Introduction

Content: The learning outcomes-based curriculum framework for a B. Sc (Honours) degree in Biological Science is intended to provide a broad framework within which Biological Science programme that responds to the needs of students and to the evolving nature of Biological Science as a subject could be developed. The framework is expected to assist in the maintenance of the standard of Biological Science programme across the country and to facilitate a periodic programme review within a broad framework of agreed expected graduate attributes, qualification descriptors, programme learning outcomes and course-level learning outcomes. The framework, however, does not seek to bring about uniformity in syllabi for a programme of study in Biological Science or in teaching-learning process and learning assessment procedures. Instead, the framework is intended to allow for flexibility and innovation in programme design and syllabi development, teaching-learning process, assessment of student learning levels.
The undergraduate level education in basic science as well as in applied science has to be broad based. Well established disciplines like Physics, Chemistry, Mathematics, Botany, Zoology, Geology and many others have long developed interfaces with each other so much that areas like Chemical Physics, Biochemistry, Biophysics, Mathematical Biology or Geophysics have themselves emerged as major disciplines. Conceptualization in each of the above fundamental disciplines has made much of the information gathered meaningful. Mechanisms underlying many biological phenomena have been discovered. These mechanisms have been shown to transcend the boundaries between plant kingdom, animal kingdom and the microbial world. As a matter of fact the new knowledge in Biology essentially deals with developmental, genetic, environmental and molecular aspects.
The Biological Science programme at the undergraduate level has been envisioned in order to emphasize the importance of inter-disciplinary nature underlying study of all the aspects of structure and function of living organisms.
The Biological Science programme at the undergraduate level has been envisioned in order to emphasize the importance of inter-disciplinary nature underlying study of all the aspects of structure and function of living organisms.
The programme has been formulated and developed with the following ideas and features:
• It tries to integrate the quantum of information from the interface areas of related science
• It brings various biology related areas under a single umbrella of Biological Science
• It provides a balanced emphasis to courses like Biodiversity, Light and Life, Proteins and Enzymes, Cell Biology, Ecology, Systems
Physiology, Molecular biology, Metabolism, Growth and Reproduction, Genetics, Defense Mechanisms and Evolutionary Biology
• It tries to remove in effect, artificial barriers among the existing sub-disciplines of Biology like Botany and Zoology
• It emphasizes the importance of living processes and phenomena rather than individual life forms

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Learning Outcome based approach to Curriculum Planning

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

Content: Nature and extent of the B. Sc (Hons) Biological Science degree programme
Biological Science is an inter-disciplinary science that aims to study the structure and function of different constituent parts/biomolecules of living organisms and their complex inter relationships to maintain and perpetuate various life forms. The scope of Biological Science as an interdisciplinary subject is very broad. The key areas of study within the disciplinary/subject area of Biological Science comprise: Biodiversity, Light and Life, Proteins and Enzymes, Cell Biology, Ecology, Systems physiology, Molecular biology, Metabolism, Growth and Reproduction, Genetics, Defense mechanisms and Evolutionary Biology. The Honours degree programme in Biological Science includes core courses in Chemistry and Biophysics so as to provide a strong fundamental background for studying the complex nature of biological interactions and regulatory framework operating in a cell.
As a part of the efforts to motivate the students of Biological Science programme to pursue research, the curricula for the programme are designed to incorporate learning experiences that offer opportunities for in depth study and hands-on laboratory experience.

Learning Outcome based approach to Curriculum Planning

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

Content: Aims of the bachelor's degree programme in Biological Science
The overall aims of an Honours degree programme in Biological Science are to:
• Provide students with learning experiences that help instill deep interests in learning Biological Science; to develop an understanding of the complex nature of biomolecules, tissues and organs and their inter-relationship and inter-dependence.
• Develop in students the ability to apply the knowledge and skills they have acquired to develop solutions for various applications in medicine like developing vaccines, drugs etc.
• Provide students with the knowledge and skill base that would enable them to undertake further studies in Biological Science and related areas or in multidisciplinary areas that involve Biological Science and help develop a range of generic skills that are relevant to pursue research, self-employment and entrepreneurship.

Graduate Attributes in Subject

>> Disciplinary knowledge

Content: Capable of demonstrating (i) comprehensive knowledge and understanding of major concepts, principles and experimental findings in Biological Science and other related fields of study, including broader interdisciplinary areas such as Microbiology, Biotechnology, Plant sciences, Evolutionary Biology, Ecology and Environmental sciences (ii) ability to use modern instrumentation/techniques for separation, purification and identification of biologically important molecules.

Graduate Attributes in Subject

>> Communication Skills

Content: Ability to convey complex technical information relating to Biological Science in a clear and concise manner both in writing as well as orally.

Graduate Attributes in Subject

>> Critical thinking

Content: Ability to employ critical thinking and efficient problem solving skills in different areas related to Biological Science like Protein and Nucleic Acid Chemistry, Cell Biology, Molecular Biology, Genetics, Microbiology, Animal Behavior, Plant Physiology and Evolutionary Biology.

Graduate Attributes in Subject

>> Cooperation/Team work

Content: Capable of working effectively in diverse teams in both classroom, laboratory as well as in field-based situations.

Graduate Attributes in Subject

>> Reflective thinking

Content: Capability for raising relevant questions relating to basic understanding and applications in the field of Biological Science and planning, executing and reporting the results of an experiment or investigation.

Graduate Attributes in Subject

>> Information/digital literacy

Content: Capable of using computers for simulation and computational work and appropriate software for analysis of data, and employing modern library search tools to locate, retrieve, and evaluate biology-related information.

Graduate Attributes in Subject

>> Moral and ethical awareness/reasoning

Content: Avoiding unethical behavior such as fabrication, falsification or misrepresentation of data or committing plagiarism, and sensitive towards environmental and sustainability issues.

Graduate Attributes in Subject

>> Leadership readiness/qualities

Content: Capable of identifying and mobilizing appropriate resources required for a project, and manage a project through to completion, while observing responsible and ethical scientific conduct.

Graduate Attributes in Subject

>> Lifelong learning

Content: Capable of making conscious efforts to achieve self-paced and self-directed learning aimed at personal development and for improving knowledge and developing skill.

Qualification Description

Content: The qualification descriptors for a B. Sc (Honours) programme in Biological Science includes the following:

• Demonstrate (i) a systematic, extensive and coherent knowledge and understanding of the academic field of study as a whole and its applications, and links to related disciplinary areas/subjects of study; including a critical understanding of the established theories, principles and concepts, and of a number of advanced and emerging issues in the field of Biological Science; (ii) procedural knowledge that creates different types of professionals related to the subject area of Biological Science, including research and development, teaching and government and public service; (iii) skills in areas related to one's specialization area and current developments in the academic field of Biological Science, including a critical understanding of the latest developments in the area of specialization, and an ability to use established techniques of analysis and enquiry within the area of specialization.

• Demonstrate comprehensive knowledge about materials, including current research, scholarly and professional literature, relating to essential and advanced learning areas pertaining to Biological Science, and techniques and skills required for identifying Biological Science-related problems and issues.

• Demonstrate skills in identifying information needs, collection of relevant quantitative and qualitative data drawing on a wide range of sources, analysis and interpretation of data using methodologies as appropriate to the subject of Biological Science for formulating evidence-based solutions and arguments.

• Use knowledge, understanding and skills for critical assessment of a wide range of ideas and complex problems and issues relating to the academic field of Biological Science.

• Communicate the results of studies undertaken in the academic field of Biological Science accurately in a range of different contexts using the main concepts, constructs and techniques of the subject of Biological Science.

• Address one's own learning needs relating to current and emerging areas of study relating to Biological Science, making use of research, development and professional materials as appropriate, including those related to new frontiers of knowledge in Biological Science.

• Apply one's knowledge and understandings relating to Biological Science and transferable skills to new/unfamiliar contexts and to identify and analyze problems and issues and seek solutions to real-life problems.

• Demonstrate subject-related and transferable skills that are relevant to some of the Biological Science-related jobs and employment opportunities.

Programme Learning Outcome in course

Content: • Demonstrate (i) in-depth knowledge and understanding about the fundamental concepts, principles and processes underlying Biological Science and its different subfields (Biodiversity, Light and Life, Proteins and Enzymes, Cell Biology, Ecology, Systems physiology, Molecular biology, Metabolism, Growth and Reproduction, Genetics, Defense mechanisms and Evolutionary Biology), and its linkages with related disciplinary areas/subjects (ii) the procedural knowledge that creates different types of professionals in the field of Biological Science and related fields such as Plant physiology, Animal Behaviour, Natural Resource Management, Microbiology, Biotechnology, Nutritional Biochemistry and in teaching, research and environmental monitoring, etc; (iii) practical skills related to specialization area(s) within Biological Science as well in other related fields of study, including broader interdisciplinary areas (life science, environmental science and material sciences)
• Demonstrate skills relating to detection and identification of clinically important biomolecules like proteins, nucleic acids, enzymes.
• Use skills required for the extraction, separation, and synthesis of a variety of biomolecules utilized in clinical diagnosis, pharmaceutical industry or in research laboratories.
• Use various bioinformatics tools for training in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.
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• Undertake hands on laboratory work and activities that help develop in students practical knowledge and skills, that are required for pursuing career in clinical diagnosis, drug design, vaccine development, pharmaceutical industry, teaching, research, environmental monitoring etc. and skills for working safely and competently in the laboratory.
• Recognize and appreciate the importance of the Biological Science and its application in academics, clinical diagnosis, prevention and treatment of diseases, agriculture, and industry and in the economic, environmental and social contexts.

Teaching-Learning Process

Content: As the programme of study in Biological Science is designed to encourage the acquisition of disciplinary/subject knowledge, understanding and skills and academic and professional skills required for biology-based professions and jobs, learning experiences should be designed and implemented to foster active/participative learning. Development of practical skills will constitute an important aspect of the teaching-learning process. A variety of approaches to teaching-learning process, including lectures, seminars, tutorials, workshops, peer teaching and learning, practicum and project-based learning, field-based learning, substantial laboratory-based practical component and experiments, open-ended project work, technology-enabled learning, internship in industry and research establishments etc. will need to be adopted to achieve this. Problem-solving skills and higher-order skills of reasoning and analysis will be encouraged through teaching strategies.

Assessment Methods

Content: The assessment of student's achievement in Biological Science will be aligned with the course/programme learning outcomes and the academic and professional skills that the programme is designed to develop. A variety of assessment methods that are appropriate within the disciplinary area of Biological Science will be used. Learning outcomes will be assessed using the following: oral and written examinations, closed-book and open-book tests; problem-solving exercises, 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, portfolios on bio-chemical activities undertaken etc.

Biodiversity
(BS C4)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. Aim of the course/paper: The Core course on Biodiversity is designed to acquaint students with variations and variability in the living world. The paper will cover important aspects of biodiversity, it’s components and relevance of conservation. Emphasis will be on developing interest and invoking a sense of responsibility among students towards conservation of plant and animal biodiversity. The course also explores different techniques and tools used to study biodiversity, such as mapping of agroforestry and animal populations of rare and endangered species. This course will motivate students to pursue career in ecology and allied fields.

Course Learning Outcomes

1. To study and understand characteristic features of different plant and animal life forms.

2. To understand recent advances in technology used in mapping and conservation of biodiversity.

3. To understand the relevance of wild relatives of cultivated plants, their domestication and green revolution.

4. To know the relevance of bioremediation and role of indicator plants in combating threats to biodiversity.

Unit 1

Unit 1 Defining Biodiversity No. of Hours: 24

Components of Biodiversity, Biodiversity crisis and biodiversity loss, Importance of biodiversity in

daily life, Biodiversity vis-a-vis climate change. Types of Ecosystems: India as mega biodiversity nation; hot spots, endemism. Study of general characteristics of cryptogams (Oedogonium, Polysiphonia, Rhizopus, Albugo, Anthoceros, Funaria, Selaginella) and phanerogams (Pinus), Angiosperm systematics: Outline of Bentham and Hooker classification

Introduction to animal diversity, Whittakers five kingdom classification, Systematic classification and general features of chordates and non chordates (Kingdom protista, Phylum-Porifera, Cnidaria, Platyhelminthes, Aschelminthes, Annelida, Arthropoda, Mollusca, Echinodermata, Protochordata, Osteichthyes, Amphibia, Reptilia, Aves and Mammals.

Unit 2

Unit 2 Modern Tools in the study of Biodiversity No. of Hours: 12

Natural Resources from plants: Food Crops, beverages, timber, fibres. Endemism, endemic animals; Assessment of mapping of biodiversity; GIS/Remote sensing; Biotechnology and Conservation, IUCN; Germplasm banks, National Parks, Botanical Gardens; Wildlife Sanctuaries, Sacred fauna.

Unit 3

Unit 3 Crop Diversity No. of Hours: 12

Wild relatives of cultivated plants; Domesticated diversity-its advantages and disadvantages, Centres of origin of cultivated plants (Vavilov)

Green revolution, the origin of Triticum aestivum and Oryza sativa through domestication, Spice diversity

Forest diversity-Types of forests (classification by Champion and Seth (1968), Agroforestry

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Unit 4

Unit 4 Bio-prospecting No. of Hours: 12

Phytoremediation: Plants as indicators and remediators of air, water and soil pollution (heavy metals, oil spills). Bioremediation, Bio mass utilization, Bioethics

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Practical

TOTAL HOURS: 60 CREDITS: 4

FAUNA

1. Study of following specimens: Euglena, Paramecium, Sycon, , Tubipora,Taenia, Ascaris Aphrodite, Leech, Peripatus, Limulus, Hermitcrab, Beetle, Pila, Chiton, Dentalium, Octopus, Asterias
2. Dissections/ Virtual demonstration: Digestive and nervous system of Cockroach; Unstained mount of Placoid scales.

3. Study of following specimens: Balanoglossus, Amphioxus, Petromyzon, Pristis, Hippocampus, Labeo, Icthyophis/Uraeotyphlus, Salamander,,Draco,Naja,any three common birds, Bat.

4. Study of a few endangered species of amphibians, reptiles, birds and mammals of India

5. To study faunal composition of water samples (Lucky drop method)

6. Report on: Biodiversity park/reserve/ NBPGR (Botany + Zoology)

FLORA

8. Study through specimens/photographs of

a) Food crops: Wheat, rice

b) Fibres: Cotton, jute

c) Timber: Teak, shisham

d) Oils: Mustard and soybean

9. Algae: Study of vegetative and reproductive structures of the following genera:

Chlamydomonas (Electron microphotograph)

Oedogonium (Temporary preparations of vegetative and reproductive features) a) Holdfast b) cap cells c) chloroplast d) oogonia e) macarandous antheridia f) nannandria (permanent slide); Vaucheria: Temporary preparation of vegetative and reproductive structure a) thallus b) antheridia and oogonia c) gongrosira stage (permanent slides)

Polysiphponia: Thallus showing heterotrichy b) cystocarp c) tetrasporophyte d) antheridia (permanent slide)

Fucus: specimen only

Fungi: Preparation of temporary mounts of asexual and sexual phases of the following:

Rhizopus: Sporangiospore and zygospores

Penicillium: condia and cleistothecia (permanent slides)

Albugo: conidia and oospores

Bryophytes: Preparation of temporary mounts of asexual and sexual phases of the following

Riccia: Thallus, sporogonia (temporary preparation), antheridia and archegonia (permanent slides)

Anthoceros: V.S. and whole mount of thallus, sporophyte (permanent slide)

Funaria: whole mount of leaf, rhizoids, gametophyte, operculum, peristome and annulus, L.S capsule (permanent slide)

Pteridophytes:

Psilotum: Morphology

Selaginella: Morphology, leaf, ligule, strobilus, microsporophyll and megasporophyll, T S stem, LS strobilus (permanent slides)

Pteris: Morphology, TS rachis, sporophyll, whole mount sporangia, spores, TS rhizome (permanent slides)

Gymnosperms:

Cycas: Morphology of coralloid root, leaf, male cone, bulbil, megasporophyll; TS coralloid root, TS rachis, TS microsporophyll, TS root, stem, LS ovule (permanent slides)

Pinus: Morphology of long and dwarf shoot, TS dwarf shoot, needle; TS young and mature stem; morphology of male cone, female cone (I, II and III year); LS male cone, LS female cone; whole mount pollen grain; LS ovule (permanent slides)

Lichens: Type study through specimens

10. Study of the characteristic features of any one flower from each family

(a). Malvaceae/ Fabaceae/Brassicaceae/Ranunculaceae (anytwo families),

(b) Asteraceae

(c) Euphorbiaceae

(d) Poaceae/Liliaceae (any one family)

References

SUGGESTED READINGS

1. Aber, J.D.and Melillo J.M., Terrestrial Ecosystems: 1991, W.B.Saunders

2. Ingrowille, M Diversity and Evolution of land plants 1992 chapman and Hall

3. Gordon Uno, Richard Storey,Randy Moore,Principles of Botany,2001, Mc Graw Hill higher education

4.Ingrowille, M. Diversity and evolution of land plants.1992 chapman and hall

5. Prithi Pal Singh 2010,An introduction to biodiversity. Ane Books Pvt. Ltd. New Delhi

6. Roland Ennos. And Elizabeth Sheffield Plant. Life.2000 Univ. Press, Cambridge, U.K

7. Edward O. Wilson (Editor) Biodiversity 1998 National Academic Press.

8. Sharma, P.D. Ecology and Environment 2014-Rastogi Publications, Meerut India

9.Kochar,S.L. A Economic Botany comprehensive study 2016. Cambridge Univ.Press.

10.Kochar,S.L Tropical Crops, a text book of Economic Botany (Macmillan International college edition) 1987

11. Gurcharan Singh. Plant Systematics: Theory and Practice. Oxford & IBH Publishing Co. Pvt. Ltd.

Additional Resources:

1.Barnes, R.D. (1982). Invertebrate Zoology, V Edition

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

3. Biology, 8th Edition Neil A. Campbell, University of California, Riverside Jane B. Reece, Berkeley, California,2008 Pearson

4. B.B. Hosetti and S. Ramkrishna Biodiversity: Concept and conservation (2011), Avishkar publishers

5.Glick, B.R. and Pasternak, J.J. (2009). Molecular Biotechnology - Principles and Applications of Recombinant DNA. IV Edition, ASM press, Washington, USA.

Teaching Learning Process

Teaching learning methods shall be:

1. Chalk and talk
2. Group discussions
3. Hands-on experiences
4. Through web based resources
5. Field visits

Assessment Methods

Students shall be evaluated on the basis of:

Class Tests
Assignments
Field reports

Keywords

Biodiversity, natural resources, bioprospecting, endemism

Biophysics
(BS C3)
Core Course - (CC) Credit:6

Course Objective(2-3)

1. This interdisciplinary course introduces the basic concepts of physics and their applications in biology for better understanding of various biological processes at cellular and molecular level.
2. Enable students in quantitative approaches to physical/biological problems.

Course Learning Outcomes

Will be able to apply scientific methodology to qualitatively and quantitatively analyze a wide variety of physical phenomena.

Unit 1

Unit 1: Mechanics No. of Hours: 08

Conservation of momentum and energy, work energy theorem, Angular momentum, Torque, motion of a particle in central force field.

Introduction to mechanical forces: mechanics of solids and fluids, viscous force, surface tension and viscoelasticity with examples.

Unit 2

Unit 2: Electrostatics No. of Hours: 08

Introduction to electrostatics: Concept of charge in Gauss's law; point charge, line charge and surface charge, Electric Potential and Field.

Dielectrics: Non polar/Polar dielectrics, Molecular theory of Dielectrics, Dielectric Constant, Gauss's Law in presence of dielectric, Three electric vectors and their relations, Electric susceptibility, Energy stored in dielectrics, Applications of dielectrics.

Unit 3

Unit 3: Waves and Oscillations No. of Hours: 14

Simple harmonic motion, Vector and the complex-exponential representations of SHM (examples of a Pendulum, spring-mass system and the electric system), damped and driven harmonic oscillator. Coupled oscillator: capacitative and inductive coupling.

Superposition principle and Superposition of waves: Young's double slit interference, Diffraction: diffraction through a single slit/double slit and grating, Resolving power, Resolution of the eye, Lasers: Principle, Population inversion, He-Ne Laser, characteristics of laser, Applications of lasers in medical science, Polarization of EM wave, Nicol prism. Doppler effect, Effects of vibrations in humans: physics of hearing, heartbeat.

Unit 4

Unit 4: Biomolecules No. of Hours: 6

Amino acids, Amino acid structure, Physical properties: pI of amino acids, amino acids as ampholytes, melting point, optical rotation, UV absorption. peptide bond, peptides and proteins. Nucleic acids, Purine & Pyrimidine bases, Watson-Crick model of DNA & its features, Types of DNA. Physical properties of DNA - Effect of heat on physical properties of DNA (Viscosity, buoyant density), Types of RNA.

Classification of carbohydrates (mono, oligo polysaccharides), Physical - isomerism D & L, optical; epimers : anomers. Classification of Lipids, Saturated fatty acids - classification of C2 to C20: even carbon: Common and IUPAC names. Unsaturated fatty acids MUFA, PUFA (2.3.4 double bonds), Omega - 3.6.9 fatty acids. Triacyl glycerol - simple and mixed - names and structure.

Unit 5

Unit 5: Biological membranes No. of Hours: 16

Colloidal solution, Micelles, bilayers, membrane models, liposomes, phase transitions of lipids, Membrane asymmetry, active, passive and facilitated transport of solutes and ions, Fick’s Laws, Nernst Planck Equations, Diffusion, Osmosis, Donnan effect, permeabilily coefficient. Ionophores, transport equation, membrane potential, action potential, neuronal synapse

Mechanobiology: Introduction to mechanobiology, Extracellular matrix, cytoskeleton, Durotaxis, mechanics of cell adhesion and migration, mechanotransduction.

Unit 6

Unit 6: Spectroscopic techniques No. of Hours: 8

Beer-Lambert law, light absorption and its transmittance. UV and visible and IR spectrophotometry-principles, instrumentation and applications. UV absorption of proteins and N.As - Hypochromism, hyperchromism, denaturation. fluorescence spectroscopy, static & dynamic quenching, fluorescent probes in the study of protein, nucleic acids. light scattering in biology, optical rotatory dispersion

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Practical

BS-C3: BIOPHYSICS (PRACTICALS)

TOTAL HOURS: 60 CREDIT: 2

1. Determination of acceleration due to gravity using Kater’s pendulum.
2. Determination of the acceleration due to gravity using bar pendulum.
3. Study of Lissajous figures using CRO.
4. Determination of the frequency of an electrically maintained tuning fork by Melde’s Experiment.

