, Flight adaptations

Unit 15. Mammalia **5 periods**

Early evolution of mammals; Primates; Dentition in mammals.

Practical

1. Study of following specimens:

Non Chordates: ***Euglena, Noctiluca, Paramecium, Sycon, , Physalia, Tubipora, Metridium, Taenia, Ascaris, Nereis, Aphrodite, Leech, Peripatus, Limulus, ,*** **Hermitcrab*, Daphnia,* Millipede, Centipede,Beetle*, Chiton, Dentalium, Octopus, Asterias, and Antedon.***

Chordates*: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander, Rhacophorus Draco, Uromastix, Naja, Viper, model of Archaeopteryx,* any three common birds-*(Crow, duck, Owl),* Squirrel and Bat.

2. Study of following Permanent Slides:

Cross section of Sycon, Sea anemone and *Ascaris(*male and female*)*. T. S. of Earthworm passing through pharynx, gizzard, and typhlosolar intestine. Bipinnaria and Pluteus larva.

3. Temporary mounts of

- **Septal & pharyngeal nephridia of earthworm.**
- **Unstained mounts of Placoid ,cycloid and ctenoid scales.**

4. Dissections of

- **Digestive System of Cockroach.**
- **Urinogenital system of Rat**

References

Campbell & Reece (2005). Biology, Pearson Education, (Singapore) Pvt. Ltd.

Raven, P. H. and Johnson, G. B. (2004). Biology, 6th edition, Tata McGraw Hill Publications. New Delhi

Additional Resources:

Barnes, R.D. (1992). Invertebrate Zoology. Saunders College Pub. USA.

Ruppert, Fox and Barnes (2006) Invertebrate Zoology. A functional Evolutionary Approach 7th Edition, Thomson Books/Cole

Kardong, K. V. (2002). Vertebrates Comparative Anatomy. Function and Evolution. Tata McGraw Hill Publishing Company. New Delhi.

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Online Resources:

- **Notes : http://vle.du.ac.in**
- **Animal Diversity Web (ADW) is an online database of animal natural history, distribution, classification, and conservation biology. Web resource https://animaldiversity.org/**
- **Online Zoo https://www.activewild.com/online-zoo/**
- **For latest news: https://www.waza.org/ The World Association of Zoos and Aquariums (WAZA) is the global alliance of regional associations, national federations, zoos and aquariums, dedicated to the care and conservation of animals and their habitats around the world.**
- **MOOC https://swayam.gov.in/courses/5686-animal-diversity**

Teaching Learning Process

Teaching-Learning process will include delivery of lectures using boards, Multimedia presentation, short documentaries on animal diversity, imparting practical based knowledge through specimens, live demonstration of diversity in surroundings

Assessment Methods

- **Course examination**
- **Multiple choice questions quiz at the end of each lecture**
- **Case- studies**
- **Oral presentation by student**
- **Report or essay writing**
- **Project based to assess the skills of scientific enquiry and problem-solving**

Keywords

INVERTEBRATES , VERTEBRATES

Aquatic Biology
(32235903)
Generic Elective - (GE) Credit:6

Course Objective(2-3)

Aquatic biology is a discipline that investigates study of all life forms like plants, animals and chemicals prevalent in the waters from different sources such as lakes, rivers, streams, wetlands, marine environments etc. It is a modern area of academic study and research oriented program. This program helps students to study about aquatic life and equip students with skills that can later lead into a profession in aquatic biology. Aquatic biology at undergraduate level works as an entry point for future aquatic biologist. Two major aspects of Aquatic biology are study of the organisms in the freshwater (Limnology) and saline waters (Marine biology). This paper focuses on research and explains processes, structures and pathways in most aquatic and wet ecosystems. Geographically, we cover aquatic ecosystems in temperate, tropical and arctic regions, and we work with both basic and applied science.

Course Learning Outcomes

This course provides a comprehensive understanding of small and large scale processes that govern the structure and function of aquatic environments. By studying this course students will be able to:-

· Receive an introduction to the physico-chemical environment, and its role in aquatic ecosystem. They get to know how environments in waters from different sources are unique with respect to each other. They learn about adaptations exhibited by organisms to survive in these typical conditions.

· Students understand how Human activities influence the physicochemical environment of water bodies, what devastating impact it has on aquatic organisms.

