### Structure of B.Sc. Life Sciences under CBCS

<table>
<thead>
<tr>
<th>CORE COURSE(12)</th>
<th>Ability Enhancement Courses (2)</th>
<th>Skill Enhancement Courses (SEC) (4)</th>
<th>Discipline Elective DSE (6)</th>
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<tr>
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<th>Plant Diversity and Human Welfare (BOTA 604) or Mushroom Cultivation Technology (BOTA 605) or Intellectual Property Rights</th>
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<tr>
<td>DSE-Botany II 1. Cell and Molecular Biology (BOTA 601) or 2. Bioinformatics (BOTA 602) or 3. Research Methodology (BOTA 603)</td>
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Details of Courses

Core Courses – Botany

1. Biodiversity (Microbes, Algae, Fungi and Archegoniate) BOTA 101
2. Plant Ecology and Taxonomy BOTA 201
3. Plant Anatomy and Embryology BOT A301
4. Plant Physiology and Metabolism BOTA 401

Discipline Specific Electives - Botany (Any two)

1. Economic Botany and Biotechnology BOTA 501
2. Analytical Techniques in Plant Sciences BOTA 502
3. Cell and Molecular Biology BOT A601
4. Bioinformatics BOTA 602
5. Research Methodology BOT A603

Core Courses: Zoology

1. Animal Diversity ZOOL 101 ; ZOOL 101
2. Comparative Anatomy and Developmental Biology of Vertebrates ZOOL 201 ; ZOOL 201
3. Physiology and Biochemistry ZOOL 301 ; ZOOL 301
4. Genetics and Evolutionary Biology ZOOL 401 ; ZOOL 401

Discipline Specific Electives: Zoology (Any two)

1. Applied Zoology ZOOL 501
2. Animal Biotechnology ZOOL 502
3. Aquatic Biology ZOOL 503
4. Insect, Vector and Diseases ZOOL 601
5. Immunology ZOOL 602
6. Reproductive Biology ZOOL 603

Core Courses-Chemistry

1. Atomic Structure, Bonding, General Organic Chemistry and Hydrocarbon
2. Chemical Energitics, Equilibria & Functional Group Organic Chemistry
3. Solutions, Phase Equilibria, conductance, Electrochemistry & Organic Chemistry
4. Coordination Chemistry, States of Matter & Chemical Kinetics
Discipline Specific Electives-Chemistry (Any two)

1. Polymer Chemistry
2. Industrial Chemical and Environment
3. Quantum Chemistry, Spectroscopy & Photochemistry
4. Chemistry of Main group Elements, Theories of acids and Bases
5. Organometallic, Bioinorganic chemistry, Polynuclear Hydrocarbons and UV, IR Spectroscopy
6. Molecules of Life

Ability Enhancement Compulsory Courses

1. English/Hindi/ MIL Communication/ Environmental Science
2. English/Hindi/ MIL Communication/ Environmental Science

Skill Enhancement Courses (Any four)

Botany

1. Biofertilizers BOTA 302
2. Herbal Technology BOT A303
3. Nursery and Gardening BOT A402
4. Floriculture BOTA 403
5. Medicinal Botany BOTA 503
6. Ethnobotany BOT A504
7. Plant Diversity and Human Welfare BOTA 604
8. Mushroom Cultivation Technology BOTA 605
9. Intellectual Property Right BOTA 606

Chemistry

1. Basic Analytical Chemistry CHEM SEC 301
2. Fuel Chemistry & Chemistry of Cosmetics and Perfumes CHEM SEC 302

3. Chemical Tech. and Society and Bus Skills for chemistry CHEM SEC 603
4. Pesticide Chemistry and Pharmaceutical Chemistry CHEM SEC 604

Zoology

1. Medical Diagonistics ZOOL 302
2. Apiculture ZOOL 402
3. Sericulture ZOOL 504
4. Aquarium Fish Keeping ZOOL 604
5. Research Methodology ZOOL 605
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<td>Course</td>
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I. The B.Sc. Life Sciences will be of three years duration semester-based Choice Based Credit System [CBCS] course.

II. There will be broadly three types of courses for B.Sc. Life Sciences degree program.

1. The Core Courses (14 courses for honours; and 4 discipline specific papers) will be of 6-credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 14 courses for earning 14 X 6 = 84 credits during six semesters. Each of the 6-credits courses will carry 100 marks. These 100 marks will be split into marks assigned for Theory [TH]: 40 marks; Practical [P]: 30 marks and Internal Assessment [IA]: 30. The Internal Assessment [30 marks] will include one Multi Choice Questions (MCQ)-based examination of 25 marks each [25 or 50 questions of 1.0 or 0.5 mark each as the case may be]; and Classroom Attendance Incentive marks (5 marks). The Lab-based practical will be of 2-hours [One credit]. A total of 14 X 6 = 84 credits could be accumulated under these courses during the Life Sciences degree program.