5. Determination of the wavelength of laser source by through diffraction of (1) Single slit (2) Double slit.

6. Comparison of capacitances using De'Sautty's bridge.

7. Determination of the coefficient of Viscosity of water by capillary flow method (Poiseuille's method).

8. Verification of Beer Law

9. Determination of Molar Extinction coefficient

10. Qualitative analysis of proteins and Nucleic acids using spectrophotometer.

11. Determination of CMC for a detergent.

References

1.An introduction to Mechanics, D. Kleppner, R. J. Kolenkow, 1973, McGraw Hill.

2. Introduction to Electrodynamics, D.J. Griffiths, 3rd (Ed)., 1998, Benjamin Cummings.

3. N. Subrahmanyam, Brij Lal and M.N. Avadhanulu, A Textbook of Optics, 25th Revised Ed., S Chand, 2016.

4. N. K. Bajaj, The Physics of Waves and Oscillations, Tata McGraw Hill.

5. Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008.

6. David Freifelder, Physical Biochemistry: Applications to Biochemistry and Molecular Bioogy, 2nd Ed., W.H. freeman and Company, 1982.

7. Hoppe et. al., Biophysics, Translation of 2nd German Ed., Springer (Verlag), 1983.

8. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, 6th Ed., Cambridge University Press, 2005.

9. Introduction to cell mechanics and Mechanobiology, Christopher. R. Jacobs (Garland Science).

10. Cellular and biomolecular mechanics and mechanobiology, Editors: Gefen, Amit (Springer)

Additional Resources:

1. Advanced Practical Physics for students, B. L. Flint and H. T. Worsnop.

Teaching Learning Process

Chalk and Talk/Board Teaching

Power-point and video Presentations

More practical approach to understand concepts clear.

Lab Visits and Educational Trips

Assessment Methods

Mid-semester and End-semester examinations

Periodic Class Tests

Individual Assignments and discussion

Group Presentations and discussions

Practical Records

Keywords

Mechanics, Electrostatics, Optics and waves, Biomolecules, Biological membranes, Mechanobiology, Spectroscopy, Proteins.

Cell Biology
(BS C6)
Core Course - (CC) Credit:6

Course Objective(2-3)

The objective of the course is to introduce to the students, the basic concepts and processes in cell biology. The emphasis will be on understanding of structure and function of cell organelles, how they communicate with each other, how cell division and regulation occurs in somatic and in germ cells. The practical content of this course is designed to understand the cellular diversity, cell measurement, cell division, different staining procedures and tonicity through different laboratory excercises.

Course Learning Outcomes

1. Students will be able to understand cell and its biology, which will help the to get insight into the origins of cells, cell diversity, cellular structure, survival and function.

2. Students will learn the basic difference between prokaryotic and eukaryotic cells, various components of membranes and organelles, how cells obtain energy, synthesize new molecules,

proliferate and communicate.

3. Students will acquire knowledge about how cells divide by means of meiosis and mitosis and will be able to correlate different factors which control cell cycle progression.

4. They will learn the significance and the role of receptors and ligands in cell signalling.

Unit 1

An Overview of Cells, Cell Wall and Cell Membrane No. of Hours: 12

History of cell biology, cell theory, overview of prokartyotic and eukaryotic cells, plant and animal cells, phages, virioids, mycoplasmas, prions. Cell wall, distribution, chemical composition, functions and variations in prokaryotic and eukaryotic cells (primary and secondary wall). Structure and functions of membrane, models of membrane structure, transport across membranes (with examples): simple diffusion, facilitated diffusion, active transport (Na+/K+ pumps, sodium/glucose symport, proton pumps) and passive transport. Phagocytosis, pinocytosis, exocytosis.

Unit 2

Mitochondria, Chloroplast and Nucleus No. of Hours:12

Structural organization and function of mitochondria, chloroplast and nucleus, (electron transport chain and oxidative phosphorylation), marker enzymes, biogenesis of mitochondria and chloroplasts, transport in mitochondria and chloroplasts (Tim/Tom; Tic/Toc) and semi-autonomous nature of mitochondria and chloroplast. Nuclear envelope, structure of nuclear pore complex, nuclear lamina, transport across nuclear membrane. Glyoxysomes function.

Unit 3

Cytoskeleton system, Cellular Movement, Extra Cellular Matrix and Cell interactions No. of Hours: 10

Structure and organization of microfilaments, intermediate filaments, microtubules, their functions, role of motor proteins (Kinesin, Dynein, myosin) in cellular movement, cilia and flagella. Extracellular matrix: composition and function (collagens, elastins, adhesive glycoproteins, fibronectins, integrins). Glycocalyx, cell-cell junctions, adhesive junctions, gap junctions and tight junctions.

Unit 4

Endomembrane system and peroxisomes No. of Hours:

10

Structure and functions of endoplasmic reticulum and Golgi apparatus, protein trafficking, coated vesicles in cellular transport processes, GERL. Structure, polymorphic form and functions of lysosomes. Structure and function of peroxisomes.

Unit 5

Signal transduction mechanism No. of Hours: 6

Signaling molecules and their receptors, functions, brief introduction of the six types of signaling pathways, intracellular signal transduction pathways, GPCR , protein kinase associated receptors

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Unit 6

Cell cycle and regulation, programmed cell death and cancer No. of Hours: 10

Overview of cell cycle. Regulation: Various check points and the role of cyclins and Cdks. Overview of mitosis and meiosis. Programmed Cell Death. Biology and elementary knowledge of development and causes of cancer. Salient features of transformed cells. Tumor viruses, oncogenes and suppressor genes.

Practical

1. Estimation of cell size by micrometry.

2. To study plasmolysis and deplasmolysis in cell.

3. To identify Gram positive and Gram negative bacteria by Gram staining.

4. Preparation of temporary slides of the following (any two):

a) Cytochemical staining of polysaccharides by PAS

b) Cytochemical staining of proteins by Bromophenol blue

c) Cytochemical staining of mitochondria by Janus Green B.

5. Study of ultastructure of cell (Plasma membrane, Nucleus, Nuclear Pore Complex, Chloroplast, Mitochondrion, Golgi bodies, Lysosomes)

6. Study of different stages of mitosis by temporary preparation/ permanent slides of onion root tips.

7. Study of different stages of meiosis by temporary preparation /permanent slides .

References

1. Cell and Molecular Biology: Concepts and Experiments, Karp, G. 6th Ed., John Wiley & Sons. Inc.2010

2. The Cell: A Molecular Approach, G.M. Cooper & R.E. Hausman. 5th Ed., Sinnauer Associates Inc. 2009

3. The World of the Cell, W.M. Becker, L.J. Kleinsmith and G.P. Bertni. 7th Ed. Pearson Benjamin Cummings Publishing, San Fransisco ,2009

Additional Resources:

1. Cell and Molecular Biology, EDP De Robertis, and RE De Robertis. 8th Ed., Lippincott Williams and Wilkins, Philadelphia. 2009

2. Nelson, D.L. and Cox, M.M, Lehninger: Principles of Biochemistry,. 6th Ed., W.H. Freeman & Company (New York) ,2013.

Teaching Learning Process

Lectures are delivered to students using traditional chalk and board method as well as LCD projection. Virtual learning environment will be introduced as learning resources (presentations, video and quiz) to enhance and support the lecture-based units. Lectures are organized in order to introduce undergraduate students to the recent research. To enhance understanding, group discussions, paper presentations and other online modules are be employed. Practicals are designed in such a way so as to develop laboratory and data analysis skills.

Assessment Methods

Student learning outcomes cannot be assessed by a single evaluation criteria. A combination of direct and indirect assessments should be used. Direct methods of assessment involves students to demonstrate their learning while indirect methods requires students to reflect on understanding.

- Regular attendance contributes to internal assessment
- Observations (information collected during group work, study sessions etc
- Tests, essays, presentations, etc. are generally direct methods of assessment
- Indirect methods include surveys and external review through viva voce interviews.
- Continuous assessment will utilize existing student course work (Portfolio) as both a grading instrument as well as data for assessing student learning outcomes. This portfolio may contain assignments, reports, class tests, case studies, presentations and practical file record.
- Internally developed class tests, quizzes etc
- End Semester Examination

Keywords

Cell Structure,Cell Cycle, Organelles, Cellular Movement, Signal Transduction, Cancer

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Chemistry
(BS C1)
Core Course - (CC) Credit:6

Course Objective(2-3)

The objective of this paper is to develop basic understanding of the structures, bonding, stability, stereochemistry and reactivity of organic molecules with focus on biomolecular reactions. The course will cover thermodynamic studies with the calculation of energies and interaction of biomolecules with their neighbouring environment. This basic knowledge will empower the students to develop basic understanding about chemistry of biomolecules, such as proteins, nucleic acids, carbohydrates and lipids.

Course Learning Outcomes

- Students will learn to know and apply the basic fundamental principles of chemistry which include- bonding, electronic effects, molecular forces and reactive intermediates to biomolecules.
- The students will gain insight into the influence of chemical bond polarisation on a molecular structure and its reactivity.
- Students will be able to identify the type of metabolic reaction and draw reaction mechanisms for key metabolic processes.
- Students will learn to recognize stereochemistry of a biomolecule and give a rational

explanation of its biological reactivity based on stereochemistry.
- The students will gain insight into thermodynamics and basic principles of thermochemistry and successfully extend the concepts learnt in this course on biological systems.

Unit 1

Unit 1 Chemical Bonding and Introduction to Nanomaterials No. of Hours: 15

Lattice energy and solvation energy. Born-Haber cycle and its applications, polarizing power and polarizability, Fajan's rules, ionic character in covalent compounds, Covalent Bonding: VB Approach, Lewis theory, VSEPR theory to explain the shapes of molecules, salient features of the Valence bond (VB) theory and the concept of hybridization, MO Approach: limitations of the VB approach, salient features of the MO theory. Rules for the LCAO method, MO treatment of homonuclear diatomic molecules such as O_2 and heteronuclear diatomic molecules such as CO. An overview of nanomaterials and classification, Bioinorganic nanomaterials, DNA & nanomaterials, natural and artificial nanomaterials, bionanocomposites.

Unit 2

Unit 2 Chemical Thermodynamics No. of Hours: 15

Qualitative idea of thermodynamics. First Law of Thermodynamics: Calculation of work (w), heat (q), changes in internal energy (E) and enthalpy (H) for expansion or compression of ideal gases under isothermal and adiabatic conditions for both reversible and irreversible processes. Calculation of w, q, E, and H for processes involving changes in physical states. Important principles and definitions of thermochemistry. Concept of standard state and standard enthalpies of formation, integral and differential enthalpies of solution and dilution. Calculation of bond energy, bond dissociation energy and resonance energy from thermochemical data. Variation of enthalpy of a reaction with temperature Kirchhoff's equation. Second law of thermodynamics, concept of entropy, Gibbs free energy and Helmoltz free energy. Calculations of entropy change and free energy change for reversible and irreversible processes under isothermal and adiabatic conditions. Criteria of spontaneity, Gibbs Helmholtz equation. Maxwell's relations. Statements of Third Law of thermodynamics: calculation of absolute entropies of substances.

Unit 3

Unit 3 Fundamentals of Organic Chemistry No. of Hours: 18

Electronic effects and their application- Inductive, resonance and Hyperconjugation. Structure and relative stability of reactive carbon intermediates-carbocations, carbanions and free radicals. intramolecular and intermolecular molecular Forces including hydrophobic, hydrophilic interactions and Hydrogen bond and their effect on stability of biomolecules. Criterion for aromaticity-

carbocyclic and heterocyclic compounds- furan, pyrrole, thiophene and Indole and imidazole. Reaction mechanism-Nucleophilic substitution and addition reaction with mechanism, Electrophilic addition to C=C systems example X_2, HX and water. Functional group approach for the following reactions to be studied with mechanism in context to their structure- Alcohols- esterification, ethers- Cleavage of C-O bond with HI, aldehydes and ketones- Nucleophilic addition and Nucleophilic addition–elimination reactions including, ammonia derivatives, Aldol condensation, carboxylic acids and acid derivatives-acidity and reactivity towards nucleophiles including solvolysis reactions. Amines-basicity and acetylation.

Unit 4

Unit 4 Stereochemistry No. of Hours: 12

Stereochemistry and its importance to biologists. Geometrical isomerism, cis-trans and E/Z nomenclature. Optical isomerism–optical activity, chirality, specific molar rotation, Stereoisomerism with two chiral centers: Enantiomers, Diastereomers, mesoisomers. Erythro and threo designation. Resolution of racemic modification. Fischer, Newman and Sawhorse projections. Relative Configuration: D/L designation. Absolute Configuration: R/S, designation of chiral centres, Conformational isomerism – ethane, butane, ethylene glycol and cyclohexane, diagrams and relative stability of conformers.

Practical

BS-C1: CHEMISTRY (PRACTICALS)

TOTAL HOURS: 60 CREDIT: 2

1. Estimation of sodium carbonate and sodium hydrogen carbonate present in a mixture

2. Estimation of Mohr’s salt by titrating it with KMnO4.

3. Synthesis and characterization of silver nanoparticles using UV-Visible spectrophotometer.

4. Determination of enthalpy of neutralization of hydrochloric acid with sodium hydroxide.

5. Determination of basicity of a diprotic acid by the thermochemical method in terms of the changes of temperatures observed in the graph of temperature versus time for different additions of a base. Also calculate the enthalpy of neutralization of the first step.

6. Determination of integral enthalpy (endothermic and exothermic) solution of salts.

7. Determination of melting and boiling points of organic compounds.

8. Mechanochemical solvent free synthesis of azomethine.

9. Acetylation of amines using green approach

10. Qualitative functional group tests for alcohols, aldehydes, ketones, carboxylic acids, esters, amines and amides.

Skill based experiment:

Polarimetry and stereochemistry: Study the optical rotation of Vitamin C as a function of pH

Linthorst Johan A.123Johanna vander Wal-Veuger2

https://doi.org/10.1016/S0187-893X(14)70536-1

References

Theory

1. J.D.Lee: A New Concise Inorganic Chemistry, E.L.B.S.

2. A Textbook of Physical Chemistry, Thermodynamics and Chemical Equilibrium ,Vol. 2, 5th Edition, McGraw-Hill Education.

3. An Introduction to Chemical Thermodynamics, 6th Edition (Rastogi R. P., R. R. Mishra), Vikas Publication.

3. Organic Chemistry, R.T. Morrison & R.N. Boyd. 6th Edition, Prentice Hall, 1992

4. Inorganic Chemistry: Principles of Structure and Reactivity, J. E. Huheey, E.A. Keiter & R. L. Keiter. 4th Ed., Dorling Kindersley Pvt. Ltd.,2008

5. Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

6.Atkins,Peter,Overton,Tina,Rourke,Jonanthan,Weller ,Mark and Armstrong,Faser. Shriver and Atkins ,Inorganic Chemistry,5th Edition,Oxford University Press,2011-12

Practicals

1. Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)

2. Ahluwalia, V. K., Dhingra, Sunita, Gulati Adarsh, College Practical Chemistry, University Press (India) Private Limited (2005)

3. Khosla, B. D.; Garg, V. C. & Gulati, A., Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).

4. Practical Inorganic Chemistry by Shikha Gulati, J L Sharma,Shagun Minocha, CBS publishers and distributors Pvt. Ltd.,2017.

Additional Resources:

A Guidebook to Mechanism in Organic Chemistry by Peter Sykes, (Sixth Edition) ,

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Teaching Learning Process

The teaching learning process will involve the traditional chalk and black board method.

Certain topics like enantiomers and diastereomers where traditional chalk and talk method may not be able to convey the concept, are taught through audio-visual aids.

Students are encouraged to participate actively in the classroom through regular presentations on curriculum based topics.

As the best way to learn something is to do it yourself, practicals are planned in such a way so as to reinforce the topics covered in theory.

Skill based experiments are open ended with idea of helping students to gain theoretical and practical knowledge of how to apply concepts learnt in theory on practical problems.

Assessment Methods

Students evaluation done on the basis of regular class test and assignments during the course as per the curriculum.

Keywords

Chemical Bonding, Nanomaterials, Thermodynamics and Thermochemistry, Electronic effects and molecular forces, Reaction mechanisms, Stereochemistry.

Ecology
(BS C7)
Core Course - (CC) Credit:6

Course Objective(2-3)

The core course on Functional Ecology is designed to acquaint students with varied aspects of Ecosystem and Ecology, including population ecology, ecosystem and community ecology, restoration as well as behaviour ecology. The emphasis will be on developing interest and invoking

a sense of responsibility among students towards ecosystem and environment around us. The course also explores different techniques and approaches of measuring and quantifying components of ecosystem for applications in various fields such as taxonomy, pollution control, population estimation and management as well as wildlife conservation. This course will motivate students to pursue career in ecology and allied fields.

Course Learning Outcomes

- Comprehend the principles and applications of ecology and ecosystem.
- Create awareness about the importance of ecosystem in general, and the effects of changes in ecosystem.
- Understand the techniques for quantitative and qualitative estimation of biotic and abiotic components of an ecosystem.
- Knowledge about the density, frequency and diversity of species in an ecosystem.
- Understand species behaviour in its natural environment.
- Understand the key factors responsible for changes in natural ecosystem such as urbanisation and human interference.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives from an ecological perspective.

Unit 1

Introduction to Ecology (6 periods)

Relevance of studying ecology, History of ecology, Autecology and synecology, levels of organization, Laws of limiting factors (Liebig’s law of minimum, Shelford’s law of tolerance), ecological range (Eury, Steno). Ecological factors (abiotic and biotic): temperature, light and soil, Soil- characteristics and horizons

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Unit 2

Population Ecology (20 periods)

Population: Unitary and Modular populations; Metapopulation: Density, natality, mortality, life tables, fecundity tables, survivorship curves, age ratio, sex ratio, dispersal and dispersion; carrying capacity, population dynamics (exponential and logistic growth equation and patterns), r and K selection, density-dependent and independent population regulation; Niche concept, Population interactions: Positive and negative interactions; Competition, Gause’s Principle for competition with laboratory and field examples, Lotka-Volterra equation for predation.

Unit 3

Community Ecology (10 periods)

Community structure: Dominance, diversity, species richness, abundance, stratification; Diversity indices; Ecotone and edge effect; Community dynamics (succession): Primary and secondary succession, Succession on a bare rock; Climax: monoclimax and polyclimax concepts (preclimax, postclimax, disclimax etc.). Concept of keystone, indicator, umbrella and flagship species.

Unit 4

Ecosystem Ecology (10 periods)

Concept, components, types of ecosystem with one example of pond ecosystem in detail (abiotic and biotic components, BOD, eutrophication). Energy flow (Grazing and Detritus food chain), linear and Y-shaped energy flow model, food web. Ecological pyramids and Ecological efficiencies. Nutrient cycle with one example of Nitrogen cycle.

Unit 5

Restoration Ecology (8 periods)

Introduction to ecology of perturbance; Major ecological disturbances (Physical and biological origin): Flood, fire invasive species, anthropogenic disturbance; Management of degraded ecosystems.

Unit 6

Behavioral Ecology (6 periods)

Social, reproductive and territorial behavior, Evolution of optimal life history, Trade-offs, semelparity and iteroparity.

Practical

PRACTICALS (CREDITS 2)

1. (a) To understand the principle and working of ecological instruments such as Anemometer, Hygrometer, Luxmeter, Rain gauge, turbidity meter, pH meter, Soil thermometer, Min-Max thermometer.

(b) To observe and record microclimatic variations (light intensity, temperature and wind velocity) at different sites in the campus.

2. (a) To study biotic interactions using specimens/ photographs/ permanent slides of Parasitic angiosperms, Saprophytic angiosperms, root nodules, velamen roots and lichens

(b) To study plant-microbe interactions by preparing temporary stained mounts of VAM fungi / mycorrhizal roots

3. To determine a minimal quadrat area for sampling and determine density, frequency and abundance of the vegetation by quadrat method

4. (a) To determine the texture, density, bulk density, particle density and pore space in the given soil sample

(b) To determine pH, Cl, SO4, NO3, base deficiency, organic matter, cation exchange

capacity in the given soil sample

5. To estimate dissolved oxygen content of given water sample using Winkler's method.

6. Plotting of survivorship curves from hypothetical life table data

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References

Suggested Readings

· Sharma, P. D. Ecology and Environment. Rastogi Publications. ISBN: 8171339050, 9788171339051

· Miller, G. T. and Spoolman, S. Living in the Environment: Principles, Connections, and Solutions. Cengage Learning. ISBN: 9781337094153, 978-1337094153

· Odum, E. P. Fundamentals of Ecology. Cengage Learning. ISBN: 0534420664, 978-0534420666

· Smith, Thomas M. and Smith, R. L. Elements of ecology 8th edition. Pearson, 2012 ISBN-13: 978-0-321-74291-9

· Ricklefs, R.E and Miller, G.L. Ecology , 4th edition W.H. Freeman, 2000 ISBN-13: 978-0716728290 ISBN-10: 9780716728290

Additional Resources:

MOOCs

· 'Ecology: Ecosystem Dynamics and Conservation from American Museum of Natural History on Coursera https://www.classcentral.com/course/coursera-ecology-ecosystem-dynamics-and-conservation-10618|url_encode'

· www.usu.edu/forestry/disturbance/bark.../Gray_March_26_DisturbanceEcology.pdf

· https://alison.com/course/diploma-in-ecology-studies

· Principles of ecology https://swayam.gov.in/courses/4075-principles-of-ecology

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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.

Field studies: Hypothetical (in class) as well as real-life (field) data will be provided for a better understanding.

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.

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 pursue research in the field of ecology as a career in future. Educational Visits: Regular field visits for data collection and estimation as well as visit to a Biodiversity Park or National Zoological Park will provide students a practical or hands on knowledge of the subject.