· Learn about the laws governing the use of freshwater systems, as well as the local, state, federal, and international agencies that enforce these laws. Laws help to control how fishing is conducted, so that we can use this important food source in sustainable ways. These laws also protect endangered species, such as sea turtles, and vulnerable species, such as coral.

· Understand and apply relevant scientific principle in the area of aquatic biology and educate others or work to conserve our natural resources,

Students may conduct research at an academic institution or industry. While many Aquatic Biologists work in the field, exploring the ecology and environmental conditions of freshwater systems, some also work in the policy field, working to ensure that environmental regulations are up-to-date with industry knowledge.

Unit 1

Credits 4

Aquatic Biomes **6 Hrs**

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

Unit 2

Aquatic Resources: **10 Hrs**

Important fin and shellfish resources of Inland (major carps, Catfish & prawn), brackish water (Hilsa), marine (demersal and pelagic), ornamental and sport fishes.

Unit 3

Freshwater Biology **24 Hrs**

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico–chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Streams:Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

Unit 4

Marine Biology **10 Hrs**

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

Unit 5

Management of Aquatic Resources **10 Hrs**

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.

Practical

Credits: 2

1. Determine the area of a lake using graphimetric and gravimetric method.

2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body. 4. Determination of BOD and COD in the water samples collected from polluted and un- polluted waters.

5. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter,Turbidity meter, PONAR grab sampler) and their significance.

6. A Project Report on a visit to a Sewage treatment plant/Marine Bioreserve/Fisheries Institutes.

References

- **Goldman, Charles R., Horne, Alexander J. published by McGraw Hill Higher Education : Limnology, 2nd Edition**
- **Odum and Barrett : Fundamentals of Ecology, 5th Edition**
- **Pawlowski : Physicochemical Methods for Water and Wastewater Treatment, 1st Edition**
- **Wetzel. Limnology: Lake and River Ecosystems:, 3rd edition.**

Teaching Learning Process

In addition to the traditional way of chalk and board teaching, teaching would be supplemented withVideo/animationsto help better understanding of the subject. For enhanced practical/field driven knowledge of students, they would be taken to laboratories or Aquatic research institutes/industries.

Assessment Methods

In addition to end of semester written examination, students would be evaluated through various methods. They would be encouraged to deliver short class lectures throughPower point presentations or to submit assignments with emphasis on relevant, recent studies in the Aquatic Biology. Students would be evaluated all-round the semester for continuous evaluation.

Keywords

Fresh water, Marine Biology, Aquatic resources, Management of resources

Environment and Public Health (32235904) Generic Elective - (GE) Credit:6

Course Objective(2-3)

Health is wealth but this wealth is directly affected by the environment. Environmental issue that affects human health is the most important trigger that has led to the urgency of conservation of environment. All the aspects of human health, including quality of life are determined by physical, chemical, biological, social and psychological factors in environment. So the sustenance of environment is the key to development of future of mankind.

The revised syllabus of the Generic Elective paper: ENVIRONMENT AND PUBLIC HEALTHaims to create awareness among students about the necessity conservation of Mother Nature. The main objective of the syllabus is to assess, correct, control and prevent those factors that can adversely affect environment and hence health of present and future generation.

Course Learning Outcomes

The Generic elective paper ENVIRONMENT AND PUBLIC HEALTH is a multidisciplinary in nature which can be opted by students from all science courses. Starting from the basic concepts of Environmental science, it gives a deep insight into the factors causing environmental degradation and its outcome in form of increasing number of diseases leading to deteoration of public health.

The paper has the following learning objectives:

- **To familiarize the students with various aspects of environmental risks and hazards.**
- **To sensitize the students about the climate change due to human activities.**
- **To create awareness about the various impacts of environmental degradation on human health through case studies and how it can be prevented.**
- **To learn about the nuclear and chemical disasters and their after effects through cases studies.**
- **To make the students familiar with the various waste management technologies and their utility.**
- **Through the topics covered in Unit 5, the students will be able to learn about diagnosis of various diseases and how to prevent them.**

By the end of this course, students will be sensitized enough to understand the importance of conservation of nature for betterment of human race and all living beings

Unit 1

Introduction **10 hrs**

Sources of Environmental hazards Hazard identification and accounting, Bioaccumulation, Biomagnification, Dose Response Evaluation, exposure Assessment.