Assessment Methods

Theory: 100 marks

Written Exam: 75 marks

Internal Assessment: 25 marks (10 Project+ 10 Assignment/Test+ 5 Attendance)

Practical: 50 Marks

Segregation for practical exam (25 marks total)

Continuous assessment (25 marks total):

Record (10 marks)

Viva (5 marks)

Continuous evaluation (5 marks)

Field report (5 marks)

Keywords

Population ecology, Ecosystem ecology, Community ecology, Restoration ecology, Behaviour ecology

Evolutionary Biology
(BS C14)
Core Course - (CC) Credit:6

Course Objective(2-3)

Theodosius Dobzhansky

in 1973 famously argued that “nothing in biology makes sense except in the light of evolution”. This course is being offered due to central importance of evolution in Biology andintroduces students to all aspects of evolutionary biology. This course is an attempt to make the students familiar with basic history of evolutionary concept, its criticism, development as a science, history of life and to create a deep understanding of mechanisms that fuel the evolution of biological systems.

Course Learning Outcomes

· Students will learn about the origins and development of evolutionary thought

· Learn about the Compelling evidences in favour of evolution like fossils, comparative anatomy and molecular homologies

· Students will learn about origin and history of life through fossil record

· Understand how biodiversity is generated by repeated speciations and lost over time due to mass extinctions.

· How the forces of evolution like variations, natural selection, genetic drift, and migration shape populations

· How novelty in organisms arise, adaptations to their environment

· Our origins from our primate ancestors

Unit 1

Unit 1 Historical Review of Evolutionary Concept No. of Hours: 7

Pre-Darwinian ideas – List of contributors influencing Darwin indicated as a timeline. Lamarckism – Merits and demerits. Darwinism – Merits and demerits, Post-Darwinian era –Modern synthetic theory; biomathematics and the theory of population genetics leading to Neo-Darwinism

Unit 2

Unit 2 History of Life No. of Hours: 12

Chemogeny – An overview of pre-biotic conditions and events; experimental proofs to abiotic origin of micro- and macro-molecules. Current concept of chemogeny – RNA first hypothesis. Biogeny – Cellular evolution based on proto-cell models (coacervates and proteinoid

microspheres). Origin of photosynthesis – Evolution of oxygen and ozone buildup.

Evolution of Eukaryotes from Prokaryotes, multicellularity. Cambrian explosion and timeline of plant and animal evolution in the Phanerozoic eon. Mass-scale extinctions – causes, significance and events. Cretaceous-Tertiary Mass Extinction in detail.

Unit 3

Unit 3 Evidences of Evolution No. of Hours: No. of Hours: 8

Paleobiological – Concept of Stratigraphy and geological timescale; fossil study (types, formation and dating methods). Anatomical – Vestigial organs; Homologous and Analogous organs (concept of parallelism and convergence in evolution). Taxonomic – Transitional forms/evolutionary intermediates; living fossils. Phylogenetic – a) Fossil based – Phylogeny of horse as a model. b) Molecule based – Protein model (Cytochrome C); gene model (Globin gene family)

Unit 4

Unit 4 Forces of Evolution – No. of hours : 18

A. Continuous and discontinuous variations ,heritable variations and their role in evolution, recombination and random assortment (basis of sexual reproduction); gene regulation .Concept of micro- and macro-evolution – A brief comparison

Natural selection as a guiding force – Its attributes and action Basic characteristics of natural selection. Colouration, camouflage and mimicry, Co-adaptation and co-evolution, Man-made causes of change – Industrial melanism; antibiotic resistance. Modes of selection, artificial selection, Polymorphism, Heterosis and Balanced lethal systems.

B. Hardy-Weinberg's Law of Genetic Equilibrium. Genetic Drift (Sewall Wright effect) as a stochastic/random force –Its attributes and action. Basic characteristics of drift; selection vs. drift, Bottleneck effect, .Founder principle. Alterations in gene frequency (when selection operates) – Calculation based on Selection Coefficient and Fitness). Fluctuations in gene frequency (when drift operates) – Calculation based on standard deviation

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Unit 5

Unit 5 Product of Evolution – Speciation No. of Hours: 7

Concept of species as a real entity, Mechanisms of speciation – Allopatric, Peripatric Parapatric and sympatric; Patterns of speciation – Anagenesis and Cladogenesis; Phyletic Gradualism and Punctuated Equilibrium (Quantum Evolution), Basis of speciation – Isolating mechanisms

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Unit 6

Unit 6 Human Ancestry and Phylogeny No. of Hours: 8

Primate characteristics and unique Hominin characteristics. Advantages and adaptations to bipedalism. Primate phylogeny leading to Hominin line. Australopithecines, Homo habilis, Homo erectus, Neanderthal man, Archaic and modern Homo sapiens. .Human migration – Theories. Brief reference to molecular analysis of human origin – Mitochondrial DNA and Y-chromosome studies

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Practical

TOTAL HOURS: 60 CREDIT : 2

(A) Evidences of fossils

1. Study of types of fossils (e.g. trails, casts and moulds and others) and Index fossils of Palaeozoic era

2. Connecting links/transitional forms - Eg. Euglena, Neopilina, Balanoglossus, Chimaera, Tiktaalik, Archaeopteryx, Ornithorhynchus

3. Living fossils - Eg. Limulus, Peripatus,Latimeria, Sphaenodon

4. Vestigial, Analogous and Homologous organs using photographs, models or specimen

(B) Selection Exemplifying Adaptive strategies (Colouration, Mimetic form, Co-evolution; Adaptations to aquatic, fossorial and arboreal modes of life) using Specimens

(C) Neo-Darwinian Studies

1. Simulation experiments using coloured beads/playing cards to understand the effects of Natural selection on allele frequencies

2. Simulation experiments using coloured beads/playing cards to understand the effects of Bottleneck effect and Founder effect on allele frequencies

(D) Phylogeny

1. Digit reduction in horse phylogeny (study from chart),

2. Study of horse skull to illustrate key features in equine evolution

3. Study of monkey and human skull - A comparison to illustrate common primate and Unique Hominin features

4. Construction of Phylogenetic tree using morphological characters

Projects:

1. Sampling of human height, weight and BMI for continuous variation

2. Sampling for discrete characterstics (dominant vs recessive) for discontinuous variations

e.g hitch-hiker's thumb, dexterity, tongue rolling, ear lobe (data categorization into 16 groups

based on the combination of 4 traits; assigning each subject to the respective group)

Visit to Geology/ Anthropology museums, Delhi University

References

1. M. Ridley, Evolution,. 3rd Ed.. Blackwell Scientific Publishing ,2004

2. B. K Hall & B. Hallgrimson Strickberger’s Evolution,. 4th Ed.. Jones and Barlett , 2008

3. C. Zimmer & D. J. Emlen,.Evolution: Making Sense of Life, 1st Ed. Roberts & Co. Publishers, 2013

4. D. Futuyma, Evolutionary Biology,. 3rd Ed. Sinauer Assoc. Inc. 1998

5. NH Barton, DEG Briggs, JA Eisen, DB Goldstein and NH Patel, Evolution,.1st Ed., Cold Spring Harbor Laboratory Press, 2007

Additional Resources:

https://evolution.berkeley.edu/evolibrary/home.php

Jonathan Weiner The Beak of the Finch: A Story of Evolution in Our Time, Knopf 1994

Elizabeth Kolbert, The Sixth Extinction: An Unnatural History, Bloomsbury, 2015

Charles Darwin, The Origin of Species: 150th Anniversary Edition , Penguin USA , 2003 ISBN-10: 0451529065

Teaching Learning Process

- Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.
- Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching..
- Research projects: Projects based on the curriculum may be given.

Assessment Methods

Theory: 100 marks

Written Exam: 75 marks

Internal Assessment: 25 marks (10 Project/ assignment+ 10 Test+ 5 Attendance)

Practical: 50 Marks

Practical examination (25 marks total):

Continuous assessment (25 marks total):

- Record (10 marks)
- Viva (5 marks)
- Continuous evaluation (5 marks)
- Report on Museum visit (5 marks)

Keywords

Darwinism, Chemogeny, Endosymbiotic theory, Cambrian explosion, fossils, homology, mass extinction, Variations, Natural selection, Genetic Drift, Speciation, Isolating mechanisms, Hominin, Bipedalism

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Genetics
(BS C12)
Core Course - (CC) Credit:6

Course Objective(2-3)

The course in Genetics provides an understanding of both classical and modern concepts in the areas of transmission, molecular and population Genetics with examples and case studies.

Practicals are well correlated with the theory topics and designed to support skill- oriented learning outcomes

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Course Learning Outcomes

On successful completion of the course the student would be able to

· Understand the concept of genotype and phenotype and describe the basic principles of Mendelian genetics,applications and extensions.

Learn and appreciate the various factors that confer genotypic and phenotypic variability.

Understand the inter relation between environment (Nurture) versus inheritance (Nature) in determining the conversion of genotype to phenotype.

· Use the concepts of bacterial and viral genetics to understand resistance patterns and to create linkage and genetic maps.

· Describe population structure by genetic variation, pedigree analysis and develop broad and balanced knowledge and understanding of key biological concepts, principles and theories related to evolution, genetic change and speciation.

· Bridge the gap between Biology and Mathematics by providing examples that require use of statistical tools for arriving at a conclusion.

· Apply the principles of transmission and inheritance in real life situations

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Unit 1

Introduction to Genetics No of hours: 02

Introduction to the basic principles of heredity. Model organisms: Escherichia coli, Saccharomyces cerevisiae, Drosophila melanogaster, Caenorhabditis elegans, Danio rerio and Arabidopsis thaliana .

Unit 2

Transmission genetics: No of hours: 22

Mendelian Genetics and Extensions

Mendel’s work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information. Principles of Inheritance, Chromosome theory of inheritance, Laws of probability, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy Penetrance and expressivity, norm of reaction and phenocopy.

Human pedigree analysis:

Pedigree conventions, characteristics of dominant and recessive inheritance; .sex linked, sex influenced and sex limited traits. Applications of pedigree analysis

Organelle heredity

Chloroplast mutation/Variegation in four ‘o clock plant and Chlamydomonas, Mitochondrial mutations in Neurospora and yeast, Maternal effects, Infective heredity-Kappa particles in

Paramecium

Chromosomal abberations

Variations in chromosome number- monosomy and trisomy of sex chromosomes and autosomes. Variations in chromosome structure- inversions, deletions, duplications and translocations.

Inheritance of complex traits

Inheritance of complex trait, analysis of quantitative traits, narrow and broad sense heritability, quantitative trait loci (QTL) and their identification. Hybrid vigor.

Unit 3

Molecular genetics No. of hours: 18

Genetics of bacteria and viruses

Complementation test, limitations of cis-trans test, intragenic complementation, rII locus of phage T4 and concept of cistron. Mechanism of genetic exchange - conjugation, transformation and transduction. Gene mapping in bacteria.

Sex determination:

Genetic basis of sex determination in Humans, Drosophila melanogaster and C.elegans

Genome Dynamics-Transposable Genetic Elements

Prokaryotic transposable elements-IS elements, Composite transpossons, Tn-3 elemenets; Eukaryotic transposable elements- Ac-Ds system in maize and P-elements in drosophila; Uses of transposons

Epigenetics:

Mechanism of dosage compensation; X chromosomal inactivation in humans. Monoallelic expressions. Epigenetic mechanisms of transcriptional regulation. Genomic imprinting

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Unit 4

Linkage, crossing over and mapping techniques: No. of hours: 6

Linkage and Crossing over, cytological basis of crossing over, Molecular mechanism of crossing over. Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and Coincidence

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Unit 5

Population and Evolutionary Genetics: No. of hours: 6

Hardy-Weinberg law, predicting allele and genotype frequencies and exceptions to Hardy-Weinberg principle.

Molecular evolution - analysis of nucleotide and amino acid sequences, molecular phylogenies, homologous sequences, sequence similarity and alignment, phenotypic evolution and speciation

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Unit 6

Introduction to genomics and proteomics No. of hours: 6

Genomes of bacteria, Drosophila and Humans; Human genome project; Introduction to Bioinformatics, Gene and Protein databases, sequence similarity and alignment, Gene feature identification. Gene Annotation and analysis of transcription and translation; Posttranslational analysis-Protein interaction

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Practical

1. Study of Linkage, recombination, gene mapping using marker based data from Drosophila.
2. Study of Phlox/ Allium Karyotype (normal and abnormal).
3. PTC testing in a population and calculation of allele and genotype frequencies.
4. Study of abnormal human karyotype and pedigrees (dry lab)
5. Squash preparation of salivary glands of Dipteran larva to observe polytene chromosomes.
6. Smear technique to demonstrate sex chromatin in buccal epithelial cells.
7. Project based experiments

References

1. Genetics (2012) 6th ed., Snustad, D.P. and Simmons, M.J., John Wiley & Sons. (Singapore), ISBN: 978-1-118-09242-2.

2. Genetics - A Conceptual Approach (2012), 4th ed., Pierce, B.A., W.H. Freeman & Co. (New York), ISBN:13:978-1-4292-7606-1 / ISBN:10:1-4292-7606-1.

3. An Introduction to Genetic Analysis (2010), 10th ed., Griffiths, A.J.F, Wessler, S. R, Carroll, S. B. and Doebley, J., W.H. Freeman & Company (New York), ISBN:10: 1-4292-2943-8.

Additional Resources:

W.S. Klug and M.R. Cummings, Concepts in Genetics, 10th Ed. Pearson Education (San Francisco) 2012.

Teaching Learning Process

· Classical chalk and board with some use of audio-visual aids and presentations.

· Learning through discussions, interactive learning and encouraging peer learning.

· Bridging the gap between Biology and Mathematics by giving examples and cases that require use of statistical tools such as chi square test, regression analysis and ANOVA to arrive at a logical conclusion.

· Engaging students in quizzes and questionnaires thus building their interest and aptitude.

· Engaging the students in epidemiological surveys to improve their observational skills, understand the importance of genetics in population data collection and applying and analysing the data to arrive at logical inferences.

Assessment Methods

· Regular closed book tests and end semester assessment

· Open book tests and assignment with questions that encourage a holistic and integrative approach to solving problems and analysing data.

· Student Presentations that help build confidence in preparing a presentation, public speaking skills and team work

· Grooming their analytical ability and problem-solving skills by providing questions that are case studies or are problem-based

· Continuous practical assessments.

Keywords

Mendelian laws, pedigree analysis, organelle heredity,chromosomal mutations, extra Mendelian Genetics, Population Genetics, Genomics, gene mapping ,conjugation, transduction, Genomics

Growth and Reproduction
(BS C11)
Core Course - (CC) Credit:6

Course Objective(2-3)

- The core course entitled Growth and Reproduction is designed to allow students to explore the development of plants from juvenile to mature phase. The genetical, physiological , and morphological changes that occur in plant body from early embryonal to late senescent phase, form the essence of the course. Sexual reproduction in higher plants is lucidly described and aims to enthuse the students to explore the myriad ways in which plants produce fruits and seeds, and encourage them to pursue further studies in pollen biology, fruit set , seed formation and other lucrative activities in economically important plants.
- Growth and reproduction is a comprehensive study of developmental biology of animals, primarily vertebrates from fertilization to organogenesis. This course will investigate both tissue level differentiation and cellular events and molecular mechanisms fundamental to development of animal forms and function. Topics include: Fertilisation, gastrulation, Extra-embryonic structures, organogenesis with special emphasis to CNS and regeneration. Further influence of environment on these events. Laboratory work will include both classical embryological study, observation of live embryos and recent experimental methods in developmental biology.

Course Learning Outcomes

After pursuing this course, students will:

· Learn the path of development of plants from juvenile to senescent stages with the accompanying genetical, cellular, physiological and morphological changes and thus be able to correlate them

· Get to know the fascinating array of flowers , fruits, and seeds and the events leading to their development.

· Will appreciate the role of pollinators and be motivated to save them through mitigation measures against climate change.

· Get hands on experience of observing patterns on pollen grains , pollen germination, embryo and endosperm dissection, and collect seeds with different dispersal mechanisms, making the course a great learning and enjoyable experience

· Students will learn to describe and order the main stages of development common to most multicellular organism.

· Identify the cellular behaviour that leads to morphological changes during development.

· Describe the main anatomical changes occurring during development and regeneration

· Explain the main stages of neural tube establishment and to understand how errors in development lead to congenital defects.

· To examine the variations in developmental events such as formation of extra embryonic structures and regeneration patterns.

· In the laboratory exercises, students will be able to visualise and appreciate concepts learnt in theory and apply experimental approaches to understand these developmental events.

Unit 1

Unit 1: Introduction to Growth and Reproduction No. of hours: 5

General growth pattern in animals and plants: plant growth curves, Juvenile, Vegetative, and Reproductive phases in growth, ageing and senescence, abscission

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Unit 2

Unit 2: Pre- Fertilization changes No. of hours: 15

Sexual reproduction in angiosperms: Structure and organisation of flower, organization of typical tetrasporangiate anther and eight nucleate embryo sac (Polygonum type), pre-fertilization events in plants – microgametogenesis and megagametogenesis, anther dehiscence, pollination, pollen-pistil interaction, pollen germination, double fertilization, pre-fertilization barriers to incompatibility.

Gametogenesis- Spermatogenesis and Oogenesis w.r.t human. Types of eggs in animals.

Unit 3

Unit 3: Post-Fertilization Changes and early development No. of hours: 22

Post fertilization events in plants: Types of embryogenesis, endosperm development, types of endosperm, seed formation, seed dispersal: mechanism and agents, Apomixis: Types and relevance, genetic regulation

Post Fertilization Events in animals; Types of Cleavages; Blastula; Fate Maps, Morphogenetic

movements during gastrulation; Gastrulation in frog and chick; Fate of Germ

layers; Neural tube formation, brief account on embryonic induction, Extra Embryonic

membranes in chick and mammal, Placenta: Functions and types based on chorionic villi distribution and histology.

Unit 4

Unit 4: Differentiation No. of hours: 18

Post-embryonic meristem in plants with special reference to Arabidopsis embryogenesis.

Role of meristem in differentiation, shoot apical meristem, root apical meristem, lateral meristem (vascular and cork cambium), floral meristem, ABC model of flowering, homeobox genes.

Organogenesis : Formation of CNS(Spinal cord, medulla, cerebellar and cerebral organisation).

Regeneration: Modes of regeneration, epimorphosis (in salamander limb) and compensatory regeneration (Liver)

Practical

TOTAL HOURS : 60 CREDITS : 2

1. Study of whole mount and sections of Frog (fertilized egg, 2, 4, 8, 16, 24 cell stage, blastula, gastrula-yolk plug stage, neural plate stage, neural tube stage, tadpole larva-external gill and internal gill stage)

2. Study of chick development from live/fertilized eggs (window viewing)

3. Study of whole mount and sections of Chick (fertilized egg, primitive streak stage, 24hrs stage, 28hrs stage, 33hrs stage, 38hrs stage, 48hrs stage, 72hrs stage, 96hrs stages) (Hamburger-Hamilton stages)

4.Study different types of mammalian placenta on the basis of histology and morphology

5. Study different stages of Micro and megagametogenesis in angiosperms-through permanent slides

6. To study per cent pollen germination using different media

7. To study embryo development in flowering plant-slides only

8. To dissect out endosperm and embryo from angiosperm seeds

9. Study of apical and lateral meristem by permanent slides

10. Survey of dispersal mechanisms of seeds

11. Project report on Visit to Zebra Fish culture Lab/ IVF Lab

Value added Project:

1.Study of ornamentation pattern of pollen wall from different plant species collected from campus and correlate it with its pollination mechanism

2. To study the development of chick embryo using a shell-less ex-ovo culture

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References

1. Botany – The Embryology of Angiosperms. S.S. Bhojwani, S. P. Bhatnagar and P.K. Dantu. 6th Edition. Vikas Publications.
2. Developmental Biology of Flowering Plants. V. Raghwan. Springer. ISBN – 978-1-4612-7054-6
3. Gilbert S: Developmental Biology 9th Ed
4. Human Embryology 3rd Edition by William J. Larsen PhD Publisher: Churchill Livingstone
5. Carlson B.M. Patterns; Foundations of Embryology.

Additional Resources:

Analysis of Biological Development 2nd Edition Klaus O. Kalthoff McGraw-Hill publications

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Teaching Learning Process

- Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.
- Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching..

Research projects: Projects based on the curriculum may be given.

Assessment Methods

Theory: 100 marks

Written Exam: 75 marks

Internal Assessment: 25 marks (10 Project+ 10 Assignment/Test+ 5 Attendance)

Practical: 50 Marks

Practical examination (25 marks total):

Continuous assessment (25 marks total):

- Record (10 marks)
- Viva (5 marks)
- Continuous evaluation (5 marks)

Project work (5 marks)

Immunobiology
(BS C13)
Core Course - (CC) Credit:6

Course Objective(2-3)

A comprehensive study that focuses on the integrative working and regulation of the both the innate and induced/adaptive defense mechanism that operate in the vertebrate system as well as the plant kingdom . It will allow students to differentiate between innate and induced/adaptive immune mechanisms and their importance in maintaining a healthy system. The students will also understand the consequences of an inappropriate immune response. They will be able to appreciate the importance of immunity in medicine / public health and control of plant disease in agriculture.

Course Learning Outcomes

Upon completion of this course, a student will be able to

· Have an overview of the immune system including cells, organs and receptors.

· Describe the basic mechanism, differences and functional interplay of innate and adaptive immunity

· Define the cellular and molecular pathways of humoral and cell-mediated immune responses

· Describe the mechanisms involved in autoimmunity and different types of hypersensitivity

· Understand the significance of regulated functioning of the immune system to prevent disorders and diseases.

· Learn about the various preexisting structural defences in plants

- Describe the various molecules induced in plants to control infection
- Understand the genetic basis of plant –pathogen interaction
- Appreciate the usefulness of vaccines in control of disease
- Learn about the importance of genetic engineering in control of plant pathogens
- Appreciate the importance of immunity in medicine / public health

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Unit 1

Introduction to Defense Mechanisms

No. of Hours: 02

Overview of defense mechanisms in plants and animals

Unit 2

Introduction to Plant Defenses and Innate Immunity in plants

No. of Hours: 05

Pre-existing structural defenses (first line of defense) - surface structures(waxy coat, cuticle, epidermal layer, hydathodes, thorns, sclereids), mineral crystals (idioblasts,) and cell wall. Biochemical defenses- secondary metabolites (terpenoids, glycosides, phenolics and alkaloids) Innate Immunity in Plants- Pattern triggered immunity (PTI),

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Unit 3

Innate Immunity in animals

No. of Hours: 10

Anatomical barriers, soluble molecules and membrane associated receptors (PRR) Complement activation by classical, alternate and MBL pathway, biological consequences of complement activation, regulation and complement deficiencies.

Haematopoiesis, cells of the innate immune system, primary lymphoid organs; cell adhesion molecules, chemokines, leukocyte extravasation, and the inflammatory response; connections between innate and adaptive immunity.

Unit 4

Induced Defenses in Plants

No. of Hours: 10

Factors causing plant stress- abiotic and biotic. Abiotic- strategies and mechanisms, Physiological and cellular responses to drought stress, salinity stress, temperature stress (freezing and heat)

Biotic- Classification of biotic stresses, major pests and diseases of economically important crops, interaction in host-pathogen systems, Flor's gene for gene concept, R gene mediated resistance, effector trigerred immunity (ETI), receptor-elicitor model, Cytological protection and induced resistance. Concept of signal transduction and other host-defense mechanisms. Heatshock proteins, Basic ROS cycle and adaptation during stress, Systemic Acquired Resistance (SAR), Phytoalexins Jasmonic acid, MAPKS,SROS,HPL, systemins, , mechanism of production and scavenging of NO.

Unit 5

Adaptive Immunity in Animals No. of Hours: 25

Antigens and haptens, Factors that dictate immunogenicity, B and T cell epitopes. Structure and distribution of classes and subclasses of immunoglobulins (Ig), Ig fold, effector functions of antibody, antigenic determinants on Ig and Ig super family. Monoclonal antibodies; Immunological methods- Antigen-antibody interactions. Secondary lymphoid organs and tissues.

B cell maturation and generation of antibody diversity. Humoral immune response against T-dependent and T-independent antigens.

Histocompatibility antigens – structure and function, T cell maturation and differentiation – Positive and Negative selection of thymocytes, Antigen Presentation by the exogenous and endogenous pathways, Activation of T cells and cell mediated immunity; Role of NK cells and Antibody dependent cellular cytotoxicity.

Unit 6

Immune dysfunction and applications No. of Hours: 08

Hypersensitivity and Transplantation Immunology; Vaccines; Control of plant pathogens and improving plant resistance by genetic engineering

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Practical

TOTAL HOURS:
60
CREDIT: 2

1.Characterization of diseases symptoms and identification of pathogenic organisms (bacterial- Xanthomonas campestris; viral- TMV; fungal- Puccinia graminis-tritici, pest and nematodes- Meloidogyne spp.).

2. Survey of structural plants defences: viz. cuticle, wax, lignin, bark, thorns, prickles,

trochomes, armour in different plants species including thigmonasty, camouflage,

mimicry.

3. Precipitation reactions – DID and SRID.

4. Immunoelectrophoresis (IEP), Countercurrent IEP, Rocket IEP

5. Agglutination reaction.

6. ELISA

7. Cell isolation and Counting- Spleen/PBMNC

References

1. Kuby Immunology (2007) 6th ed., Kindt, T.J., Goldsby, R.A. and Osborne, B.A., W.H Freeman and Company (New York), ISBN:13: 978-0-7167-8590-3 / ISBN: 10:0-7617-8590- 0.

2. Immunology: A Short Course (2009) 6th ed., Coico, R and Sunshine, G., John Wiley& sons, Inc (New Jersey), ISBN: 978-0-470-08158-7.

3. Biochemistry and Molecular Biology of Plants, B.B.Buchanan, W. Gruissem and R.L.Jones. Wiley Blackwell; ISBN: 9780470714218

4. Lincoln Taiz andEduardo Zeiger, Plant Physiology,. 5th edition, Sinauer associates Inv Publishers,Sunderland,Mssachusetts,U.S.A 2010; ISBN 978-0-87893-7

5. Practical Immunology: Leslie Hudson, Frank C Hay (1980), Blackwell Scientific

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Teaching Learning Process

- Traditional chalk and talk method to be supplemented with presentations / videos
- Involvement of students in the learning process is encouraged
- Emphasis on hands on experience during practical hours
- Subject related lectures to be organized on recent advancements
- Visits to various research laboratories / industry to understand the applications of the subject

Assessment Methods

- Continuous internal assessment in the form of class tests
- Seminar presentation related to the topics covered
- Assignments covering major topics
- End semester examination
- Continuous evaluation of practicals during practical hours

Keywords

Antigen, Antibody, Complement, MHC ,TLR, B cells,T cells, APC, Cytokines, PAMP, Vaccines, R-Avr ,Secondary metabolites, Structural defenses, Jasmonic acid, Salicyclic acid, Idioblasts, SAR

Light and Life
(BS C2)
Core Course - (CC) Credit:6

Course Objective(2-3)

The Core course on Light and Life explores the physical properties of light and its interplay with living organisms. Light as a source of energy and information has shaped life on earth over the last 3.6 billion years. We see the world around us because the light reflected to the retina is processed to our brain (Photoreception), we breathe in oxygen because it has been evolved by the plants around us due to the light dependent Photosynthesis . Where there is no natural light, organisms produce their own (Bioluminescence). Maintaning co-ordination with the surrounding light regime is fundamentally important to the inherent biological clock in organisms which needs re-calibration almost every 24 hours (Circadian Rhythms), whereas a disruption may lead to adverse effects.Every part of the spectrum is used in one way or the other by different life forms. In this paper students will be able to appreciate the delicate processes of LIFE that are dependent on LIGHT.

Course Learning Outcomes

1. · Understanding the nature of light
2. · Comprehending the impact of light on biodiversity from pole to pole.
3. · Knowledge about the various photoreceptors in plants and animals
4. · Appreciate and understand the mechanism of photosynthesis
5. · Understanding Bioluminescence , Photoperiodism and Biological Rhythms
6. · Knowledge about the ecological and physiological responses to Light

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Unit 1

Unit 1 Introduction to Light and Life No. of Hours 10

Nature of light (Wave and Particle), spectrum of light. Measurement of light (Lux, Candela,Foot Candle).Polarized light, light attenuation in water.Light as an ecological factor affecting distribution of plants and animals (Phyto and Zoo geography), in terrestrial and aquatic ecosystems. Latitudinal Diversity gradient.Altitudinal and latitudinal variations in light intensity and photoperiod.Diel vertical migration

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Unit 2

UNIT 2 Photoreception No. of Hours 8

Comparative account of chemistry and functionalroles of pigments associated with harvesting light energy: photoreceptors in plants:chlorophylls, caroteniods, phycobilinoproteins, bacteriochlorophylls, etc. Photoreception in animals, opsinsevolution of eyes, colour vision and visual processing in human eye.

Unit 3

Unit 3 Photosynthesis No. of Hours 15

History, Structure of chloroplast, Photosynthetic equation, Photosynthetic electron transport (cyclic and non-cyclic), photolysis of water, oxygen-evolving complex (OEC), concept of Reaction centres, Q-cycle, Dark Reactions in Photosynthesis, C3, C4, CAM cycle, Regulation of PCR cycle, photorespiration (C_2 cycle), photoautotroph vsphotoheterotrophs; Photoautotroph vs. chemoautotroph,Anoxygenic and oxygenic photosynthesis.

Unit 4

Unit 4 Bioluminescence No. of Hours 7

Definition, discovery, diversity of organisms, Functions and mechanism of Bioluminescence (Photinuspyralis, Aequorea victoria).

Unit 5

Unit 5 Photoperiodism No. of Hours 12

Photoperiodism:phytochromes, LDP, SDP, DNP plants, vernalization, vernalin,etiolation and de-etiolation. Animal responses to changing photoperiodism.Morphological,Anatomical, Physiological and Behavioural adaptations to extreme light conditions inplants and animals.Three rhythm domains, Biological clock and Circadian rhythms. Sleep disorders, Shift work disorder, Jetlag.

Unit 6

Unit 6Ecological and physiological responses to Light No. of Hours 8

Color in animals: chromatophores and colour changes in animals, morphological and physiological colour change. Light as an inducer for biosynthesis/activation ofenzymes, hormones and other biomolecules (Vitamin D, Melatonin, RuBisco).Thymine dimer formation, skin cancer and cataract in response to UV exposure.

Practical

TOTAL HOURS: 60 CREDIT: 2

1. To study light penetration in water using Secchi disc.
2. To demonstrate the effect of light on soil fauna using Berlese funnel setup.
3. To study the effect of light and darkness on the chromatophores of fish.
4. To test / survey for colour blindness using Ishihara charts.
5. To study oxygen liberation during photosynthesis using Hydrilla. Measurement of light using Luxmeter.
6. Separation of Chloroplast pigments by Paper Chromatography.
7. Demonstration of Hills Reaction and study the effect of Light intensity (any 2 light conditions).
8. To study the effect of Light intensity and CO_2 concentration on the rate of photosynthesis.

Student Projects

1. 1. To study etiolation and de-etiolation.
2. 2.To study Diurnal variations in Human Body Temperature and Heart Rate

3. 3.To make a report on Bioluminiscent Organisms (Plants and Animals)

References

1. Biochemistry and Molecular Biology of Plants, B.B.Buchanan, W. Gruissem and R.L. Jones. American Society of Plant Physiologists,2000.
2. Introduction to Plant Physiology, W.G.Hopkins, Norman P.A. Huner, Wiley 2009.
3. Photobiology: Science of Light and Life, L.O. Bjorn. 3rd Ed., Springer
4. Eckert , Animal Physiology-mechanisms and adaptations, D.Randall, W. Burggren& K. French. 5th Ed., W.H. Freeman and Co.
5. Photobiology, E.Kohen, R.Santus, J.G. Hirschberg. 1 Ed., Academic Press (1995)
6. Plant Physiology and Development, Sixth Edition by Lincoln Taiz, Eduardo Zeiger, Ian M. Møller, and Angus Murphy, published by Sinauer Associates.

Additional Resources:

1. Bioluminescence: Chemical Principles and Methods, Osamu Shimomura,World Scientific, 2012

2. Light and Life, Michael Gross, Oxford University Press, 2003

Teaching Learning Process

- Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.
- Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching..
- Research projects: Projects based on the curriculum may be given.

Assessment Methods

Assessment Methods (may be expanded keeping in view needs and outcomes of the subject).

Theory: 100 marks

Written Exam: 75 marks

Internal Assessment: 25 marks (10 Project+ 10 Assignment/Test+ 5 Attendance)

Practical: 50 Marks

Practical examination (25 marks total):

Continuous assessment (25 marks total):

- Record (10 marks)
- Viva (5 marks)

- Continuous evaluation (5 marks)
- Project work (5 marks)

Keywords

Light, Latitude, Photoperiod, Pigments, Photoreceptors, Vision Bioluminescence, Photosynthesis, Biological clock, Circadian rhythm , Biogeography , animal color, Vitamin D

Metabolism and Integration
(BS C10)
Core Course - (CC) Credit:6

Course Objective(2-3)

The main objective of this core paper being offered to Biological sciences students is to

1. Offer a detailed and comprehensive knowledge about the various metabolic pathways that are operating in the cell for providing both energy as well as synthesizing the major building blocks present in the cell.

2. It also integrates all the pathways with respect to tissue specificity under healthy conditions and the aberrations that result in disease and disorders.

3. To prepare students for higher education in any field related to medical and clinical biochemistry.

Course Learning Outcomes

On successful completion of this course, the student will be able to:

1. Demonstrate an understanding of the metabolic pathways - the energy-yielding and energy-requiring reactions in life.

2. Demonstrate an understanding of the diversity of metabolic regulation, and how this is specifically achieved in different cells.

3. Describe how these biochemical processes are not isolated but tightly integrated, with specific control sites and key junctions.

4. Explain molecular mechanisms underlying major inherited and lifestyle diseases related to metabolism.

5. Connect specific symptoms in clinical case presentations to metabolic disorders.

6. Perform and analyse various biochemical assays that enable students to understand the concepts of clinical biochemistry.

Unit 1

Introduction to Metabolism Hours: 8

Principles of bioenergetics-Standard free energy change, metabolic roles of ATP-Phosphoryl

group transfer, nucleotidyl group transfer. Experimental approaches to study of metabolism;

Primary and secondary metabolism, Energetics, classification of organisms based on utilization of carbon and energy sources

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Unit 2

Carbohydrate and Lipid Metabolic Pathways Hours: 14

Carbohydrates metabolism - Glycolysis, alcoholic and lactic acid fermentation, Pasteur Effect, gluconeogenesis, Cori cycle, glucose-alanine cycle, futile cycle. TCA cycle, HMP shunt, glycogen metabolism

Lipid metabolism - Mobilization of triglycerides, metabolism of glycerol, -oxidation of saturated, monounsaturated and poly-unsaturated fatty acids, even and odd chain fatty acids. Ketogenesis and significance, Biosynthesis of C-16 palmitic acid, brief overview of cholesterol metabolism and lipoprotein cycle

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Unit 3

Amino acid and Nucleotide metabolism Hours: 8

Protein catabolism – Transamination and deamination, Urea cycle, glycogenic and ketogenic amino acids, secondary metabolites from amino acids

Nucleotide metabolism – De novo and salvage pathway, porphyrin catabolism

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Unit 4

Oxidative phosphorylation Hours: 6

Components, properties and function of electron transport system, chemiosmotic hypothesis, inhibitors and uncouplers, Shuttle systems

Unit 5

Metabolic Integration Hours: 8

Metabolic changes during starve-feed cycle, exercise, diabetes and alcohol abuse, xenobiotic metabolism

Unit 6

Metabolic Disorders Hours: 8

Inborn errors of metabolism - Phenylketonuria, Alkaptonuria,Maple syrup and Gauchers

Carbohydrate and metabolic disorders - fructose intolerance, lactose intolerance, lactic acidosis, Galactosemia, genetic deficiency of Glucose-6-phosphate dehydrogenase

Lipid and glycogen storage disorders

Lifestyle disorders - Diabetes Mellitus and obesity

Nutritional disorders – Kwashiorkor and Marasmus

Practical

TOTALHOURS:60 CREDIT: 2

1. Estimation of Random Blood Glucose – Glucose Oxidase method
2. Estimation of Oral Glucose tolerance test (O- GTT).
3. Determination of Lipid Profile:Total Cholesterol (TC),High Density Lipoproteins (HDL) and Triglycerides (TG).
4. Estimation of SGPT and SGOT in serum/plasma sample.
5. Estimation of Bilirubin in serum/plasma sample.
6. Estimation of creatinine in serum/plasma sample.
7. Estimation of Urea.

8. Project:

References

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H.

Freeman and Company (New York), ISBN:13:978-1-4641-0962-1 / ISBN:10:1-4641-0962-1.

2. Textbook of Biochemistry with Clinical Correlations (2011) 7th ed., Devlin, T.M., John

Wiley & Sons, Inc. (New Jersey), ISBN:978-0-470-28173-4.

3. Peter W. Hochachka and George. N. Somero ,Strategies of Biochemical Adaptation, Saunders College Publishing,1973.ISBN 10: 0721647057 / ISBN 13: 9780721647050

4. Schlegel H.G., General Microbiology , Cambridge University Press Cambridge, 1993, ISBN 10: 0521439809 / ISBN 13: 9780521439800

Teaching Learning Process

Classical chalk and board with some use of audio-visual aids and presentations and other online resources.

Learning through discussions and ICT enabled blended classrooms

During the Practical class, students given ample opportunities to work individually as well as in groups to perform different experiments.

Students are encouraged for self-directed learning which enable them to become independent thinkers

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Assessment Methods

- Examinations:

Regular closed book class tests and end semester test.

- Assignments:

Open booked tests and assignment with questions that encourage a holistic and integrative approach to problem solving

- Presentations:

To improve team work, oral skills and handling defense.

- Practical examinations:

Grooming their analytical ability and problem-solving skills by providing case studies, practical based questions, maintaining practical records and viva -voce

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Keywords

Metabolism, bioenergetics, carbohydrate metabolism, lipid metabolism, amino- acid and nucleotide metabolism, metabolic integration, metabolic disorders, Oxidative phosphorylation.

Molecular Biology
(BS C9)
Core Course - (CC) Credit:6

Course Objective(2-3)

The objective of the course is to introduce to the students the basic knowledge about how DNA is replicated, how genes are transcribed and translation takes place in prokaryotes and eukaryotes, so that students can apply this knowledge in enhancing their analytical and problem solving skills and develop an interest to pursue research.

Course Learning Outcomes

- Students will acquire basic knowledge about the structure of DNA and various forms of DNA, about organization of genome in various life forms and how DNA is replicated in cells
- Students will acquire basic knowledge about the process of transcription, RNA processing and translation in prokaryotes and eukaryotes
- Students will learn about the various ways in which the DNA can be damaged leading to mutations and lesions and different ways to repair DNA damage
- Students will learn about the various ways in which these biological processes are regulated and the significance of regulation in maintaining life forms

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Unit 1

Nucleic Acids: Structure and Organization

No. of Hours: 12

History of DNA discovery, features of the double helix, various forms of DNA. Denaturation and reassociation of DNA, hyperchromicity, melting temperature, factors affecting T_m of DNA molecules. Types of RNA and their structure. Definition of a gene, organization of genes in viruses, bacteria and eukaryotes. Complexity of eukaryotic genes and chromosomes, supercoiling of DNA and its importance, linking number, topoisomerases, inhibitors of topoisomerases and their application in medicine, Nucleosome structure and packaging of DNA into higher order structures.

Unit 2

Replication of DNA

No. of Hours: 10

General features of DNA replication, the chemistry of DNA synthesis, DNA polymerase, the replication fork, enzymes and proteins in DNA replication, E coli DNA polymerases, stages of replication-initiation, elongation and termination, origin of replication, replication in eukaryotes, end replication problem, telomerase, various modes of replication. Comparison of replication in prokaryotes and eukaryotes. Inhibitors of replication.

Unit 3

Transcription and RNA processing

No. of Hours: 14

DNA-dependent RNA polymerase, sigma factor, bacterial promoters, identification of DNA binding sites by DNA footprinting, three stages of RNA synthesis (initiation, elongation and termination), rho-dependent and rho-independent termination, Transcription in eukaryotes, Transcription factors, inhibitors of transcription and applications as antibiotics. RNA processing, modification of eukaryotic mRNA at the 5’ and the 3’ end, splicing introns, alternative splicing, exon shuffling and RNA editing, processing of rRNAs and tRNAs.

Unit 4

Translation

No. of Hours: 10

Features of the genetic code, triplet nature, degeneracy, wobble hypothesis. Experimental approaches used to decipher the genetic code. The ribosome as a supramolecular machine, structure of tRNAs. The five stages of protein biosynthesis, charging of tRNAs, aminoacyl-tRNA synthetases, initiation in prokaryotes and in eukaryotes, elongation, termination. Inhibitors of protein synthesis and their application in medicine.

Unit 5

DNA damage and Repair No. of Hours: 4

Molecular basis of mutations, types of mutations - transition, transversion, frame shift mutations. DNA damage by hydrolysis, alkylation, oxidation and radiation. Mutations caused by base analogs and intercalating agents. Ames test. Replication errors and their repair, mismatch repair system. Repair of DNA damage-direct reversal of DNA damage, base excision repair, nucleotide excision repair, translesion DNA synthesis.

Unit 6

Regulation of Gene expression No. of Hours: 10

Principles of gene regulation, negative and positive regulation, concept of operons, regulatory proteins, activators, repressors, DNA binding domains. Regulation of gene expression in bacteria, lac operon and trp operon, induction of SOS response, synthesis of ribosomal proteins. Overview of regulation of gene expression in eukaryotes, heterochromatin, euchromatin, chromatin remodeling, DNA binding activators and co-activators, regulation of galactose metabolism genes in yeast, Riboswitches, RNA interference, siRNA, miRNA

Practical

1. Identification of nucleotide bases by paper chromatography
2. Ultraviolet absorption spectrum of DNA/RNA
3. Determination of DNA concentration by A_{260nm}
4. Quantitative estimation of DNA by DPA method
5. Quantitative estimation of RNA by orcinol method
6. Isolation of chromosomal DNA and to assess the purity by A_{260}/A_{280} Ratio
7. Isolation of total RNA from bacteria/yeast

References

1. Lehninger: Principles of Biochemistry (2013) 6th ed., Nelson, D.L. and Cox, M.M., W.H. Freeman & Company (New York), ISBN:13: 978-1-4292-3414-6 / ISBN:10-14641-0962-1.
2. Molecular Biology of the Gene (2008) 6th ed., Watson, J.D., Baker, T.A., Bell, S.P., Gann, A., Levine, M. and Losick, R., Cold Spring Harbor Laboratory Press, Cold Spring Harbor (New York), ISBN:0-321-50781 / ISBN: 978-0-321-50781-5.

Additional Resources:

1. Lewin's Gene X (2018) 10th Edition. Benjamin Lewin; Jocelyn E Krebs; Stephen T Kilpatrick; Elliott S Goldstein, Bartlett Learning Publishers, LLC, ISBN: 978-0-7637-6632-0.

Teaching Learning Process

Lectures are delivered to students using traditional chalk and board method as well as LCD projection. Virtual learning environment will be introduced as learning resources (presentations, video and quiz) to enhance and support the lecture-based units. Lectures are organized in order to introduce undergraduate students to the recent research. To enhance understanding, group discussions, paper presentations and other online modules are be employed. Practicals are designed in such a way so as to develop laboratory and data analysis skills.

Assessment Methods

Student learning outcomes cannot be assessed by a single evaluation criteria. A combination of direct and indirect assessments should be used. Direct methods of assessment involves students to demonstrate their learning while indirect methods requires students to reflect on understanding.