Unit 2

Climate Change **10 hrs**

Greenhouse gases and global warming, Acid rain, Ozone layer destruction, El Nino La Nina Southern Oscillation (ENSO), Effect of climate change on public health

Unit 3

Pollution **15hrs**

Air, water, noise pollution: sources, effects and control

Smog: Causes and its effect on human health, Effect of noise on Human health, Water borne diseases, Respiratory ailments (Asthma).

Nuclear accidents and holocaust. Case Histories and their aftermath of: Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident.

Unit 4

Waste Management Technologies **15 hrs**

Classification and Characteristics of solid and hazardous waste, Sewage treatment and its management, Solid waste management, Handling and disposal: Biomedical waste and Nuclear waste

~~Case Histories and their aftermath of: Bhopal gas tragedy, Chernobyl disaster, Seveso disaster and Three Mile Island accident~~.

Health risk due to hazardous waste (Minamata disease)

Unit 5

Diseases **10 hrs**

Causes, symptoms and control of tuberculosis, Vector borne diseases (Dengue, Malaria), ~~Asthma~~ , Typhoid, ~~Minamata disease~~, Cholera, Cancer, Infectious diseases

Practical

1. **To determine pH, Cl, SO_4, NO_3 in soil samples from different locations.**
2. **To determine pH, Cl, SO_4, NO_3 in water samples from different locations.**
3. **To determine dissolved oxygen in water samples collected from different water bodies by Winkler's Method.**
4. **To measure the COD of water sample from various sources**
5. **To study the methods adopted for segregation of domestic and hospital wastes into different categories.**
6. **A report based on a visit to thermal power plant/ solid waste management site/ Sewage Treatment Plant/ Nuclear Power Plant**

References

· **Vasudevan, N., Essentials of Environmental Science, Narosa Publishing house, Delhi, 2006.**

Additional Resources:

Suggested reading:

· **Cutter, S.L., Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi, 1999.**

· **Kolluru Rao, Bartell Steven, Pitblado R and Stricoff —Risk Assessment and Management Handbook‖, McGraw Hill Inc., New York,1996.**

· **Kofi Asante Duah —Risk Assessment in Environmental management‖, John Wiley and sons, Singapore, 1998.**

· **Kasperson, J.X. and Kasperson, R.E. and Kasperson, R.E., Global Environmental Risks, V.N. University Press, New York, 2003.**

· **Joseph F Louvar and B Diane Louver Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey 1997**

ONLINE TOOLS AND WEB RESOURCES:

· **e-PG Pathshala**

· **SWAYAM**

· **Coursera**

· **Khan's academy**

· **CMS vatavaran documentaries**

- **BBC**
- **Discovery**
- **National geographic**
- **Science Insider**

Teaching Learning Process

Generic Elective papers are interdisciplinary in nature. This paper has been revised for better understanding of the subject by the students even from unrelated disciplines. For an effective teaching learning process, the following points must be included:

1. Student-teacher interaction: Instead of teaching in a complete lecture mode, there should be interactive teaching for better understanding of the topic.

2. Field trips/ Visits: The topics under Waste management can be understood through visits to waste treatment plants.

3. Group projects: These can be extended practicals other than the ones included in the syllabus which may include collection of data, data analysis and preparing report.

4. Incorporation of media and multimedia: Screening of documentaries/movies relevant to the current scenario of environmental degradation.

5. Oral Presentation: Students can present case studies or Government's initiative relevant to the topics related to the paper.

6. Quizzes and debates: These can be used for better understanding of the topics.

7. Continuous evaluation: Through tests, presentation, assignments and project work

Assessment Methods

Assessment methods:

The various methods can be adopted for continuous evaluation of the students:

- **Regular class test**
- **Oral presentation as part of assignment**
- **Participation in discussion**
- **Project work with viva**
- **Performance in regular and extended practical**

Keywords

Environment, Pollution, Environmental hazards, Public Health, Climate Change, Waste management technologies

EXPLORING THE BRAIN: STRUCTURE AND FUNCTION (32235905) Generic Elective - (GE) Credit:6

Course Objective(2-3)

Exploring the Brain Structure and function is designed for science undergraduates with the aim to provide them a rock-hard groundwork for understanding neural structures as well as its functions which are prerequisites for higher studies in neurology and psychiatry courses. This introductory course will lead students to explore the nervous system on multiple levels. They will learn about the structure of human brain as well as cellular & molecular components of nervous system which come together in neuronal circuits for conducting signals and memory consolidation. This course is also designed to familiarise students with different neurological disorders, neurophysiological as well as neuroimaging techniques used for its diagnosis. Overall, this course will provide students basic knowledge and awareness about field of neuroscience. The course content is mapped to provide an overview brain anatomy and various aspect of nervous system to our undergraduate who wishes to pursue higher studies or research in the field of neuroscience.

Course Learning Outcomes

Upon completion of the Neuroscience major, students should be able to:

1) Define the cellular, and anatomical-level organisation of the brain.

2) Understand the properties of neuronal and non neuronal cells that make up the brain including the propagation of electrical signals used for cellular communication

3) Understand how the interaction of cells and neural circuits leads to various higher level activities like cognition and behaviour.

4) Understand principles /mechanism underlying various neurological disorders.

5) learn about neuroimaging methods used for disease diagnosis.

6) Neurophysiological methods for sleep and epilepsy analysis.

Unit 1

Introduction. (4 hours)

Early and Nineteenth century views of the Brain; Neuron doctrine; Organisation and Classification of nervous system.

Unit 2

Evolution and Adaptation of Brain: 6 hours

Brain evolution and behavioral adaptation; Theories of brain evolution – involving addition of structure or areas, involving new formation and reorganisation of circuits.

Unit 3

Understanding Brain Structure through Development. 8 hours

Formation of neural tube, Primary brain vesicles; Differentiation of forebrain, midbrain and hindbrain. Cerebral cortex - neocortical evolution and structure-function relationship. Gross anatomy of human brain, Spinal cord; Cranial nerves, Meninges, ventricular system.

Unit 4

Cellular Neurobiology: Neurons and Glia 8 hours

Neurons and Glia: Neurons - Soma, Axon, Dendrite; Classification of Neurons; Glia -Astrocytes, Oligodendrocytes and other other non-neuronal cells. Action potential: its generation and propogation. Synapse: Types of synaptic transmission, Principles of synaptic transmission and synaptic integration.

Unit 5

Chemical Control of the Brain, Behavior, learning & Memory: 18 hours

Structure and functions of Hypothalamus; Pituitary and Pineal glands. Diffuse modulatory systems of the brain - noradrenergic, serotonergic, dopaminergic and cholinergic system. Neurotransmitters, Ionotropic and metabotropic

receptors. Molecular basis of learning and memory formation: role of the cortex and hippocampus; Synaptic plasticity & memory consolidation

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Unit 6

Rhythms of the Brain: 6 hours

Biological Rhythms: Circadian Rhythms and Zeitgebers; Electroencephalogram; Sleep rhythms, neural mechanisms of sleep.

Unit 7

Neurological Disorders: 10 hours

Neurodegeneration in Alzheimer and Parkinson disease. Psychosocial and biological approaches to mental illness like Obsessive-Compulsive Disorder (OCD); Attention-Deficit/Hyperactivity Disorder (ADHD) and Schizophrenia; Neuroimaging techniques: Positron emission tomography (PET), Computed tomography (CT) and magnetic resonance imaging (MRI) for disease diagnosis.

Practical

1. **Dissection and study of Drosophila nervous system.**
2. **Observation and quantitation of Drosophila photoreceptor neurons.**
3. **Perform histochemistry of spinal cord and brain to identify neurons and subcortical structures.**
4. **Action potential: simulations under normal conditions and in presence of toxins.**
5. **Prepare a brief project on electrophysiological hallmark of sleep-wake staging or epileptogenesis.**

References

- **Neuroscience: Exploring the brain, 4th Ed, Mark F. Bear, Barry W. Connors, Michael A. Paradiso, 2015.**
- **Principles of Neural Science, 4th Ed., ER Kandel, JH Schwartz and TM Jessell, McGraw-Hill Companies, 2000.**
- **From Molecules to Networks: An Introduction to Cellular and Molecular Neuroscience by John H. Byrne. Ruth Heidelberg and M. Neal Waxham**

Additional Resources:

Suggested reading: *include MOOC, Online videos, SWAYAM, research papers etc. (Keeping in mind that they should be able to utilise these resources.*