- Regular attendance contributes to internal assessment
- Observations (information collected during group work, study sessions etc
- Tests, essays, presentations, etc. are generally direct methods of assessment
- Indirect methods include surveys and external review through viva voce interviews.
- Continuous assessment will utilize existing student course work (Portfolio) as both a grading instrument as well as data for assessing student learning outcomes. This portfolio may contain assignments, reports, class tests, case studies, presentations and practical file record.
- Internally developed class tests, quizzes etc
- End Semester Examination

Keywords

DNA structure, DNA replication, DNA damage, Transcription, Translation, RNA processing, Regulation of gene expression

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Proteins and Enzymes
(BS C5)
Core Course - (CC) Credit:6

Course Objective(2-3)

The objective of the course is to introduce the students to proteins, most remarkable biomolecules in terms of diversity of function, their structure and various techniques employed to purify proteins and to the world of enzymes, biological catalysts with remarkable properties with an aim to develop an understanding of enzyme kinetics, mechanism of enzyme action, regulatory properties and their applications in medicine.

Course Learning Outcomes

- Students will acquire basic knowledge about the functional diversity of proteins and different levels of structural organization of proteins
- Students will learn about the relationship between protein structure and function the techniques that are used to purify proteins
- Students will acquire insight into enzyme kinetics, inhibition, regulation and mechanism of action
- Students will acquire knowledge about the applications of enzymes in medicine and industry

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Unit 1

Introduction to covalent structures of protein

No. of Hours: 12

Amino acids and their properties. Biologically important peptides - hormones, antibiotics and growth factors. Conjugated proteins, multimeric proteins and metalloproteins. Diversity of proteins. Organization of protein structure- primary, secondary, tertiary and quaternary structures. Protein sequencing- Edman degradation. Solid phase peptide synthesis. Nature of stabilizing bonds- covalent and non covalent. Peptide bond- dihedral angles. Ramachandran map, Secondary structure- Helices, sheets and turns.

Unit 2

Tertiary structures and Protein Folding

No. of Hours: 10

Tertiary and quaternary structures. Motifs and domains. Structures of myoglobin and haemoglobin. Oxygen binding curves, influence of 2,3-BPG, CO_2. Concerted and sequential models for allosteric proteins. Haemoglobin disorders. Denaturation and renaturation of proteins. Introduction to thermodynamics of folding. Role of chaperones, chaperonins and PDI. Defects in protein folding: Alzheimer’s and Prion based.

Unit 3

Purification and analysis of proteins No. of Hours: 10

Ammonium sulphate fractionation, dialysis. Ion exchange chromatography, molecular sieve chromatography, affinity chromatography, HPLC and FPLC. Gel electrophoresis, SDS-PAGE, IEF and 2-D electrophoresis.

Unit 4

Introduction to enzyme kinetics No. of Hours: 12

Nature of enzymes - protein and non-protein (ribozyme, abzymes). Cofactor and prosthetic group. Classification of enzymes. Fischer’s lock & key and Koshland’s induced fit hypothesis. Enzyme specificity. Enzyme Kinetics- Michaelis-Menten equation, Lineweaver-Burk plot. Determination of Km, Vmax, Kcat. Factors affecting enzyme activity. Enzyme Inhibition- Reversible (competitive, uncompetitive, non-competitive, mixed). Mechanism based inhibitors.

Unit 5

Mechanisms of enzyme action and regulation

No. of Hours: 10

Acid-base and covalent catalysis (chymotrypsin, lysozyme). Metal activated enzymes and metalloenzymes. Allosteric regulation, feedback inhibition (ATCase), reversible covalent modification (glycogen phosphorylase). Activation by proteolytic cleavage, zymogens. Regulation of pyruvate dehydrogenase. Coenzymes.

Unit 6

Enzymes in medicine and industry No. of Hours: 6

Isoenzymes. Application of enzymes in diagnostics (SGPT, SGOT, creatine kinase, alkaline and acid phosphatases), Enzyme immunoassay (HRP), enzyme therapy (Streptokinase). Metal base drug interaction. Enzyme immobilization and its applications.

Practical

1. Estimation of proteins by Biuret and Lowry's method.
2. Determination of isoelectric pH of casein.
3. Ammonium sulphate fractionation of crude homogenate from germinated mung beans
4. Assay for acid phosphatase activity and specific activity.
5. Progress curve of enzyme
6. Effect of pH on enzyme activity

7. Determination of Km and Vmax using Lineweaver-Burk plot.

References

1. Nelson, D. L. and Cox, M.M. Lehninger, Principles of Biochemistry, 5th Ed., W.H. Freeman and Company (N.Y., USA.), 2008.
2. Voet, D. and Voet, J.G. Biochemistry, 3rd Ed., John Wiley & Sons, Inc. USA, 2004.
3. Fundamentals of Enzymology (1999) 3rd ed., Nicholas C.P. and Lewis S., Oxford University Press Inc. (New York), ISBN:0 19 850229 X.
4. The Tools of Biochemistry (1977; Reprint 2011) Cooper, T.G., Wiley India Pvt. Ltd. (New Delhi), ISBN: 978-81-265-3016-8.

Additional Resources:

1. Physical Biochemistry (2009) 2nd ed., Sheehan, D., Wiley-Blackwell (West Sussex), ISBN: 9780470856024 / ISBN: 9780470856031.

Teaching Learning Process

Lectures are delivered to students using traditional chalk and board method as well as LCD projection. Virtual learning environment will be introduced as learning resources (presentations, video and quiz) to enhance and support the lecture-based units. Lectures are organized in order to introduce undergraduate students to the recent research. To enhance understanding, group discussions, paper presentations and other online modules are be employed. Practicals and projects are designed in such a way so as to develop laboratory and data analysis skills.

Assessment Methods

1. Mid-semester and End-semester examinations
2. Periodic Class Tests
3. Assignments
4. Open book tests
5. Class Presentations
6. Practical Records
7. Group Discussions

Keywords

Proteins, Peptide bond, Conformation, Enzyme, Catalysis, Kinetics, Inhibition.

Systems Physiology
(BS C8)
Core Course - (CC) Credit:6

Course Objective(2-3)

Physiology is the science of function in living organisms.The course provides an understanding of fundamental principles of animal physiology and how these principles are incorporated into adaptations of different animal groups. The curriculum emphasizes on integrating the knowledge of how systems within diverse organisms function and respond to changes in their environment.A comprehensive way to understand the complexity of an organ system is to cover the comparative aspects of animal physiology.An applied theme of the paper is based on the “Krogh's principle”, named after the Danish physiologist August Krogh, winner of the Nobel Prize in Physiology in 1920, which proposes use of specific organisms convenient to study specific questions to address the central concept of evolutionary adaptations. This approach proves to be of practical value and provides the basis to understand vital functions in organisms.

Course Learning Outcomes

After completing this course, the students should be able to

· Understand the importance of homeostasis in different animals

· Know how animals obtain energy from their environment

· Understand unique role of various organs and organ systems in performing various vital functions

· Understand the role of physiology in adapting to various environments

· Integrate critical thinking and scientific knowledge from diverse organisms and integrate them in an effective manner

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Unit 1

Unit 1: Generation and utilization of energy No.of Hours: 15

Feeding patterns found in different animals; intracellular and extracellular digestion, digestive enzymes, carbohydrate digestion: Cellulose digestion in animals

Terrestrial, aquatic and aerial locomotion; Locomotorycost:running, swimming and flying;Strategies offlight ininsects and birds; Role of buoyancy in swimming: various factors including gas floats

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Unit 2

Unit 2: Gas exchange in organisms No. of Hours: 7

Physiology of aquatic and aerial breathing; Respiratory organs in aquatic and terrestrial systems:tracheain insects,gills in fishes, lungs in birds; Role of skin in respiration

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Unit 3

Unit 3: Bulk transport No. of Hours: 10

General plan and physiology of circulatory system in invertebrates and vertebrates:blood and its components; closed and open systemof circulation, single circulation and double circulation: circulation patterns of cockroach,bony fishes and amphibians. Physiology of heart: cardiac output, regulation of heartbeat- Starling’s Law

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Unit 4

Unit 4: Regulatory Physiology No. of Hours: 18

Homeostasis in animals: regulation of water and solutes in aquatic andterrestrial animals; osmoconformers and osmoregulators, Osmoregulatory organs: gills in fishes, rectal glands and nasal glands in birds; Physiology of osmoregulation in marine invertebrates, elasmobranchs and bony fishes (freshwater and marine); Water balance in terrestrial animals: arthropods and kangaroo rat

Excretion of nitrogenous wastes in animals: contractile vacuole,nephridia and malphigian tubules; Ammonotelic,ureotelic and uricotelic organisms.

Patterns of thermoregulation: ectotherms and endotherms; heat exchange with surroundings; tolerance to high temperature in ectotherms- lethal temperature, tolerance to cold and freezing (freeze tolerant and intolerant animals), maintenance of body temperature by endotherms in cold(arctic fox/ penguins) and hot (camel) climate.

Unit 5

Unit 5: Integrative Physiology No. of Hours: 10

An overview of neuronal structure and function; General principles of sensory physiology- chemoreceptors: gustatory and olfactory; mechanoreceptors: statocyst in invertebrates and lateral line system of fishes; Infrared and thermal energy reception; electroreception

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Practical

TOTAL HOURS: 60 CREDITS: 2

1. Effect of isotonic, hypotonic and hypertonic saline solutions on erythrocytes

2. Preparation of temporary mounts: nerve cells

3. Enumeration of white blood cells using haemocytometer

4. Preparation of blood smear and Differential Leucocyte Count (D.L.C)

5. Study of sections of mammalian oesophagus, stomach, ileum, rectum, liver, trachea, lung, kidney,spinal cord, skin

6. Mounting of septal and pharyngeal nephridia of earthworm*

* subject to UGC guidelines

Value Added Experiments:

1. Effect of respiratory CO_2 on pH of a solution
2. Study of insect wings and their venation
3. Observation of cockroach heartbeat*

References

1. Schmidt-Nielsen, K. (2005). Animal Physiology: Adaptation and environment. 5th edition. Cambridge University Press.

2. Randall D., Burggren W. and FrenchK. (2002), Eckert Animal Physiology.5th edition. W. H. Freeman

3. Hoar, W.S. (1983) General and comparative physiology. 3rd edition. Prentice-Hall

Additional Resources:

1. Moyes C.D., Schulte P.M. (2006) Principles of Animal Physiology. 8th edition. Pearson Education, Inc.

2. Campbell, N.A. and Reece J.B (2011). Biology. IX Edition. Pearson, Benjamin, Cummings.

3. Starr C., Taggart R.(2006). Biology: The Unity and Diversity of Life. 2nd edition. Brooks/Cole Thomson Learning

https://www.coursera.org/learn/physiology

Teaching Learning Process

· Apart from chalk-and board teaching, usage of power point presentations, video tutorials,

discussion of e-resources.

· As part of peer learning, regular group discussions can be held amongst the students to enhance their knowledge on course-related topics.

· To enhance learning of hypothesis-driven research and develop communication skills of students, presentations and debates can be organized on various themes as prescribed in the syllabus while focusing on the latest development in them.

· Visit of students to an Institute of Eminence/ Organizing talks by eminent scientists/physicianscan help deepen interest of students in the field. Students can be encouraged to undertake internships in these places to get exposure to latest technologies.

Assessment Methods

Assessment of Theory and Practical component 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
- Continuous assessment: 5 marks
- Practical records: 10 marks
- Viva voce: 5 marks

· Semester end exam: 25 marks

Keywords

Homeostasis, digestion , locomotion ,buoyancy , respiration, circulation, heart, osmoregulation , excretion, thermoregulation, sensory physiology

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Animal Behaviour and Chronobiology
(BS DSE-2)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Although humans have always been fascinated with behaviour of animals, the formal discipline of animal behaviour-ethology-is a relatively new concept. It gained momentum when Konrad Lorenz, Karl von Frisch and Nikolaas Tinbergen, were jointly awarded the Nobel Prize in Physiology or Medicine in 1973 for their work of developing ethology.

1. This course aims to provide an overview of scientific study of animal behaviour: its underlying mechanisms and evolutionary relation, including neural, hormonal, and genetic basis of behaviour.
2. Animal behaviour is the bridge between the molecular and physiological aspects of biology.
3. Chronobiology studies how natural rhythms affect living organisms.
4. The related laboratory exercises will provide hands-on experience for many of these concepts.
5. The knowledge gained from studying animal behavior and chronobiology has had a huge impact in the fields of medicine, psychology and the social sciences.
6. The course will help the students to understand the huge importance of animal behavior and chronobiology and how can this knowledge be used in an applied way.

Course Learning Outcomes

After completing this course, the students should be able to

- Describe basic concepts of ethology
- Key concepts to understand animal behaviour
- The fascinating range and complexity of behaviour in animals
- Basic concepts of chronobiology and its application to human pathology
- Designing and implementing experiments to test hypotheses relating to animal behavior and use of basic statistical analyses appropriate to the experiment’s design

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Unit 1

Unit 1: Introduction to Animal Behavior and Chronobiology No. of Hours: 2

Origin, history and significance of ethology: Brief profiles of Karl von Frisch, Ivan Pavlov, Konrad Lorenz, Niko Tinbergen, Franz Halberg

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Unit 2

Unit 2: Mechanisms of Behavior No. of Hours: 8

Proximate and ultimate causes of behavior; Innate behavior: Instinct, FAP; Learning: Associative learning: Classical and Operant conditioning; Non-associative learning: Habituation, Imprinting; Stimulus filtering; Sign stimuli; Code breakers

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Unit 3

Unit 3: Patterns of Behavior No. of Hours: 10

Reflexes: Types of reflexes, reflex path, characteristics of reflexes (latency, after discharge,

summation, fatigue, inhibition) and its comparison with complex behavior. Orientation: Primary and secondary orientation; kinesis-orthokinesis, klinokinesis; taxis-tropotaxis and klinotaxis, menotaxis (light compass orientation).

Unit 4

Unit 4: Social Behavior and Sociobiology No. of Hours: 15

Concept of Society; Degree of sociality; Insects' society with Honey bee as example: Society organization and caste system, Haplodiploidy in honeybees; polyethism vs polymorphism; Dance as means of communication; Experiments to prove distance and direction component of dance, learning ability in honey bee, swarming and formation of new hive/queen, Altruism andReciprocal altruism, Hamilton's rule and inclusive fitness with suitable examples,.

Unit 5

Unit 5: Sexual Behavior No. of Hours: 10

Asymmetry of sex, Sexual dimorphism mate choice, Intra-sexual selection (male rivalry: competition, territoriality, infanticide), Inter-sexual selection (female choice), , Consequences of mate choice for female fitness, Reproductive behaviour pattern (Courtship, mating system, Parental care).

Unit 6

Unit 6: Biological rhythm No. of Hours: 15

Types and properties of biological rhythms: Circadian rhythms, Tidal rhythms, Lunar rhythms; Role of zeitgebers in Entrainment, Role of melatonin, Relevance of biological clocks, Sleep disorders: endogenous and exogenous; Chronotherapy.

Practical

TOTAL HOURS: 60 CREDITS: 2

1. To study the nesting behaviour of birds and social insects.

2. To study the behavioral responses of wood lice to dry condition.

3. To study behavior responses of wood lice in response to humid condition.

4. To study habituation in snail/ earthworm/ dog.

5. To study the phototaxis behavior in insect larvae.

6. Study and actogram construction of locomotor activity of suitable animal models.

7. To study the behavioral activities of animals in field and prepare a short report.

Value Added Experiments:

1. Study of circadian functions in humans (daily eating, sleep and temperature patterns).

2. Food Selection in insect larvae / ants/ Food preference in Drosophila

3. Larval Host/Resource Preference

References

1. McFarland David, Animal Behavior: Psychobiology, Ethology and Evolution.3rd Ed. Benjamin Cummings, 1998

2. An A. Manning & MS Dawkins, Introduction to Animal Behavior, Cambridge University Press, 2012

3. J. Alcock, Animal Behavior,. 10th Ed., Sinauer Associate Inc., 2013

4. Mandal. Textbook of Animal Behaviour. 3rd edition., PHI Pvt. Ltd.

Additional Resources:

1. W. Paul, Sherman and J Alcock, Exploring Animal Behavior, Sinauer Associate Inc., Massachusetts, 2013

8. E-RESOURCES

https://www.coursera.org/learn/animal-behaviour https://en.wikibooks.org/wiki/Animal_Behavior https://www.coursera.org/learn/circadian-clocks

Teaching Learning Process

- Apart from chalk-and board teaching, usage of power point presentations, video tutorials, discussion of e-resources.
- As part of peer learning, regular group discussions can be held amongst the students to enhance their knowledge on course-related topics.
- To enhance learning of hypothesis-driven research and develop communication skills of students, presentations and debates can be organized on various themes as prescribed in the syllabus while focusing on the latest development in them.
- Visit of students to a Forest/ Wild life Sanctuary/Biodiversity Park/Zoological Park can help them understand field observations. Students can be encouraged to undertake internships in these places so as to deepen their interest in this field.

Assessment Methods

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

a. Theory: Total marks: 100

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Internal assessment: 25 marks

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Mid-term test: 10 marks

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Written Assignment or presentation: 10 marks

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Attendance: 5 Marks

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Semester end exam: 75 marks

b. Practicals: Total 50 marks

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Continuous Evaluation: 25 marks

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Practical class attendance: 5 marks

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Practicals performance: 5 marks

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Practical records: 10 marks

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Viva: 5 marks

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Semester end exam: 25 marks

Keywords

Animal behaviour, ethology, sexual selection, altruism, chronobiology, biological rhythms, biological clock, circadian rhythms

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Biotechnology
(BS DSE-3)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The aim of this course is to make students understand:

- The basic concept of creating recombinant DNA using restriction enzymes and vectors and to introduce that DNA into host cells.
- Engineering DNA to create plants and animals with improved qualities
- The ethical issues involved in the field of Biotechnology.

Course Learning Outcomes

At the end of this course, students should be able to understand:

- Basic concepts pertaining to the techniques used in recombinant DNA technology (RDT).
- Biology of plasmids, and phages and their uses in designing different cloning vectors.
- Designing and application of expression vectors for prokaryotIc systems
- Fundamental concepts of animal and plant biotechnology with their applications in creating transgenic animals and plants, and therapeutics.
- Ethical concerns related to genetically modified organisms and impact of biotechnology on the society.

Unit 1

Basic Recombinant DNA technology Hours 12

Overview of recombinant DNA technology, Restriction-modification systems, Restriction endonucleases and other enzymes used in manipulating DNA molecules, Cloning vectors used in prokaryotes and eukaryotes, plasmid vectors (pBR322, pUC8, pGEM3Z), bacteriophage based vectors (M13 and lambda), vectors for yeast, animals and plants, Joining DNA fragments, linkers and adaptors, introduction of DNA into bacterial cells and selection for recombinants, direct selection, colony and plaque hybridization, Polymerase chain reaction and DNA sequencing.

Unit 2

Expression of cloned genes Hours 10

Vectors for expression of foreign genes in E. coli, cassettes and gene fusions, Challenges in producing recombinant protein in E. coli, Production of recombinant protein by eukaryotic cells, Fusion tags and their role in purification of recombinant proteins, Protein engineering.

Unit 3

Plant Biotechnology Hours 12

Introduction to cell and tissue culture, Plant tissue culture media (composition, types and preparation), plant hormones and growth regulators in tissue culture, Preparation of suitable explants for organogenesis, Micropropagation on large scale, somatic embryogenesis, protoplast culture and somatic hybridization, Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Agrobacterium mediated gene transfer, Mechanisms of DNA transfer into animal cells, general features of Ti and their use as vectors, reporter genes,

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Unit 4

Animal Biotechnology Hours 12

Characteristics of cells in culture, Culture media – composition and preparation, Balanced salt solution - chemical, physical and metabolic functions of different constituents of culture medium- Role of CO_2 ,Culturing and maintenance of different animal cell lines (Primary and established cell lines), methods of gene transfer to animal cells, creating transgenic animals, Artificial Insemination.

Unit 5

Applications in Plant and Animal Biotechnology Hours 10

Transgenic plants, Crop improvement, herbicide resistance, insect resistance, production of recombinant gene products like Insulin and Factor VIII, Animal models for tackling human diseases (Gene knock out in mice models), Gene therapy, Recombinant vaccines.

Unit 6

Biosafety, Bioethics and Society Hours 4

Biosafety, containment issues, emergence of antimicrobial resistance, risks and controversies linked with genetically modified organisms and plants, Significance of patents.

Practical

1. Isolation of plasmid DNA from E. coli cells

2. Digestion of plasmid DNA with restriction enzymes and agarose gel electrophoresis

3. Amplification of a DNA fragment by PCR

4. Transformation of E. coli cells with plasmid DNA

5. Selection of Transformants by antibiotic resistance

6. Aseptic Culture of explants on nutrient media.

References

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

2. Principles of Gene Manipulation and Genomics (2006) 7th ed., Primrose, S.B., and Twyman, R. M., Blackwell publishing (Oxford, UK) ISBN:13: 978-1-4051-3544-3.

3. Molecular Biotechnology: Principles and Applications of Recombinant DNA (2010) 4th ed., Glick B.R., Pasternak, J.J. and Patten, C.L., ASM Press (Washington DC), ISBN: 978-1-55581-498-4 (HC).

Additional Resources:

1. Molecular cloning: A laboratory manual(1089),2nded ,J.sambrook,E.F.Fritsch and T.Maniatis, Cold spring Harbor laboratory press (3 vol;1959 pages,ISBN: 0879693096

Teaching Learning Process

1.Various modes of teaching will be adopted, including

lectures through chalk and talk,
PowerPoint presentations and online resources

2. Students will be encouraged to give presentations that will build their confidence to face group discussions.

3. During the practical classes students will be given an opportunity to work both individually and in groups to perform practicals. Students will also be encouraged to understand the rationale behind each step of an experiment which will enable them to develop the habit of carefully designing experiments in the future and to trouble shoot.

Assessment Methods

Classroom tests: At the end of every unit, a class test will be given to test the students' understanding of a particular topic taught in the class

Assignments: Assignments will be given at regular intervals for continuous learning and assessment. This will help students to get in-depth understanding of the course.

Mid-semester exam: to test the knowledge and understanding of various topics before the final exam.

Practical assessment: During and at the end of every practical, students will be assessed viva voce in addition to performing the experiment. Students will also be assessed during mock practical examination before the final practical exam.