- **Alberts B, Johnson A, Lewis J, Raff M, Roberts K, Walter P (eds). 2002. *Molecular Biology of the Cell,* 4th ed. New York: Garland.**
- **Kelly RB. 1993. Storage and release of neurotransmitters. Cell 72:43–53.**
- **Kimelberg HK. 2010. Functions of mature mammalian astro- cytes: a current view. The Neuroscientist 16:79–106.**
- **Bezanilla F. 2008. Ion channels: from conductance to struc- ture. Neuron 60:456–468.**
- **Goedert M, Spillantini MG. 2006. A century of Alzheimer's disease. Science 314:777–781. Neuroscience-Eds. Dale Purves et. al. (3rd Ed), Sinauer Associates, Inc.-2004**
- **Nerve Cells and Animal Behaviour-2nd Ed, Peter J Simmons and David Young-CUP-2003**
- **Essential Psychopharamacology- Neuroscientific Basis and Practical Applications- 2nd Edn.-Stephan M. Stahl-CUP-2000**
- **Phantoms in the Brain - Vilayanur S. Ramachandran and Sandra Blakeslee-1998**
- **The Human Brain Book - Rita Carter-2009**

Online tools and web resources:

- **Learn Medical Neuroscience. Virtual Lab. https://www.learnmedicalneuroscience.nl/virtual-lab/sensory-systems/**
- **Allen Brain Atlases:http://portal.brain-map.org**
- **Human Brain project:https://www.humanbrainproject.eu/en/**
- **Neuroscience learning resource: https://www.hhmi.org/biointeractive/neuroscience-collection**
- **JoVE Science Education. https://www.jove.com/science-education-library**
- **Coursera- Introduction to Neuroanatomy.**
- **Coursera- General principles of sensory system part 1 and 2.**
- **Swayam (MHRD) Portal:**
  - **Demystifying The Brain online course –Neuroscience of Human Movement online**
  - **How The Brain Creates Mind online course**
  - **Learning about Learning: A Course on Neurobiology of Learning and Memory**
  - **Cognitive Science online course**

Teaching Learning Process

Knowledge will be shared between teacher and students through two way communication. Learning among students will be facilitated by using problem solving exercises, elaborative quiz-based learning, smart class-based teaching, using

multimedia and animation videos as well as interactive sessions. They will be motivated to take up mini-project works, prepare models and participate in group discussions for increasing their awareness about experimental neuroscience.

Assessment Methods

- **Continuous assessment will be made during entire semester. Summative assessment will be collected through as mid semester and semester end evaluations.**
- **students will be asked to give powerpoint or black-board presentation on related topics to increase their basic presentation skills and knowledge.**
- **students will be provided feedback on assignments to improve their writing skills and academic performance.**
- **From time to time learners will be given theoretical & practical problems to test their theoretical skills and promote practical knowledge.**

Keywords

Neuroscience, Neuroanatomy, Circadian rhythms, Sleep, Neurochemistry, Action potentials, learning & memory, Synaptic plasticity, Neurotransmitters, Cognitive, Neurodegenerative diseases, Alzheimer, Parkinson disease.

Food Nutrition and Health (32235906) Generic Elective - (GE) Credit:6

Course Learning Outcomes

On the completion of the course students will have a better understanding of the association of food and nutrition in promoting healthy living. It will also equip students with the means to think more holistically about the relationship between nutrition science, social and health issues.

Students can move on to do Masters in Nutrition studies and can apply for jobs as food safety officers, food analysts, food inspectors, food safety commissioners or controllers for jobs in organisations like FSSAI. They can also specialise in various fields of Nutrition like Renal, Paediatric, sport, Oncology etc

Unit 1

Unit 1: Basic concept of food and nutrition

Food Components and food-nutrients

Concept of a balanced diet, nutrient needs and dietary pattern for various groups- adults, pregnant and nursing mothers, infants, school children, adolescents and elderly

Unit 2

Unit 2: Nutritional Biochemistry:

Carbohydrates, Lipids, Proteins- Definition, Classification, their dietary source and role

Vitamins- Fat-soluble and Water-soluble vitamins- their dietary source and importance

Minerals- Iron, calcium, phosphorus, iodine, selenium and zinc: their biological functions

Dietary Fibre - Classification, sources, composition, properties & nutritional significance. Elementary idea of Probiotics, Prebiotics, Organic Food.