Keywords

Recombinant DNA technology, Vectors,Transformation,Transgenic plants and animals, Plant tissue culture, Bioethics

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Endocrinology
(BS DSE-4)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The course entitled Endocrinology is designed to enable the students to understand and appreciate the delicate network and balance of hormones required for a healthy functioning of the body. The course emphasizes on the different types of hormones along with their physiological action. The students will be taught the consequences of any hormonal imbalances (over and underproduction of hormones) with special emphasis on human diseases. The course is designed to help students understand the role of the endocrine system in maintaining homeostasis, integrating growth and development, responding to the environment and for successful reproduction.

Course Learning Outcomes

- Students will be able to understand the role of endocrine system in maintaining ionic and glucose homeostasis.
- Students will be able to describe molecular, biochemical and physiological effects of all hormones and factors on cells and tissues.

- They will understand the integrative communications that regulate, growth, appetite, metabolism and reproduction.
- The course prepares the student for interpreting clinical parameters in a real life situation.

Unit 1

Introduction to Endocrinology No. of Hours: 3

History of endocrinology, characteristic of hormones, Classification –Local and circulating

hormones, chemical classification, Neurosecretions and neurohormones

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Unit 2

Hypothalamic-Pituitary system No. of Hours: 12

Hypothalamus; structure of hypothalamus, names and functions of important hypothalamic

nuclei, neuroendocrine regulation of endocrine glands and feedback mechanisms. Disorders of Growth hormone and ADH. PituitaryGland, structure of pituitary, Anterior and Posterior Pituitary and its hormones, their secretion, transportation, storage, functions and hypothalamic regulation. Hypothalamus- Hypophysis axis. Pineal gland, secretions and their functions in biological rhythms and reproduction.

Unit 3

Thyroid-Parathyroid system No. of Hours: 8

Thyroid gland; structure of thyroid gland, synthesis and functions of thyroid hormones, mode of action, regulation of thyroid hormone secretion; thyrocalcitonin. Disorders of thyroid gland (hypothyroidism, hyperthyroidism, Graves disease, Goiter).

Parathyroid Glands: Secretion, Action of parathyroid hormones, role of parathyroid hormone

and calcitonin in calcium homeostasis, disorders of parathyroid gland

(hyperparathyroidism).

Unit 4

Adrenal gland and its hormones No. of Hours: 12

Structural of Adrenal Gland – Synthesis and structure of hormones of the adrenal cortex

and medulla; Biological Action of glucocorticoids, mineralocorticoids, adrenaline and

noradrenaline on carbohydrate and protein metabolism and cardiovascular system,

osmoregulation, Stress (Flight and fight response) and diseases related to adrenal cortex and medulla (primary hyperaldosteronism, Cushing's syndrome, pheochromocytoma)

Unit 5

Pancreas and Gastrointestinal hormones No. of Hours: 15

Structure of Pancreatic Islets of Langerhans and hormones secreted by it; insulin secretion

(proinsulin) its activation, Glucagon secretion, mode of action of both hormones in

controlling the blood glucose level. Diabetes mellitus. A brief account of hormones of gastrointestinal tract (Gastrin, Secretin family of hormones) and kidney. Regulation of appetite and satiety: Leptin and Grehlin hormones.

Unit 6

Reproductive endocrinology No. of Hours: 10

Male Reproductive system; hormonal control of testes; chemistry and biosynthesis of

testosterone, functions of testosterone. Female Reproductive system, role of hormones in

Female Sexual cycle, placental hormones; parturition and lactation

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Practical

1. Study of the permanent slides of all the endocrine glands
2. Estrous cycle of rat.- Vaginal smear
3. Castration/ ovariectomy (subject to availability of rat)
4. Study of LH and HCG hormones using Ovulation and Pregnancy kits .
5. Tissue processing, microtomy and hematoxylin/eosin staining of endocrine glands: ovary, testis, thyroid and adrenal.
6. Determination assays of T3 and T4 using ELISA.
7. Estimation of blood glucose level using glucometer/ glucose kit.

References

J. Larry Jameson, editor. Harrison's Endocrinology. 2nd Ed McGraw-Hill Press (New

York) 2010

2. Turner, D.C. and Bagnara, J.T. (Editor). General Endocrinology. W. B. Saunders

Company (Philadelphia, Pennsylvania), 1976

3. Guyton A.C., Hall, J.E. Textbook of Medical Physiology 11th Ed. Elsevier Saunders 2006

4. Mac Hadley , Jonathan Levine Endocrinology Pearson; 6 edition

Additional Resources:

1. https://www.endotext.org/ A free clinical endocrinology internet resource.

2. https://www.mooc-list.com/tags/endocrine-system

3. https://www.mooc-list.com/course/anatomy-gastrointestinal-reproductive-and-endocrine-systems-edx

Teaching Learning Process

· Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.

· Active learning strategies: Group discussions, book reviews, paper presentations, videos, animations, are some methods that can be employed for effective teaching..

Case studies

Assessment Methods

1. Written Assignment.
2. Quiz and MCQs
3. Class Presentations
4. Case studies
5. Mid Term Examination
6. Practical Records
7. End semester examination

Keywords

Endocrine, Hormone, Hormone Receptors, Feedback regulation, Diabetes, Hypothyroid, Hyperthyroid, Testosterone, Estrogen, Growth Hormone, Calcitonin, ADH, Parathyroid

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Microbiology
(BS DSE-8)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

1. To describe the historical perspectives that are important in the development of microbiology and make students aware ofthe diversity, distribution and characteristic features of various microorganisms

2. To make students aware of the indispensable role of microorganisms in the environment, biotechnology, fermentation, medicine and other industries important to human welfare

3. To prepare students for higher education in microbiology related disciplines.

Course Learning Outcomes

On completion of this paper, students should be able to:

- Identify different microbes
- Perform routine microbiological practices including sterilization, media preparation, maintenance of microbial culture, staining etc.
- Test microbial cultures for antibiotic resistance.
- Pursue research using microbes.

Unit 1

Unit 1: History of Microbiology No. of Hours: 6

History of development of microbiology as a discipline, Spontaneous generation versus biogenesis, contributions of Anton von Leeuwenhoek, Joseph Lister, Paul Ehrlich, Richard Petri, Charles Chamberland, Edward Jenner, Louis Pasteur, Robert Koch, Martinus W. Beijerinck, Sergei Winogradsky, Alexander Fleming, Elie Metchnikoff and Emil von Behring

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Unit 2

Unit 2 Diversity of Microbial world and Microbial Cell organization No. of Hours: 14

Difference between prokaryotic and eukaryotic microorganisms. General characteristics of different groups: Acellular microorganisms (Viruses, Viroids, Prions) and Cellular microorganisms (Bacteria, Archaea, Algae, Fungi and Protozoa) with emphasis on distribution, occurrence and morphology. Cell-wall: Composition and detailed structure of Gram positive and Gram negative cell walls, mechanism of Gram's staining. Cell Membrane: Structure, function and chemical composition of bacterial and archaeal cell membranes.

Unit 3

Unit 3: Microbial Nutrition and Growth No. of Hours: 14

Nutritional types of microorganisms, growth factors, culture media- synthetic and complex, types of media; isolation of pure cultures, growth curves, mean growth rate constant, generation time; influence of environmental factors on growth of microbes: effect of pH, temperature, solute, oxygen concentration, pressure and radiations. Sterilization, disinfection and antiseptics. Use of physical methods (heat, low temperature, filtration, radiation) and chemical agents (phenolics, halogens, heavy metals, sterilizing gases) in microbial control.

Unit 4

Unit 4: Pathogenicity of Microorganisms and Antimicrobial Chemotherapy No. of Hours: 12

Introduction to pathogenic microbes; disease, pathogenesis, diagnosis, vaccine, treatment and symptoms (TB, HIV, Malaria) General Characteristics of antimicrobial drugs, determining the level of antimicrobial activity: dilution susceptibility test and disc diffusion test. Mechanism of action of penicillin, vancomycin and tetracycline.

Unit 5

Unit 5: Applications of Microbiology No. of Hours: 14

Importance of microbiology in food and industries. Basic design of fermenter, continuous and discontinuous culture. Preparation of fermented food products such as yoghurt, curd and cheese. Preparation of alcoholic beverages like wine and beer. Single cell proteins. Treatment of waste water (Municipal treatment plant) and sewage. bioremediation and biodegradation.

Practical

1. To prepare and sterilize the culture media for the growth of microorganisms.

2. To perform various culture transfer techniques: Solid to solid (streaking), liquid to solid (spreading), liquid to liquid, solid to liquid and determine CFU/ml.

3. To stain bacteria using methylene blue.

4. To perform Gram staining.

5. To prepare temporary mount of algae (spirogyra)/fungi (penicillium).

6. To study the growth curve of E.coli.

7. Study of different shapes of bacteria, fungi, algae, protozoa using permanent slides/ pictographs.

References

Compulsory

1. J. Willey, L. Sherwood & C. Woolverton, Prescott's Microbiology. 10th Ed., McGraw Hill international, (2017). ISBN 13: 9781259657573

2. MJ Chan, ECS Krieg & NR Pelczar, Microbiology, 5th Ed. McGraw Hill International, (2004). ISBN 13: 9780094623206

Additional Resources:

1. M. T. Madigan, J. M. Martinko & D. A. Stahl, Brock Biology of Microorganisms, 13th Ed., Pearson Education International. (2010). ISBN 13: 9780321649638.

2. J. G. Cappuccino, and N. Sherman, Microbiology: A Laboratory manual, 10th Ed. Benajamin/Cummings (2013), ISBN 13: 9780321840226.

Teaching Learning Process

Various modes of teaching will be adopted, including lectures through chalk and talk, PowerPoint presentations and online resources shall be used.During the practical classes students will be given an opportunity to work both individually and in groups to perform practicals. Students will also be encouraged towards self-directed learning which enable them to develop the habit of independent learning and to get in-depth understanding of the solution of particular problem.

Assessment Methods

Classroom tests: At the end of every unit, a class test will be given to test the students' understanding of a particular topic taught in the class

Assignments: Assignments will be given at regular intervals for continuous learning and assessment. This will help students to get in-depth understanding of the course.

Mid-semester exam: to test the knowledge and understanding of various topics before the final exam.

Practical assessment: During and at the end of every practical, students will be assessed viva voce in addition to performing the experiment. Students will also be assessed during mock practical examination before the final practical exam.

Keywords

Microorganisms, Diversity, Culture, Pathogenicity, Industrial microbiology

Natural Resources Management
(BS DSE-5)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The course will enable students to understand the role of natural resources in maintaining ecological balance.

It will help them to appreciate different types of natural resources and the threats faced by them.

The syllabus covers basics concepts as well as applied aspects required in conservation and natural resource management.

Course Learning Outcomes

Students shall be able to:

· Define and differentiate between biological and physical natural resources

· Appreciate the role of natural resources in ecological, economic and socio-cultural activities

· Understand the effect of anthropogenic interference on natural resources

· Understand the laws and policies associated with resource management and conservation

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Unit 1

Unit 1: Natural Resources and Sustainable Utilization No. of Hours: 10 Definition and types of Natural resources (physical and biological), Concept, Guiding principles of sustainable development, Brundtland commission, approaches to sustainable utilization (economic, ecological and socio-cultural), Biodiversity register

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Unit 2

Unit 1: Natural Resources and Sustainable Utilization No. of Hours: 10

Definition and types of Natural resources (physical and biological), Concept, Guiding principles of sustainable development, Brundtland commission, approaches to sustainable utilization (economic, ecological and socio-cultural), Biodiversity register

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Unit 3

Unit 3: Biological Resources No. of Hours: 12

Biodiversity-definition, types and level; Significance; Categories of threats; climate change, Management strategies; Bioprospecting; Introduction to IPR; CBD; National Biodiversity Action Plan, Biodiversity Act 2002, Living planet index, Ecological footprint

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Unit 4

Unit 4: Forests and Energy No. of Hours: 12

Definition and types, Cover and its significance (phytogeographical distribution with special reference to India); Agroforestry, Major and minor forest products (non-wood forest products); Depletion; Management (joint forest management), Renewable and non-renewable sources of energy (tidal energy, ocean thermal energy conversion)

Unit 5

Unit 5: Contemporary practices in Resource Management No. of Hours: 12

EIA, GIS, Participatory Resource Appraisal, Ecological Footprint with emphasis on carbon footprint, Resource Accounting; Types of waste and waste management strategies (solid waste, landfill sites, biogas, e-waste, vermicompost), National and international efforts in resource management and conservation

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Practical

1. Estimation of solid waste generated by a domestic system (biodegradable and non-biodegradable) and its impact on land degradation.

2. Collection of data on forest cover of specific area and correlate it with conservation and socio-economic practices.

3. Measurement of woody species by DBH (diameter at breast height) method.

4. Calculation and analysis of ecological/ carbon footprint by using online calculators.

5. Ecological modelling (climate change models).

6. Estimation of soil organic carbon by Walkley and Black’s method.

7. Determine canopy cover and basal area of grassland species.

8. Visit to landfill sites/ mining area/sewage treatment plant.

9. Demonstration/ project on vermicomposting

References

1. N. Vasudevan, Essentials of Environmental Science, Narosa Publishing House, (New Delhi),

2006

2. J. S.Singh, S.P Singh and S. Gupta, Ecology, Environment and Resource Conservation, Anamaya Publications, (New Delhi), 2006

3. An P.P Rogers, K.F Jalal and J.A Boyd, Introduction to Sustainable Development,. Prentice Hall of India Private Limited (New Delhi), 2008

4. Singh J S., Singh S P., Gupta S R, Ecology and Environmental Science and Conservation. S Chand and Company Ltd. 2017. ISBN: 978-93-837-4600-2

Additional Resources:

1. B W Pandey, Natural Resource Management. 2005. Mittal Publications

2. K K Singh, Natural Resources Conservation and Management. 2008. M D Publications Pvt. Ltd.

Teaching Learning Process

Teaching methodology:

1. Lecture cum discussion methods
2. Group discussions
3. Case studies
4. Reinforcement of concepts using e-resources
5. Field visit
6. Project based learning

Assessment Methods

Teaching methodology:

1. Lecture cum discussion methods
2. Group discussions
3. Case studies
4. Reinforcement of concepts using e-resources
5. Field visit

6. Project based learning

Keywords

Natural resources, sustainable development, waste management, climate change, forestry, ecological footprint

Nutritional Biochemistry
(BS DSE-7)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

The course in Nutritional biochemistry being offered as an elective to students of biological sciences aims at providing them with Nutrition based concepts of cellular metabolism. It focuses on the concept of energy metabolism and is a comprehensive study of the cellular and biochemical mechanisms that govern the digestion ,assimilation and utilization of major and minor dietary components required to maintain health. It also outlines the factors and biochemical events that cause ill-health due to malnutrition

Course Learning Outcomes

On complete of the course the student will be able to

1. Understand the digestion absorption and utilization of the major dietary components like Carbohydrates ,proteins and lipids.

2. Comprehend and appreciate the importance of Energy metabolism f the body in regulating body composition and health.

3. Appreciate and understand the role of Dietary fiber, essential fatty acids, lipotropic factors in coordinating biochemical and cellular

events that ensure good health.

4. Understand the biochemical mechanism by which vitamins and minerals regulate cellular metabolism and health.

5. Develop an inquisitive learning approach to seek answers regarding the role of the microbiome, food drug interactions

and medicinal properties of food components that are essential for maintaining good health

Unit 1

Introduction to Nutrition and Energy Metabolism HOURS: 6

Defining Nutrition, role of nutrients. Unit of energy, Biological oxidation of foodstuff. Physiological energy value of foods, SDA. Measurement of energy expenditure, BMR and RMR- factors affecting BMR. Recommended Nutrient Intakes (RNI) and Recommended Dietary Allowances for different age groups.

Unit 2

Macronutrients No. of HOURS: 20

Food sources of carbohydrates, Review functions of carbohydrates. Factors affecting Digestion, absorption and utilization. Glycemic index and glycemic load. Dietary fiber and role of fibre in health. Role of gut microbiome in nutritive health. Role of Pre amd probiotics in gut health.

Essential Fatty Acids; Functions of EFA, RDA, – excess and deficiency of EFA. Dietary implications of fats and oils, Combination ratios of n6 and n3, MUFA, PUFA and SFA Factors affecting Digestion, absorption and utilization. Importance of the following: a) Omega – fatty acids. Omega 3/ omega 6 ratio b) Phospholipids c) Cholesterol in the body d) Mono, Polyunsaturated and Saturated Fatty Acids.

Review of functions of proteins in the body, Digestion and absorption. Essential and Nonessential amino acids. Complete protein ,Amino Acid Availability, Antagonism, Toxicity, Imbalance ,Amino acid complementation and Supplementation in foods. Effects of deficiency. Food source and Recommended Dietary Allowances for different age group. Amino acid pool. NPU, Biological Value, Nitrogen balance. PEM and Kwashiorkor.

Unit 3

Micronutrients: Vitamins No. of HOURS: 12

Vitamin A, D, E, K Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME), Deficiency. Role of Vitamin A as an antioxidant, in Visual cycle, dermatology and immunity. Role of Vitamin K in Gamma carboxylation. Role of Vitamin E as an antioxidant. Extra-skeletal role of Vitamin D and its effect on bone physiology. Hypervitaminosis.

Vitamin C- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); role as cofactor in amino acid modifications. The B Complex vitamins- Dietary sources, RDA, Adsorption, Distribution, Metabolism and excretion (ADME); Thiamine-TPP roe in metabolism and deficiency disease; Niacin- Metabolic interrelation between tryptophan, Niacin and NAD/ NADP; Vitamin B6-conversion to Pyridoxal Phosphate. Role in metabolism, Biochemical basis for deficiency symptoms; Vitamin B12 and folate- metabolic role, homocysteine cycle, Biochemical basis for deficiency symptoms.

Unit 4

MicroMinerals and trace elements No. of HOURS: 10

Calcium, Iron and Phosphorus- Distribution in the body digestion, Absorption, Utilization , Transport, Excretion, Balance, Deficiency, Toxicity, Sources, RDA.

Iodine, Fluoride, Mg, Cu, Zn, Se, Manganese, Chromium, Molybdenum Distribution in the human body, Physiology, Function, deficiency, Toxicity and Sources

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Unit 5

Assessment of Nutritional status No. of HOURS: 6

Direct methods of assessment-Anthropometric measurements; Biochemical assessment; clinical signs; dietary records and nutrient intake. ROS assessment, GTT and glycosylated Hb, Differential diagnosis of B12 and folate.

Unit 6

Food-drug interactions and Nutraceuticals No. of HOURS: 6

Nutrient interactions affecting ADME of drugs. Drug induced nutrient deficiency: Alcohol, Antibiotics, Antimalarial drugs. Role of microbiome in maintaining Nutritive health.

Neutraceuticals and Food as medicine: turmeric, garlic, ginger, cumin, asafoetida

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Practical

1. Anthropometric assessment for a healthy individual and in cases of Kwashiorkor, Marasmus and Obesity.
2. Blood Lipid profile
3. Determination of oxidative stress: TBARS, antioxidant enzymes in hemolysate.
4. Estimation of vitamin in drugs/food/serum.
5. Estimation of minerals in drugs/food/serum.
6. Glycosylated haemoglobin
7. Nutritive value of foods
8. Case studies.

References

1. Textbook of Biochemistry with Clinical Correlations (2011) Devlin, T.M. John Wiley & Sons, Inc. (New York), ISBN: 978-0-4710-28173-4.

2. Krause's Food and Nutrition Care process.(2012); Mahan, L.K Strings,S.E, Raymond,J. Elsevier's Publications. ISBN- 978-1-4377-2233-8.

3. The vitamins, Fundamental aspects in Nutrition and Health (2008); G.F. Coombs Jr. Elsevier's Publications. ISBN-13- 978-0-12- 183493-7.

4. Principles of Nutritional Assessment (2005) Rosalind Gibson. Oxford University Press. ISBN: 9780195171693

Additional Resources:

1. Nutritional Biochemistry. Author, Tom Brody. Edition, 2. Publisher, Harcourt Braces, 1999. ISBN, 9814033251, 9789814033251.

Teaching Learning Process

Classical chalk and board with some use of audio-visual aids and presentations.

Learning through discussions and encouraging peer learning and vertical learning

Engaging the students in epidemiological surveys to improve their observational skills, understand the importance in field nutritional assessment protocols in public health data collection and applying and analysing the data to arrive at logical inferences.

Assessment Methods

· Regular closed book tests

· Open booked tests and assignment with questions that encourage a holistic ad integrative approach to solving.

· Presentations to improve team work, oral skills and handling defence.

Honing their analytical ability and problem-solving skills by providing questions that are case studies or are problem-based

Keywords

Nutrition, Energy Metabolism, Macronutrients, Vitamins, Minerals, Assessment of nutritional status, Food-drug interactions, Nutraceuticals

Plant Physiology
(BS DSE-1)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

Aim of the course:

Plant physiology is a fascinating field of plant sciences and gives the students an insight into the structure - function integration in plants. The complex interactions of the plant with the environmental and edaphic factors form a major portion of plant physiological studies. How plants respond to maintain their homeostasis in the changing environmental conditions is one of the most recent fields of investigation in plant physiology. This DSE course titled 'Plant Physiology and Signaling ' aims to familiarize the students with this important subject along with the signaling pathways associated with physiological phenomena.

Course Learning Outcomes

After completing the course the students will be able to –

1. 1) appreciate the plant processes that occur at cell, organ, and whole plant level,
   2) understand the integration of soil, atmosphere, and plant in carrying out the life processes in plants,
   3) understand the complex regulation of phenomena of growth, flowering, combating stress etc.,
   4) assess the effect of climate change on some physiological phenomena and investigate mitigation measures ,
   5) use the knowledge to help crop growers, fruit farmers, floriculturists and others.