Unit 3

Unit 3: Health **15**

Introduction to health- Definition and concept of health

Major nutritional Deficiency diseases- Protein Energy Malnutrition (kwashiorkor and marasmus), Vitamin A deficiency disorders, Iron deficiency disorders, Iodine deficiency disorders- their causes, symptoms, treatment, prevention and government programmes, if any.

Life style related diseases- hypertension, diabetes mellitus, Atherosclerosisand obesity- their causes and prevention through dietary and lifestyle modifications

Social health problems- smoking, alcoholism, drug dependence and Acquired Immuno Deficiency Syndrome (AIDS) - their causes, treatment and prevention

Benefit of nutritional therapies, exercise and diet in prevention and management of mental disorders.

Causes and Prevention of Lactose intolerance and common types of Food allergies and food intolerance

Unit 4

Unit 4: Food hygiene: **15**

Potable water- sources and methods of purification at domestic level

Food and Water borne infections: Bacterial infection: Cholera, typhoid fever, dysentery causes and preventive strategies; Viral infection: Hepatitis, Poliomyelitis, Protozoan infection: amoebiasis, giardiasis; Parasitic infection: taeniasis and ascariasis their transmission, causative agent, sources of infection, symptoms and prevention

Brief account of food spoilage: Causes of food spoilage and their preventive measures

Practical

1. To detect adulteration in a) Ghee b) Sugars c) Tea leaves and d) Turmeric

3. Estimation of Lactose in milk and diagnosis of lactose intolerance by measuring hydrogen gas during expiration

4. Ascorbic acid and Calcium estimation in food by titrimetry

5. Estimation of blood Glucose and serum cholesterol

6. Study of the stored grain pests from slides/ photograph (*Sitophilus oryzae*, *Trogoderma granarium*, *Callosobruchus chinensis* and *Tribolium castaneum*): their identification, damage caused and control strategies.

7. Determination of Saponification values, iodine values and acid values of lipids.

8. Study of different methods of Food preservation – Drying, Freezing, Frying, canning, bottling etc. Aseptic handling : Sources of contamination of foods. Visit to canning industry and dairy firm etc.

9. Project- Undertake computer aided diet analysis and nutrition counseling for different age groups.

OR

Identify nutrient rich sources of foods (fruits and vegetables), their seasonal availability and price

OR

Study of nutrition labeling on selected foods

References

1. **1.Food, Nutrition and Health by Shashi Goyal & Pooja Gupta (ISBN: 9788121940924)**

2. **2. Food, Nutrition and Health 1st Edition by Linda Tapsell, Oxford(ISBN: 978-0195518344)**

3. **3. Principles of Therapeutic Nutrition and Dietetics by Avantina Sharma. CBS Publishers and Distributors Pvt. Ltd.**

4. **4. Elia M et al (eds) : Clinical Nutrition, Wiley-Blackwell A John Wiley & Sons Ltd.**

5. Gibney MJ et al (eds) Introduction to human nutrition, Wiley-Blackwell A John Wiley & Sons Ltd, Nutritional Society, 2009.

Additional Resources:

1. **Advances in Food and Nutrition Research (ISSN: 10434526)**
2. **Comprehensive Reviews in Food Science and Food Safety (ISSN: 15414337)**
3. **Current Nutrition and Food Science (ISSN: 15734013)**
4. **Food Analytical Methods (ISSN: 19369751)**
5. **Food and Nutrition Research (ISSN: 16546628)**
6. **Journal of Nutrition and Health (ISSN: 22883886)**
7. **Journal of Nutrition, Health and Aging (ISSN: 12797707)**

Teaching Learning Process

1. **Lecture using powerpoint and chalk-blackboard method & RBPT**
2. **Use of IT-CT facility**
3. **Survey based short projects as assignments**
4. **Visit to Prominent Food and nutrition laboratories to learn about basic techniques**

Assessment Methods

1. **Quizzes, multiple choice questions, fill in the blanks and short answers**
2. **Student presentation**
3. **Take-home Assignments**
4. **End of term theory and Practical examination**

Keywords

Food, Nutrition, Health, Management of Health, Food Hygiene, Control of Food pest

Human Physiology
(32235907)
Generic Elective - (GE) Credit:6

Course Objective(2-3)

Introducing students to the principles of normal biological function in human body. To outline basic human physiology and correlate with histological structures. To introduce how animals maintain an internal homeostatic state in response to changes in their external environment. To inculcate further hands-on practical skills useful in routine life. To promote students for subsequent biological courses that requires an understanding of the physiology of organisms.