Unit 1

TOTAL HOURS: 60 CREDITS: 4

Unit 1: Plant Nutrition: uptake and distribution No. of Hours: 8+7+5

- Water potential and its components (solute potential, pressure potential, gravimetric potential and matric potential); intercellular water transport (diffusion, mass flow and osmosis), short-distance transport (water absorption by roots), aquaporins, pathway of water movement (apoplast and symplast), water and ion uptake from soil into roots, structural features of xylem which facilitate water and solute transport, root pressure, guttation, ascent of sap, cohesion-tension theory; Transpiration and its significance, factors affecting transpiration, antitranspirants; Mechanism of stomatal movement (starch-sugar hypothesis, proton

transport theory)

- Essential elements (macronutrients and micronutrients, criteria of essentiality, roles), methods of study and use of nutrient solutions (ash analysis, hydroponics and aeroponics), mineral deficiency symptoms, Soil cation exchange capacity, transport of ions across cell membrane-passive transport: simple (Fick's law) and facilitated diffusion (carrier and channel proteins), Donnan equilibrium, Nernst equation, active transport, proton ATPase pump, P-type ATPase and V-type ATPase, electrochemical gradient, ion flux, uniport, co-transport.
- Source-sink relationship, experimental evidence in support of phloem as the site of sugar translocation (aphid technique, girdling experiment), features of phloem cells with reference to photoassimilate translocation (phloem sealing mechanism, P-proteins, sieve tube-companion cells interaction, composition of phloem sap), pressure flow model, mechanism of photoassimilate translocation (phloem loading and unloading).

Unit 2

Unit 2: Nitrogen metabolism No. of Hours: 10

Biological Nitrogen fixation by free living organisms and in symbiotic association (nodulation, signals between symbionts- nod and nif genes, structure and function of enzyme Nitrogenase. Nitrate assimilation: Nitrate and Nitrite reductase. Primary and secondary ammonia assimilation in plants; ammonia assimilation by GS, GOGAT, GDH, seed storage proteins in legumes and cereals.

Unit 3

Unit 3: Plant Growth Regulators No. of Hours: 8

Discovery, basic structure and precursors, bioassays, physiological roles and commercial applications of auxins, gibberellins, cytokinins, abscisic acid and ethylene, Introduction to mode of action of hormones; General account of secondary metabolites, allelopathy.

Unit 4

Unit 4: Physiology of Flowering No. of Hours: 10

Photoperiodism: SDPs, LDPs, DNPs, photoinductive cycle (perception of photoperiodic signal and florigen), phytochrome (discovery and structure), red and far-red light responses on photomorphogenesis, fluence response, vernalization.

Unit 5

Unit 5: Signal transduction and stress physiology No. of Hours: 8

Spatial and temporal aspects of signal transduction, signal perception at plasma membrane

(characteristic features of membrane receptors, receptor kinases), signal transduction and amplification via second messengers (calcium, lipid signaling molecules, mitogen-activated protein (MAP) kinase cascade, cyclic nucleotides), Plant responses to abiotic stress through signaling pathways; developmental and physiological mechanisms that protect plants against environmental extremes; biotic stress (plant defense mechanisms, PAMP/MAMP triggered immunity (PTI), effector-triggered responses, SAR, pathogenesis-related proteins).

Unit 6

Unit 6: Environmental effects on plant physiological phenomena No. of Hours: 4

Effect of increase in CO_2 on photosynthesis and nutritional status of plant and soil, CO_2 fertilization effect on plants, effect of climate change induced warming on enzymes of photosynthesis (Rubisco) and respiration, blockers of photosynthetic electron transport as potential herbicides.

Practical

TOTAL HOURS: 30 CREDITS: 2

Practicals

- 1. To determine the osmotic potential of plant cell sap by incipient plasmolytic method.
- 2. To determine the water potential by weight method.
- 3. To study the effect of two environmental factors on transpiration of an excised twig.
- 4. To calculate stomatal index and stomatal frequency of two surfaces of leaves of a mesophyte and a xerophyte.
- 5. To study the effect of light intensity and carbon dioxide on O_2 evolution in photosynthesis.
- 6. To demonstrate the activity of nitrate reductase in two plant sources.
- 7. To perform chemical separation of photosynthetic pigments using solvent extraction method.

Demonstrations

- 1. Suction due to transpiration
- 2. Rooting of cuttings
- 3. Bolting
- 4. Delay of senescence / fruit ripening
- 5. Respiration in roots
- 6. Effect of pH on anthocyanin pigments

References

- 1. Hopkins, W.G. and Huner, A. (2008) Introduction to Plant Physiology. John Wiley and Sons. U.S.A. 4th edition.

- 2. Taiz, L., Zeiger, E. Moller, I.M. and Murphy, A. (2015) Plant Physiology and Development, Sinauer Associates Inc. U.S.A 6th edition.
- 3. Noggle G.R. and Fritz,G.J. (1986) Introduction to Plant Physiology, 2nd Ed. Prentice-Hall of India Ltd., New Delhi.
- 4. Salisbury, F.B. and Ross, C.W. (2005) Plant Physiology, Thomson Wadsworth, 4th edition.
- 5. Bhatla, S.C. and Lal M.A (2018) Plant Physiology, Development and Metabolism, Springer Nature, 1st edition.
- 6. Nobel, P.S. (2009) Physicochemical and Environmental Plant Physiology, Academic Press, 4th edition.
- 7. Uprety, D.C. and Reddy, V.R. (2016), Crop response to global warming, Springer.
- 8. Kochhar, S.L. and Gujral, S.K. (2011), Comprehensive Practical Plant Physiology, Macmillan India Ltd, New Delhi.
- 9. Bajracharya D. (1999) Experiments in Plant Physiology-A Laboratory Manual, Narosa Publishing House, New Delhi.

Teaching Learning Process

Teaching – learning tools-

1. Visual aids: computer animations of physiological phenomena to be used to augment chalk and talk method.
2. Hands on approach: practicals and projects.
3. Experiments to be carried out in groups to encourage collaborative work culture.
4.

   Assignments, e-presentations and designing new experiments to encourage innovative spirit.

Assessment Methods

Theory: 100 marks

Written Exam: 75 marks

Continuous assessment (25 marks total)

· Class test (10 marks)

· Assignments 10 marks)

· Attendance (5 marks)

Practical: 50 Marks

Practical examination (25 marks total)

Continuous assessment (25 marks total):

· Continuous evaluation (10 marks)

· Lab record (10 marks)

· Attendance (5 marks)

Keywords

water potential, essential elements, photoassmilate, stress, signal transduction, climate change

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Wild Life Conservation
(BS DSE-6)
Discipline Specific Elective - (DSE) Credit:6

Course Objective(2-3)

- The Discipline Specific Paper on Wildlife Conservation and Management aims to familiarize students with diverse aspects of wildlife and their conservation, including the significance of wildlife, major natural and anthropogenic threats, as well as management of their population and habitats.
- The course also explores different techniques, perspectives, and approaches to both identify and achieve wildlife management goals.
- The main objective of this course is to develop interest and invoke a sense of responsibility among students towards wildlife conservation.
- 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, its conservation and management.
- Understanding major causes of wildlife depletion and important in-situ and ex-situ strategies for the conservation of their genetic diversity.
- Comprehending the applications of ecology, biodiversity and animal behaviour to formulate strategies for the management of wildlife populations and their habitats.
- Getting familiar with application of various techniques and equipment in wildlife estimation.
- Understanding the management practices required to achieve a healthy ecosystem for wildlife population along with emphasis on conservation and restoration.
- Awareness about the wildlife diseases and the quarantine policies; Knowledge about the Protected Area Networks in India; Ecotourism; Human-animal conflict and other challenges in wildlife management.

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Acquiring a practical experience of natural habitat of wildlife and hands-on training in wildlife techniques in a protected area.

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Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to wildlife.

Unit 1

Unit 1: Introduction No. of Hours: 4

Values of wildlife; Ethics of wildlife conservation; Causes of depletion; Importance of conservation.

Unit 2

Unit 2: Evaluation and management of wild life habitat No. of Hours: 12

- Physical parameters: Topography, geology and water; Biological Parameters food, cover; Setting back succession: Grazing, logging, Mechanical treatment; Advancing successional process: Cover construction.

Unit 3

Unit 3: Population estimation No. of Hours: 12

Standard estimation procedures: Faecal analysis of ungulates and carnivores: Hair, antler, pug marks and hoof marks identification; Geographical Information System (GIS), Global Positioning System (GPS), and Remote Sensing (RS).

Unit 4

Unit 4: Modern Concepts and strategies of Wildlife Management No. of Hours: 15

Protected Area Network (PAN): Preservation of general genetic diversity: in-situ and ex-situ conservation strategies; National parks, sanctuaries, Biosphere reserves; Conservation and community reserve, Important features of protected areas in India; WWFN, IUCN, and CITES. Wild life Legislation – Wildlife Protection act (1972), its amendments and implementation. IUCN Red data book and red list categories (only names); Project Tiger: Tiger conservation - Tiger reserves in India; Management challenges in Tiger reserve; Objectives and activities of Project Elephant and Project Crocodile.

Unit 5

Unit 5: Management of excess Population and Translocation No. of Hours: 10

Bio- telemetry; Common diseases of wild animal: Zoonosis (Ebola and Salmonellosis), Rabies, Foot and mouth disease and Tuberculosis; Quarantine; Population Viability Analysis (PVA), rescue, rehabilitation and reintroduction.

Unit 6

Unit 6: Challenges in Wildlife Management No. of Hours: 7

Poaching, illegal trading, conflict management and shifting from extraction to preservation;

effect of extinction of a species on ecosystem, Human-animal conflict; Eco tourism / wild life tourism in forests.

Practical

TOTAL HOURS: 60 CREDITS: 2

1. Identification and study of five mammalian, avian and 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, nest and antlers.
4. Demonstration of different field techniques for flora and fauna: PCQ, 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); Birds of Prey (Eagle, Kite, Vulture, Falcon, Hawk and Owl) and Poisonous snakes (Cobra, Krait, Viper).
7. A report based on a visit to a National Park/ Wildlife Sanctuary/ Biodiversity Park or any other wildlife conservation site.

References

SUGGESTED READINGS

1. G. Caughley & A.R.E. Sinclair, Wildlife Ecology and Management, Blackwell

Science, 1994

2. R Woodroff, S Thirgood and A. Rabinowitz, People and Wildlife, Conflict or Coexistence?,.

Cambridge University Press, 2005

3. T A Bookhout, Research and Management Techniques for Wildlife and Habitats,. 5th

Ed. The Wildlife Society, Allen Press, 1996

4. W J Sutherland, The Conservation Handbook: Research, Management and Policy, ,

Blackwell Sciences, 2000

5. ML Hunter, J.B. Gibbs and E.J. Sterling, Problem-Solving in Conservation Biology

and Wildlife Management: Exercises for Class, Field, and Laboratory,. Blackwell

Publishing. 2008

6. Saha, G. K. and Mazumdar, S. Wildlife Biology: An Indian Perspective. PHI Publishing, 2017.

Additional Resources:

Concepts in wild life management by B. B. Hossetti, Daya Publishing House, Delhi, 1997.MOOCs

·MOOCS

https://papaco.org/mooc-on-species-conservation/

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https://www.iucn.org/theme/protected-areas/our-work/capacity-development/moocs

.

https://www.zsl.org/united-for-wildlife-free-conservation-courses

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https://wildlife.org/next-generation/career-development/online-courses/

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https://www.openlearning.com/umtmooc/courses/wildlife-management

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Teaching Learning Process

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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.

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Hands-on field-based training: The case study approach with real-life examples from the field to get a better understanding of the subject and its applications.

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Interaction with wildlife expert: Lecture and real experience on Challenges in wildlife management by a wildlife expert help students to have a feeling of belonging with the course.

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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.

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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.

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Research projects: Field based research projects develop interest in the subject and also motivate students to peruse research as a career in future.

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Educational Visits: 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 and allow them to interact with forest officers.

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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

Theory: 100 marks

Written Exam: 75 marks

Internal Assessment: 25 marks (10 Project+ 10 Assignement/Test+ 5 Attendance)

Practical: 50 Marks

Segregation for practical exam (25 marks total):

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2 spots each may be given from unit 1 and 2 (2+2=4 marks).

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From unit 3 and 6, two setups with questions may be given (3+3= 6 marks).

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From unit 4-6, students may be asked to assess the abundance and diversity of the species in a given hypothetical area through any two of the circular, quadrat and rectangular method (total 8 marks).

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Lastly, any other technique (besides the ones mentioned earlier) from unit 4 and 5 may be given to students to perform (3 marks).

Continuous assessment (25 marks total):

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Record (10 marks)

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Viva (5 marks)

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Continuous evaluation (5 marks)

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Field report (5 marks)

Keywords

Wildlife Habitat management, wildlife population estimation, pugmarks, wildlife management challenges, Project tiger, Protected Area Network, red list

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Biochemical Techniques
(BS SEC-6)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The objective of the course is to introduce various biochemical and biophysical techniques to the students and to provide them with an understanding of the principle underlying these techniques and laboratory skills in the form of practical exercises so that students can apply this knowledge to improve their understanding of the subject.

Course Learning Outcomes

- Students will acquire knowledge about the principles and applications of spectrophotometric and chromatography techniques used in a Biological Sciences lab.
- Students will learn about the principle and application of electrophoresis and centrifugation techniques.
- It will also give them an opportunity to get hands on experience to develop their laboratory skills expected of any biochemist working in a research lab.

Unit 1

Spectroscopic Techniques No. of Hours: 6

Electromagnetic radiation, interaction of radiation with biomolecules, principle of UV-visible absorption spectrophotometry, Lambert's Law, Beer's Law, working of a spectrophotometer. Applications of UV-visible absorption spectrophotometry. Flourescence spectrophotometry, principle and applications.

Unit 2

Chromatography
No. of Hours: 10

Introduction to chromatography. Principle and applications of Paper Chromatography, Thin Layer Chromatography, Ion Exchange Chromatography, Gel filtration and Affinity Chromatography. HPLC.

Unit 3

Electrophoresis
No. of Hours: 10

Principle of electrophoresis, Gel electrophoresis, discontinuous gel electrophoresis, PAGE, SDS-PAGE, Native and denaturing gels. Agarose gel electrophoresis, buffer systems in electrophoresis. Electrophoresis of proteins and nucleic acids, detection and identification. Molecular weight determination, Isoelectric Focusing of proteins.

Unit 4

Centrifugation
No. of Hours: 4

Principle of centrifugation, basic rules of sedimentation, sedimentation coefficient. Various types of

centrifuges, types of rotors. Application of centrifugation, differential centrifugation, density gradient centrifugation (rate zonal and isopycnic).

Practical

1. Verification of Beer's Law
2. Protein estimation by Biuret/Lowry's method
3. Separation of amino acids by thin layer chromatography (TLC)
4. Separation of sugars/nucleotide bases by paper chromatography
5. To perform ion exchange/gel filteration chromatography
6. To perform agarose gel electrophoresis
7. Isolation of mitochondria and assay of its marker enzyme SDH

References

Boyer, R.F., Biochemistry Laboratory: Modern Theory and Techniques, 6th ed., Boston, Mass: Prentice Hall, 2012, ISBN-13: 978-0136043027.

Plummer D. T., An Introduction to Practical Biochemistry 3rd ed., Tata McGraw Hill Education Pvt. Ltd. (New Delhi), 1998, ISBN: 13: 978-0-07-099487-4 / ISBN:10: 0-07-099487-0.

Wilson K. and Walker J., Principles and Techniques of Biochemistry and Molecular Biology, 7th ed., Cambridge University Press, 2010, ISBN 978-0-521-51635-8.

Additional Resources:

Cooper T G, The Tools of Biochemistry 2nd ed., Wiley-Interscience Publication (New Delhi), 2011, ISBN: 13:9788126530168.

Freifelder, D., Physical Biochemistry: Applications to Biochemistry and Molecular Biology 2nd ed., W.H. Freeman and Company (New York), 1982, ISBN:0-7167-1315-2 / ISBN:0-7167-1444-2.

Teaching Learning Process

The teaching learning process will involve the traditional chalk and black board method.

Certain topics where traditional chalk and talk method may not be able to convey the concept, are taught through audio visual aids.

Students are encouraged to participate actively in the classroom.

As the best way to learn something is to do yourself, practicals are planned in such a way so as to reinforce the topics covered in theory.

Assessment Methods

Students are periodically assessed based on comprehensive assignments and written tests.

Various assessment activities include class tests, quizzes, projects and assignments.

The experimental skills and data analysis are evaluated in the practical classes as part of the continuous evaluation.

Keywords

Spectrophotometry, Chromatography, Proteins, Nucleic Acids, Centrifugation and Electrophoresis

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Bioinformatics
(BS SEC-3)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The objective of this course is to impart basic understanding of bioinformatics and computational biology. The course will introduce the broad scope of bioinformatics by discussions on the theory and practices of computational methods in biology. This course also aims to provide students with a practical hands-on experience with common bioinformatics tools and databases. Students will be trained in the basic theory and application of programs used for database searching, protein and DNA sequence analysis, and prediction of protein structures.

Course Learning Outcomes

After completion of the course, a student will

- Understand the basics of bioinformatics and computational biology and develop awareness of the interdisciplinary nature of this field.
- Demonstrate the use of several softwares/tools in biology
- Discuss, access and use biological databases in public domain
- Understand protein structure using visualization softwares
- Be able to gain understanding of sequence alignments
- Analyze phylogeny using alignment tools
- Comprehend the fundamental aspects of in-silico protein structure prediction
- Understand how theoretical approaches can be used to analyze biological systems
- Obtain knowledge on applications of bioinformatics from genomes to personalized medicine.

Unit 1

Unit 1 Introduction to bioinformatics No. of Hours: 2

Introduction to Bioinformatics, Historical background. Scope of bioinformatics - Genomics, Proteomics, Computer aided drug design (CADD) and Systems Biology.

Unit 2

Unit 2 Biological databases and data retrieval No. of HOURS: 10 =""">

Introduction to biological databases - primary, secondary and composite databases, NCBI, nucleic acid databases (GenBank, EMBL, DDBJ, NDB), protein databases (PIR, Swiss-Prot, TrEMBL, PDB), metabolic pathway database (KEGG, EcoCyc, and MetaCyc), small molecule databases (PubChem, Drug Bank, ZINC, CSD). Organism specific databases (E. coli, yeast, Arabidopsis, mouse, Drosophila Melanogaster), Structure viewers (Ras Mol, J mol) and File formats.

Unit 3

Unit 3 Sequence alignment & Phylogeny No. of HOURS: 10="">

Similarity, identity and homology. Concept of Alignment – local and global alignment, pairwise and multiple sequence alignments, BLAST and CLUSTALW, Phylogeny and its importance, Methods of Phylogeny, Software for Phylogenetic Analyses

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Unit 4

Unit 4 Genomics No. of HOURS: 2="">

Introduction to genomics, comparative and functional genomics, gene structure in prokaryotes and eukaryotes, Genome annotation, gene prediction approaches and tools.

Unit 5

Unit 5: Applications of Bioinformatics No. of HOURS: 6 =""">

Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Applications in Microbial Genomics, Crop improvement & Health Care

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Practical

1. Sequence retrieval (protein and gene) from NCBI and Molecular file formats - FASTA, GenBank/Genpept.

2. Structure download (protein and DNA) from PDB and Molecular viewer by visualization software (Pymol / Rasmol/Jmol)

3. BLAST suite of tools for pairwise alignment

4. Multiple sequence alignment (CLUSTALW/TCoffee) and construction of phylogenetic trees

5. Secondary structure prediction of RNA/Protein

6. Tertiary structure prediction (SWISSMODEL) and Protein structure evaluation - Ramachandran map (PROCHECK)

7. Design probe and primers for a given gene sequence

8. Gene Prediction Tools (GLIMMER/GENSCAN)

References

1. Bioinformatics – Principles and Applications (2008), 1st ed. Ghosh, Z. and Mallick, B., Oxford University Press (India), ISBN: 9780195692303.

2. Bioinformatics and Functional Genomics (2003), 1st ed., Pevsner, J., John Wiley & Sons, Inc. (New Jersey), ISBN: 0-47121004-8.

Teaching Learning Process

Hands-on computer demonstration, Lectures, Presentations, Blended classroom approaches, Popular Science Articles, Research Papers

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Assessment Methods

1. Written Assignment

2. Computer based assignments

3. Quiz and MCQs

4. Online Evaluation Modules

5. End semester Examinations

Keywords

Biological Databases, NCBI, PDB, Visualization Softwares, Sequence Alignment, BLAST, Multiple

Sequence Alignment , Gene Prediction, Secondary Structure Prediction

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Medical Diaognostics
(BS SEC-2)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Medical diagnosis is the process of determining which disease or condition explains a person's symptoms and signs. This paper is aimed to provide students a unique opportunity to study how doctors and clinicians come to a conclusion regarding disease prediction, prevention, diagnosis and optimal treatment regimens. The students will learn about importance of technology in healthcare and study the various medical diagnostic tools, techniques and technologies frequently used in medical practice. The related laboratory exercises will provide hands-on experience for many of these concepts in clinical context. The course will help the students to understand the biomedical basis of various diseases, the skills required to understand the common signs and symptoms related to diseases, the scientific approach to make a differential diagnosis, and the practical use of technology in healthcare diagnosis and management.

Course Learning Outcomes

After completing this course, the students should be able to

· Understand the various symptoms associated with early diagnosis of common diseases

· Describe key concepts related to categorization of diseases (infectious/non-infectious diseases, lifestyle/genetic basis)

· Describe biomedical basis of common diseases

· Describe the analytical biochemistry related to diagnostic tests; various tests/ technology available to help in diagnosis of various diseases

· Develop basic skills to use some common diagnostic instruments and tests

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Unit 1

Biomedical Basis of Diseases No. of Hours: 10

Study of disease burden: India and global perspective; brief pathophysiology and diagnosis/ study of specific biomarkers of some prevalent diseases and disorders: complex disorders (diabetes, cardiovascular diseases, obesity, polycystic ovarian syndrome, autism spectrum disorder, schizophrenia); infectious (amoebic dysentery, sepsis, pulmonary and extra-pulmonary tuberculosis, malaria, cholera, dengue, pneumonia, AIDS, swine flu, hepatitis, Japanese

encephalitis, chikungunya, filariasis, hantavirus, and Zika); autoimmune diseases (rheumatoid arthritis, systemic lupus erythematosus, myasthenia gravis, multiple sclerosis); Cancer-types and staging; how pathogenesis is related to symptoms.

Unit 2

Analytical Technology No. of Hours: 10

Brief description of the following analytical techniques: liquid chromatography (LC/HPLC); gas chromatography-mass spectrometry (GC-MS); nuclear magnetic resonance spectroscopy (NMR); atomic force and scanning electron microscopy (AFM and SEM); electrochemistry; immunohistochemistry; molecular diagnosis of genetic diseases

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Unit 3

Diagnostic methodology No. of Hours: 10

Outline the diverse methodology used in hospitals: histopathology, biochemistry, haematology (enzymatic and protein markers in blood: alkaline phosphatase (ALP), alanine aminotransferase (ALT), aspartate aminotransferase (AST), blood urea nitrogen (BUN), creatinine, creatine Kinase (CK), lactate dehydrogenase (LDH), serum GGT {Gamma glutamyl transaminase (-GT)}, myoglobin (Mb), troponin T (cTNT), C-reactive Protein (US-CRP), HbA1c) and microbiology laboratories; Basic concepts of X-ray, CT, MRI, Ultrasound, ECG, Echo; Latest advancements in the field of medical diagnostics: embedded sensors and wearables, biomedical informatics

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Practical

1. ABO Blood typing
2. Analysis of urine for abnormal constituents
3. Body temperature and blood pressure under normal condition and condition of stress
4. Estimation of blood glucose/cholesterol by kit
5. Determination of bleeding time/clotting time
6. Interpretation of ECG
7. Medical imaging: X-rays of bone fracture; Ultrasound, MRI; CT-Scan; PET-Scan
8. A visit to pathology laboratory/ related research laboratory and submission of report

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References

1. Daniel W.W. Biostatistics-A Foundation for Analysis in the Human Health, 9

th

Edition, John Wiley & Sons, 2009

2. Robbins S.L. Pathological basis of Disease. W B Saunders Company, 1974

3. Macleod J. Davidson's Principles & Practice of Medicine: A textbook for students and doctors' 14th Edition. Churchill Livingstone, 2013

4. Guyton A.C. and Hall J.E. Textbook of Medical Physiology 11th edn. Saunders, 2006

Additional Resources:

1. Hage D S and Carr J D, Analytical Chemistry & Quantitative Analysis, Prentice Hall, 2010

2. Berg J.M., Tymoczko J.L., Stryer L. Biochemistry, 5th edn. W.H. Freeman & Co. 2002

3. Brant W.E. and Helms C.A. Fundamentals of Diagnostic Radiology, 3rd edn. Lippincott Williams &Wilkins, 2007

E-RESOURCES

https://www.coursera.org/learn/neuroscience-neuroimaging

https://www.edx.org/course/introduction-to-biomedical-imaging-0

https://www.coursera.org/learn/mri-fundamentals

https://swayam.gov.in/courses/5285-bio-medical-image-processing-science-and-technology

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Teaching Learning Process

· Apart from chalk-and board teaching, usage of power-point presentations, video tutorials, and discussion of e-resources.

· As part of peer learning, group discussions on some clinical case-studies will be held amongst the students to enhance scientific approach.

· To enhance clinical knowledge and develop communication skills of students, presentations can be organized on various themes as prescribed in the syllabus while focusing on the latest development in field of clinical diagnosis.

· Visit of students to a pathology laboratory/ research laboratory/Mohalla clinics working in the area of medical diagnosis and development of new diagnostic and management tools/ organizing talks of eminent clinicians can help deepen interest of students in the field. Students will also be encouraged to undertake internships in these places.

Assessment Methods

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

a. Theory: Total marks: 50

b. Practicals: Total 50 marks

· Continuous Evaluation: 25 marks

- Practical class attendance: 5 marks
- Practicals performance/ Report: 5 marks
- Practical records: 10 marks
- Viva: 5 marks

· Semester end exam: 25 marks

Keywords

Disease, Prognosis, Diagnosis, Health management, Medical imaging

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Medicinal Botany
(BS SEC-1)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Plants are indispensible to mankind, with numerous plants are known to possess medicinal values. Nowadays, there is an increasing emphasis on indigenous system of medicine on medicinal plants. Keeping the therapeutic importance of medicinal plants in mind this course is designed to provide education and training on diverse perspectives of medicinal plants. The course also offers comprehensive knowledge about understanding the difference between ancient wisdom and modern system of medicine.

Course Learning Outcomes

Students will learn to

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Identify and describe the common medicinal plants in their vicinity.

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Know about the traditional therapeutic sciences (Ayurveda, Siddha and Unani) which have been used since the ancient times.

.

Know about the importance of conservation strategies for medicinal plants

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Understand the importance of medicinal plants, significance of ethnobotany, role of ethnic groups in the conservation of medicinal plants.

Unit 1

Unit 1: History, Scope and Importance of Medicinal Plants No. of Hours:12

Introduction to indigenous systems of medicine (Ayurveda, Unani and Siddha)- Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Siddha: Origin and Basis of Siddha medicinal system, Unani: History, concept: Umoor-e- tabiya. Plants used in Ayurveda, Siddha and Unani system with special reference to Carum carvi, Allium cepa, Allium sativum, Asparagus racemosus, Vitis vinifera, Linum usitatissimum, Amaranthus paniculatus; Polyherbal formulations (with special reference to Safi, Chyawanprash, Trifala, sualin, amukkara choorna, gandhak rasayana). Natural products – Compounds responsible for biological activity of medicinal plants: their biology, and pharmacology(Curcumin,vinblastine,vincristine,Ecliptine,Cinchonine,Azadirachtin,Artemisinin).

Unit 2

Unit 2: Conservation of Endangered and Endemic Medicinal Plant No. of Hours:6

Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanical Gardens, herbal gardens, Ethnomedicinal plant gardens Germplasm conservation, cryopreservation (Cryo banks and DNA banks),Propagation of Medicinal Plants: In vitro and In vivo strategies.

Unit 3

Unit 3: Ethnobotany and Folk Medicines No. of Hours: 12

Introduction, concept, scope and objectives; Ethnobotany in India: Methods to study ethnobotany; Folk medicine, Role of ethnobotany in modern medicine with special reference to Rauvolfia serpentina, Trichopus zeylanicus, Artemisia, Withania Application of natural products for treatment of - Jaundice, cardiac ailments, infertility, diabetes, blood pressure and skin diseases. Role of ethnic groups in conservation of plant genetic resources; Brief account of biopiracy and IPR.

Practical

SUGGESTED PRACTICALS

1. To locate any ten common medicinal plants in the surrounding area (Description, diagram, medicinally important plant part, characteristic feature, therapeutic uses).
2. To extract the active principle from any four medicinal plants. (Aloe vera, Ocimum, Azadirachta, Catharanthus, Adhatoda, Withania)
3. Write the details of any two commonly used medicines from the indigenous system of medicine (Ayurveda,Siddha and Unani)
4. Field trip (Industries/Institutes) / e-presentations (System of medicine, Conservation strategies, propagation of medicinal plants, folk medicines, application of natural products to certain diseases listed in the syllabus)
5. Herbarium preparation for any two medicinal plants.
6. To compare the total phenolic content of few locally available medicinal plants
7. Laboratory records

References

SUGGESTED READINGS

1. Trivedi P C, Medicinal Plants: Ethnobotanical Approach, Agrobios, 2006
2. Purohit and Vyas,. Medicinal Plant Cultivation: A Scientific Approach, 2nd edition. Agrobios, 2008
3. Abdin, M.Z. and Y.P. Abrol, Y.P. 2006. Traditional Systems of Medicine. Narosa Publishing House, New Delhi.
4. Colton C.M. 1997. Ethnobotany: Principles and Applications. John Wiley and Sons.
5. Jain, S.K. 1990. Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.
6. Jain, S.K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur 9.
7. Kumar, S. 2018. Ethnobotany, Kojo press, New Delhi

Teaching Learning Process

Teaching-Learning:

Visualization tools: The traditional teaching method using chalk and talk method to be

supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.

Eductional Trips: Field trips and trips to industries and institutes will enhance the understanding of their theoretical concepts and giving them direct exposure to natural surroundings.

Active learning strategies: Group discussions, book reviews, e-presentations can be employed for effective teaching.

Projects: Projects based on the curriculum may be given.

Assessment Methods

Assessment Methods

Theory: 50 marks

Written Exam: 50 marks

Practical: 50 Marks

Practical examination (25 marks total)

Continuous assessment (25 marks total):

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Project report on field trip/ e-presentation (10 marks)

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Lab record (10 marks)

.

Attendance (5 marks)

Keywords

Keywords:

Ayurveda, Siddha, Unani, Ethnobotany, Conservation, Folk medicine, Cryopreservation

Organic Farming
(BS SEC-4)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

Biofertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability. The SEC course entitled “Biofertilizers and Organic farming” introduces the concept of organic farming and its eco-friendly practices, which is gaining momentum to nullify the adverse effects of chemical fertilizers and pesticides. The use of biofertilizers helps in sustainable agriculture by fixing atmospheric nitrogen, mobilizing fixed macro and micro nutrients or converting insoluble phosphorus in the soil to soluble forms to be available to plants. The course also introduces eco-friendly, low-tech, knowledge-rich approaches to students.

Course Learning Outcomes

After pursuing this course, students will

1) learn the importance of biofertilizers and organic farming over chemical inputs in agriculture system,

2) learn techniques for the identification, isolation and mass multiplication of various micro-organisms,

3) develop entrepreneurship skills and gain awareness in production of organic inputs, and

4) be able to design resource efficient farming system for small and marginal farmers for improving their economy while meeting the quality food demand in a sustainable environment.

Unit 1

Unit 1 Introduction: 4 hours

Types and importance of biofertilizers, organic farming system, history of biofertilizer production, classification of microorganisms used in biofertilizer production.

Unit 2

Unit 2 Rhizobium, Azospirillum and Azotobacter: 6 hours

General characteristics, isolation, identification, mass multiplication and carrier-based inoculants; Biofertilizers available in the market.

Unit 3

Unit 3 Cyanobacteria (blue green algae): 4 hours

Role of Algal biofertilizers in sustainable agriculture; Characteristics of Azolla-Anabaena azollae (BGA) association and their role in rice cultivation; Role of Algal Bio-Fertilizers in reducing greenhouse gases.

Unit 4

Unit 4 Mycorrhizal association: 6 hours

Types of mycorrhizal association, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5

Unit 5 Biological control of plant diseases: 4 hours

Use of microbial inoculants as potential biopesticides for sustainable agriculture and integrated pest management.

Unit 6

Unit 6 Organic farming: 6 hours

Conventional farming, organic farming, importance of organic farming, status and scope of organic farming in India; Green manure and organic fertilizers, biocompost methods and types; and method of vermicomposting – field Application.

Practical

PRACTICALS

1. (a) Isolation of Rhizobium from root nodules by pour plate technique

(b) Temporary mount preparation to study Rhizobium by gram staining method

2. Isolation and study of Blue-green algae (BGA) from Azolla leaves
3. (a) Isolation of Arbuscular Mycorrhizal fungal spores from rhizospheric soil

(b) In vivo mass multiplication of isolated fungal spores using Sorghum roots

(c) Study of arbuscules and vesicles in colonized roots by temporary mount preparation

4. Test for pH, NO_3, Cl^- and Organic matter of different compost / landfill leachate
5. Study of earthworm (Eisenia foetida), bio-control agents (pheromones traps, Trichoderma, Pseudomonas, Neem) through specimen/ photographs

Project and Field Visit

1. Industrial/Institute and/ or Organic farm visit and compilation of report.
2. Project on any topic mentioned in the syllabus such as Rhizobium technology, AMF technology, Organic farming, Vermicomposting technology, Bio compost, Azolla culture

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References

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand and Co, New Delhi.

2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.

3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology.Emkay -Publication, New Delhi.

4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

5. Subba Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

7. S.P. Palaniappan and K. Annadurai (2018) Organic Farming: Theory & Practice. Scientific Publisher

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Teaching Learning Process

Visualization tools: The traditional teaching method of using chalk and talk to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.

Active learning strategies: Group discussions and paper presentations can be employed for effective teaching.

Research projects: Projects based on the curriculum to be given.

Assessment Methods

Theory: 50 marks

Written Exam: 50 marks

Practical: 50 Marks

Practical examination (25 marks total)

Continuous assessment (25 marks total):

· Project report on field trip/ e-presentation (10 marks)

· Lab record (10 marks)

· Attendance (5 marks)

Keywords

Rhizobium, Blue green algae, Mycorrhizal associations, compost, recycling, Organic Farming

Course Objective(2-3)

Biofertilizers being essential components of organic farming play vital role in maintaining long term soil fertility and sustainability. The SEC course entitled “Biofertilizers and Organic farming” introduces the concept of organic farming and its eco-friendly practices, which is gaining momentum to nullify the adverse effects of chemical fertilizers and pesticides. The use of biofertilizers helps in sustainable agriculture by fixing atmospheric nitrogen, mobilizing fixed macro and micro nutrients or converting insoluble phosphorus in the soil to soluble forms to be available to plants. The course also introduces eco-friendly, low-tech, knowledge-rich approaches to students.

Course Learning Outcomes

After pursuing this course, students will

1) learn the importance of biofertilizers and organic farming over chemical inputs in agriculture system,

2) learn techniques for the identification, isolation and mass multiplication of various micro-organisms,

3) develop entrepreneurship skills and gain awareness in production of organic inputs, and

4) be able to design resource efficient farming system for small and marginal farmers for improving their economy while meeting the quality food demand in a sustainable environment.

Unit 1

Unit 1 Introduction: 4 hours

Types and importance of biofertilizers, organic farming system, history of biofertilizer production, classification of microorganisms used in biofertilizer production.

Unit 2

Unit 2 Rhizobium, Azospirillum and Azotobacter: 6 hours

General characteristics, isolation, identification, mass multiplication and carrier-based inoculants; Biofertilizers available in the market.

Unit 3

Unit 3 Cyanobacteria (blue green algae): 4 hours

Role of Algal biofertilizers in sustainable agriculture; Characteristics of Azolla-Anabaena azollae (BGA) association and their role in rice cultivation; Role of Algal Bio-Fertilizers in reducing greenhouse gases.

Unit 4

Unit 4 Mycorrhizal association: 6 hours

Types of mycorrhizal association, occurrence and distribution, phosphorus nutrition, growth and yield – colonization of VAM – isolation and inoculum production of VAM, and its influence on growth and yield of crop plants.

Unit 5

Unit 5 Biological control of plant diseases: 4 hours

Use of microbial inoculants as potential biopesticides for sustainable agriculture and integrated pest management.

Unit 6

Unit 6 Organic farming: 6 hours

Conventional farming, organic farming, importance of organic farming, status and scope of organic farming in India; Green manure and organic fertilizers, biocompost methods and types; and method of vermicomposting – field Application.

Practical

PRACTICALS

1. (a) Isolation of Rhizobium from root nodules by pour plate technique

(b) Temporary mount preparation to study Rhizobium by gram staining method

2. Isolation and study of Blue-green algae (BGA) from Azolla leaves
3. (a) Isolation of Arbuscular Mycorrhizal fungal spores from rhizospheric soil

(b) In vivo mass multiplication of isolated fungal spores using Sorghum roots

(c) Study of arbuscules and vesicles in colonized roots by temporary mount preparation

4. Test for pH, NO_3, Cl^- and Organic matter of different compost / landfill leachate
5. Study of earthworm (Eisenia foetida), bio-control agents (pheromones traps, Trichoderma, Pseudomonas, Neem) through specimen/ photographs

Project and Field Visit

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References

1. Dubey, R.C., 2005 A Text book of Biotechnology S. Chand and Co, New Delhi.

2. Kumaresan, V. 2005, Biotechnology, Saras Publications, New Delhi.

3. John Jothi Prakash, E. 2004. Outlines of Plant Biotechnology.Emkay -Publication, New Delhi.

4. Sathe, T.V. 2004 Vermiculture and Organic Farming. Daya publishers.

5. Subba Rao, N.S. 2000, Soil Microbiology, Oxford & IBH Publishers, New Delhi.

6. Vayas,S.C, Vayas, S. and Modi, H.A. 1998 Bio-fertilizers and organic Farming AktaPrakashan, Nadiad

7. S.P. Palaniappan and K. Annadurai (2018) Organic Farming: Theory & Practice. Scientific

Publisher

Teaching Learning Process

Visualization tools: The traditional teaching method of using chalk and talk to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.

Active learning strategies: Group discussions and paper presentations can be employed for effective teaching.

Research projects: Projects based on the curriculum to be given.

Assessment Methods

Theory: 50 marks

Written Exam: 50 marks

Practical: 50 Marks

Practical examination (25 marks total)

Continuous assessment (25 marks total):

- Project report on field trip/ e-presentation (10 marks)
- Lab record (10 marks)
- Attendance (5 marks)

Keywords

Rhizobium, Blue green algae, Mycorrhizal associations, compost, recycling, Organic Farming

Public Health and Management
(BS SEC-5)
Skill-Enhancement Elective Course - (SEC) Credit:4

Course Objective(2-3)

The SEC paper Public Health and Management aims to provide the undergraduate students a thorough understanding of the basics of public health and management of health and health hazards.

The paper will help the students understand the various environmental hazards and the fate of the hazardous toxins in the environment along with the dose response evaluation and exposure assessment.

The students will be made aware of the various types of pollution: Air, water, Noise, Light, Soil and their impact and effect on health of living beings.

This paper will help the students to understand the types and characteristics of Waste handling and disposing with special emphasis on Biomedical waste, Nuclear waste and thermal power plant waste. These concepts will be augmented with various case histories to help them understand management of these hazards.

In addition to this the students will learn about various infectious and non-infectious diseases along with the socio-economic factors of diseases and the role of health service organisations in Disease Management. The students will be taught about various Bacterial, Viral, Protozoan and Mosquito Born diseases and their control and Management. In addition to this, students will be made to understand about the various lifestyle related diseases like Hypertension, Obesity, PCOD and Diabetes. This section will enable the students to understand what changes they should make in their lifestyle to prevent these lifestyle related problems. Also, students will be made aware of genetic diseases like Autism, Downs syndrome, etc. In addition to this the students will be able to understand about various Nutritional Deficiencies.

Course Learning Outcomes

- Awareness about Public Health and its management.
- Understanding major causes of environment and human health hazards.
- Comprehending the applications for waste management. Getting familiar with management strategies and techniques.
- Awareness about the increased pollution levels in the environment and its effect on human health.
- Knowledge about social and economic factors for different types of disease.
- Acquiring a practical experience on public health and hygiene.
- Perform critical thinking, literature review; scientific writing as well as presentations; and participation in citizen science initiatives with reference to human health.

Unit 1

Credits: 2

Pollution No. of Hours: 6

Air, water, Noise Pollution and Light pollution sources and effects

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Unit 2

Waste Management and Hazards No. of Hours :7

Types and Characteristics of Wastes, Biomedical waste handling and disposal, Nuclear waste handling and disposal, Waste from thermal power plants. Case histories on Bhopal gas tragedy, Chernobyl disaster and Seveso disaster and Three Mile Island accident and their aftermath, Government awareness programs.

Unit 3

Infectious Diseases No.of Hours : 9

Social and Economic factors of diseases, roles of health services and other organisations: diseases: Hepatitis, Dengue, Chikungunia, Zika, Nepa, Ebola, Bird flu, Sexually transmitted diseases.

Unit 4

Non-infectious diseases No. of Hours: 8

Lifestyle and Inherited (Obesity, Diabetes and Hypertension) /Genetic diseases (Autism, Down syndrome and Thalassemia/ Sickle cell anaemia), Nutritional deficiency: Vitamin deficiency, Iron deficiency and Protein deficiency.

Practical

1. To study the following medically important organisms- Mosquito, Housefly, Cockroach, Ants and Rats.

2. Testing potability of water for human consumption by MPN method.

3. Calculate the BMI of students analyse the results with suitable statistical tools.

4. Measure the blood pressure using sphygmomanometer, analyze and correlate with lifestyle.

5. Data collection case study or interview of the individuals suffering from diseases (eg. Hypertension, Diabetes, Tuberculosis, PCOD etc.)

6. A visit to water purification/ Sewage treatment/ Sulabh International/ Effluent treatment plant/ CPCB/ NIMR etc. and submission of report.

References

1. Cutter, S.L. Environmental Risk and Hazards, Prentice-Hall of India Pvt. Ltd., New Delhi. 1999

2. Kolluru R., Bartell S., Pitblado R. and Stricoff, S., Risk Assessment and Management Handbook. McGraw Hill Inc., New York. 1996

3. Kofi, A.D., Risk Assessment in Environmental management, John Wiley and sons, Singapore, 1998.

4. Joseph, F. L. and Louver, B.D., Health and Environmental Risk Analysis fundamentals with applications, Prentice Hall, New Jersey. 1997

5. Park text book of preventive and social medicine

6. Goel S. Gupta P. Food Nutrition and Health, 2012 Edition-I, ISBN: 81-219-4092-3.

Additional Resources:

· Annual report, National Institute of Nutrition Council of Medical Research, Hydrabad-500007.

· Count what you eat, National institute of Nutrition, Indian Council of Medical Research, Hydrabad-500007.

· Journal of the American diabetic association.

· Diabetes care journal.

· WHO (1979), WHO Chronicles 33: 107.

E- Resources

1. https://www.mooc-list.com/course/epidemiology-public-health-practice-coursera

2. https://www.mooc-list.com/course/essentials-global-health-coursera

3. htt://www.nutritiontext.com.

4. http://www.eatright.org

Teaching Learning Process

- Visualization tools: The traditional chalk and talk method to be supplemented with LCD projection system. Projection of videos or short movies available on the subject will enhance the understanding of the subject.
- Active learning strategies: Group discussions, book reviews, paper presentations, videos,

animations, are some methods that can be employed for effective teaching.
- Research projects: Projects based on the curriculum may be given.

Assessment Methods

The students would be continuously evaluated during the semester. In addition to end of semester exam, there would be class tests, assignments to evaluate students. The students would be encouraged to give presentations and have group discussions on relevant topics to enhance their understanding and this could also be used as a part of their continuous evaluation.

Theory: 50 Marks

Practical: 50 Marks

Practical Performance (25 Marks total):

Continuous assessment (25 Marks total):

- Record (10 marks)
- Viva (5 marks)
- Attendance (5 marks)
- Project Report (5 marks)

Keywords

Pollution, Waste Management, Health Hazards, Nutritional deficiency, Infectious and Non-infectious diseases, Lifestyle diseases, Genetic diseases.