Course Learning Outcomes

Students would be able to identify the histological features and explain the physiological functions of human body.
Students would be able to make a connection between understanding of physiology and healthy lifestyle decisions.

Students would acquire hands-on skill of important laboratory procedures used to examine and assess some basic physiological functions. Students would demonstrate information skills to evaluate, and use resources to stay updated in the field of recent physiological advances.

Unit 1

Digestion and Absorption of Food 12 hrs Structure and function of digestive gland system; Digestion and absorption of carbohydrates, fats and proteins; Nervous and hormonal control of digestion (in brief)

Unit 2

Functioning of Excitable Tissue (Nerve and Muscle) 10 hrs Histology of nervous tissue; Propagation of nerve impulse (myelinated and non- myelinated nerve fibre); Structure of skeletal muscle; Mechanism of muscle contraction (Sliding filament theory); Neuromuscular Junction.

Unit 3

Respiratory Physiology 8 hrs Structure and function of Respiratory tract and Lungs; Ventilation, External and internal Respiration; Transport of oxygen and carbon dioxide in blood; Factors affecting transport of gases.

Unit 4

Renal Physiology 8 hrs Functional anatomy of kidney; Mechanism and regulation of urine formation.

Unit 5

Cardiovascular System 8 hrs Structure of heart; Coordination of heartbeat; Cardiac cycle and ECG

Unit 6

Endocrine and Reproductive Physiology 14 hrs Structure and function of endocrine glands and related disorders (pituitary, thyroid, parathyroid, pancreas, adrenal, ovaries, and testes); Brief account of spermatogenesis and oogenesis; Menstrual cycle

Practical

Preparation of temporary mounts: Neurons and Blood film. Preparation of Haemin and Haemochromogen crystals. Estimation Demonstration of haemoglobin estimation using Sahli's haemoglobinometer. Examination of permanent histological sections of mammalian oesophagus, stomach, duodenum, rectum, lung, kidney, thyroid, pancreas, adrenal, testis, ovary. Determination of ABO Blood group. Recording of Blood Pressure by using a Sphygmomanometer in resting condition.

References

Widmaier E, Raff H and Strang K. (2013) Vander's Human Physiology: The Mechanism of Body Functions. McGraw-hill Education 13th Edition. Tortora, G.J. and Derrickson, B.H. (2009). Principles of Anatomy and Physiology, XII Edition, John Wiley and Sons, Inc.
Additional Resources: Additional Resources: · Guyton, A.C. and Hall, J.E. (2011). Textbook of Medical Physiology, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company. · Kesar, S. and Vashisht, N. (2007). Experimental Physiology, Heritage Publishers. · Prakash, G. (2012). Lab Manual on Blood Analysis and Medical Diagnostics, S. Chand and Company Ltd.

Teaching Learning Process

Interactive learning using chalk and board, powerpoint presentations, group discussions, audio visual aids, etc.

Assessment Methods

Diagnostic assessment – to check the knowledge base. It is desired as being a generic elective paper students would come from diverse streams ((science, commerce and arts). Formative assessment - written test/viva voce to check the retention of the topic. At the end summative assessment could be done and students are rewarded on the basis of; Presentations Test Project reports Theory & practical examination

Keywords

Physiology, Histology, Function, Anatomy, Physiological pathways, control and coordination.

Insect Vector and Disease (32235908) Generic Elective - (GE) Credit:6

Course Objective(2-3)

Course Objective:

Insect vectors cause many diseases which lead to millions of deaths across the world every year especially in developing countries. The rate of pathogen transmission by insects is increasing at an alarming rate posing a growing threat to the human population. Disease transmission by these insects can be prevented only by studying their biology, modes of transmission of pathogens by them, evaluation of associated risk factors, devise effective methods to control these insects and resolve the challenges posed.

Course Learning Outcomes

Course Learning Outcome:

After completing this Course, the students will be able to:

- **identify different insects and classify them based on their morphology and behavior;**
- **describe the host-pathogen relationships and the role of the host reservoir on transmission of parasite;**
- **explain various modes of transmission of parasite by Insect vectors;**
- **recognize various possible modern tools and methodologies for laboratory diagnosis, surveillance and treatment of diseases;**
- **define various terms related to insect transmitted diseases such as vectorial capacity, mechanical and biological transmission, host specificity etc.;**
- **identify the risk groups and characterize them on the basis of exposure risk;**
- **explain control methods of insect vector diseases including preventing their spread, spreading awareness on public health programs and mitigating insect borne diseases;**
- **employ the use of advanced management strategies in disease control with respect to parasite evolution.**

Unit 1

Unit:1	**Introduction to Insects**	**10-hrs**
General Features of Insects, Classification of insects up to Orders - key identification features; Morphological features: Head – Eyes, Types of antennae, Types of Mouth parts w.r.t. feeding habits: siphoning type (butterfly), sponging type (housefly), biting and chewing type (cockroach), piercing and sucking type (mosquito), chewing and lapping type (honey bee); thorax: types of legs.		

Unit 2

Unit:2	**Concept of Vectors**	**4-hrs**
Brief introduction to Carriers and Vectors (mechanical and biological vector); Insect reservoirs; Host-vector relationship; Vectorial capacity; Adaptations in insects to act as vectors; Host Specificity; Modes of disease transmission - vertical and horizontal transmission.		

Unit 3

Unit: 3	**Insects as Vectors**	**10-hrs**
~~Classification of insects up to Orders~~, Features of Orders with insects as vectors (Diptera, Siphonaptera, Siphunculata, Hemiptera) wrt evolutionary, anatomical, physiological, cellular and molecular adaptations towards their role as vectors; Management strategies to control insect vectors – Quarantine, Cultural, Mechanical, chemical, Biological, Behavioral.		

Unit 4

Unit:4	Dipterans as disease vectors	20-hrs

Dipterans as important insect vectors – Mosquitoes, Sand flies, Houseflies;

Study of mosquito borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; control of mosquitoes;

Study of sand-fly borne diseases – Leishmaniasis, phlebotomus fever; Control of sand flies.

Study of house fly as important mechanical vector; Myiasis; Control of house-fly.

Unit 5

Unit: 5	Siphonapterans as disease vectors	5-hrs

Fleas as insect vectors; Host-specificity; Study of flea borne diseases – Plague, typhus fever; Control of sand flies.

Unit 6

Unit:6	Siphunculata as disease vectors	6-hrs

Human louse (head, body and pubic louse) as disease vectors; study of louse borne diseases – Typhus fever, relapsing fever, trench fever, vagabond's disease, phthiriasis; control of human louse.

Unit:7	Hemipterans as disease vectors	5-hrs

Bugs as insect vectors; Blood sucking bugs; Chagas disease; Bed bugs as mechanical vectors; Control and prevention methods.

Practical

Practicals

[Credits: 2]

1. Study of different kinds of mouth parts of insects slides/specimens

2. Study of insect vectors through permanent slides or photographs: *Aedes, Culex, Anopheles, lice (head, body, pubic), bed bug, Phlebotomas* (sand fly), *Musca domestica* (house fly)

3. Study of different diseases transmitted by above insect vectors Project report on any one disease transmitted by insect vector

References

Recommended:

1. Service, M.W. 1980. A Guide to Medical Entomology, Macmillan Press.

2. Ricard P. Lane & Roger W. Crosskey 1993. Medical insects and Arachnids. Springer Science and Business Media, B. V.

3. Burgess, N.R.H and Cowan, G.O. 1993. A colour atlas of medical entomology. Springer Science and Business Media, B. V.

Additional Resources:

Suggested reading:

1. Kenneth G. V. Smith. 1973. Insects and other Arthropods of Medical Importance. John Wiley and Sons.

2. Nicholas R. H. Burgess. 1981. Arthropods of Medical importance, Published by Noble Books Ltd. Hampshire

Teaching Learning Process

Teaching and learning Process:

1. Classroom teaching using Power point presentations enabled with related photographs of insect vectors, their life stages and disease diagnosis.

2. Case studies of epidemics caused by insects as vectors.

3. Visit to local diagnostic centre to have an overview of various medical tests conducted to detect and confirm vector transmitted diseases.

Assessment Methods

Assessment methods:

- **Continuous and Comprehensive Formative assessment (attendance+ assignment+ test): 25 marks**
- **Summative Assessment**

Term end theory exam: 75 marks

Term end practical exam (no. of practicals attended+ project + exam+ record book): 50 marks

Keywords

Keywords: Insect, Vector, Diseases, Mosquito, host, parasite

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