2. The Elective Courses will be chosen from a pool of courses and which may be very specific or specialized or advanced or supportive to the discipline/ subject of study or which provides an extended scope or which enables an exposure to some other discipline/ subject/ domain or nurtures the candidate’s proficiency / skill. The Elective Courses will include;

Discipline Specific Elective [DSE] Courses: A total of 4 courses offered under the main discipline/ subject of study is referred to as Discipline Specific Elective. These courses are discipline related and/ or interdisciplinary in nature. A total of 4 X 6 = 24 credits could be accumulated under DSE courses during the Honours degree program.
**Generic Elective [GE] Courses:** A total of 4 courses of 6-credits each including 2 credits assigned for the practical component of each of these courses i.e. one course per 1st to 4th semester will be studied by the candidates. An elective course chosen from an unrelated discipline/ subject, with an intention to seek exposure beyond discipline(s) of choice is called Generic Elective Course. The purpose of this category of papers is to offer the students the option to explore disciplines of interest beyond the choices they make in Core and Discipline Specific Elective papers. Further, a course offered in a discipline/ subject may be treated as an elective by other discipline/ subject and vice versa and such electives may also be referred to as Generic Elective Course. A total of 4 X 6 = 24 credits could be accumulated under GE courses during the Honours degree program.

3. **Ability Enhancement Compulsory Courses [AECC]:** Ability Enhancement Courses are of two types; Ability Enhancement Compulsory Courses [AECC] and Skill Enhancement Courses [SEC]. A total of 4 X 4 = 16 credits could be accumulated under these courses during the Life Sciences degree program i.e. 4 X 2 = 8 credits for AECC, and 4 X 2 = 8 credits for SEC courses.

The AECC courses are the mandatory courses based upon the content that leads to knowledge enhancement; i. Environment Science and ii. English/ Hindi/ MIL Communication. All these are mandatory courses for obtaining a B.Sc. Life Sciences degree in the concerned subject. These courses are mandatory for all disciplines. SEC courses are value-based and/ or skill-based and are aimed at providing hands-on-training, competencies, skills etc. A minimum of two such courses for obtaining an Honours degree are selected amongst the courses designed to provide value-based and/ or skill-based knowledge and may contain both theory and lab/ hands-on training. The main purpose of these courses is to provide students life-skills in hands-on mode so as to increase their employability.

III. Practical [P] component has been included in every core and discipline/ generic specific elective paper. The list of practicals to be conducted by the candidates has been provided alongside each of such courses. The marks (30 marks) for the practical examination will be split as follows;

- Write up of Practical I: 5 marks
- Write up of Practical II: 5 marks
- Performance of any one of these practicals: 7 marks
- Practical record/ notebook: 5 marks
- Viva voce: 8 marks

IV. **Classroom Attendance Incentive:** Those candidates who have greater than 75% attendance (for those participating in Co-curricular activities, 25% will be added to per cent attendance) will be awarded CCA marks as follows:
V. The admission to B.Sc. Life Sciences programme of Himachal Pradesh University will be as per guidelines of Himachal Pradesh University, Shimla from time to time.

i. The candidate should have passed 10+2 (class XII) Examination or its equivalent from a recognized Board/University with any of the three subjects out of Physics, Chemistry and Biology or any other science subjects with 50% or equivalent grade (for SC/ST candidates marks of eligibility will be 45% or equivalent grade).

ii. In case of candidates who are studying in University/Board/College/Schools in any of the foreign countries the eligibility/Qualifying marks will be the same as recognized/equivalent to 10+2 by the University or the association of the Indian University with 50% marks of equivalent grade (for SC/ST candidates, eligibility will be 45% marks or equivalent grade).

iii. The candidate who has appeared in the qualifying examination but whose result has so far not been declared can also apply but his/her eligibility for the entrance test will be purely provisional subject to the condition that he/she has to produce a passing certificate scoring at least the minimum percentage of marks as prescribed for the qualifying examination on the day and the specified time of counseling.

iv. The candidate shall not be more than 22 years of age as on 01st July of the year of admission. Date of birth as recorded in the Secondary Education Board/University Certificate Only will be considered as authentic.
Core Course: Botany Paper I

Biodiversity (Microbes, Algae, Fungi and Archegoniate)

(BOTA 101 TH)

(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Microbes (10 Lectures)
Viruses – Discovery, general structure, replication (general account), DNA virus (T-phage); Lytic and lysogenic cycle, RNA virus (TMV); Economic importance; Bacteria – Discovery, General characteristics and cell structure; Reproduction – vegetative, asexual and recombination (conjugation, transformation and transduction); Economic importance.

Unit 2: Algae (12 Lectures)
General characteristics; Ecology and distribution; Range of thallus organization and reproduction; Classification of algae; Morphology and life-cycles of the following: Nostoc, Chlamydomonas, Oedogonium, Vaucheria, Ectocarpus, Polysiphonia. Economic importance of algae

Unit 3: Fungi (12 Lectures)
Introduction- General characteristics, ecology and significance, range of thallus organization, cell wall composition, nutrition, reproduction and classification; Morphology and life cycles of Phytophthora, Rhizopus (Zygomycota) Penicillium, Venturia (Ascomycota), Puccinia, Agaricus (Basidiomycota); Symbiotic Associations-Lichens: General account, reproduction and significance; Mycorrhiza: ectomycorrhiza and endomycorrhiza and their significance

Unit 4: Introduction to Archegoniate (2 Lectures)
Unifying features of archegoniates, Transition to land habit, Alternation of generations.

Unit 5: Bryophytes (10 Lectures)
General characteristics, adaptations to land habit, Classification, Range of thallus organization. Classification (up to family), morphology, anatomy and reproduction of Marchantia and Funaria. (Developmental details not to be included). Ecology and economic importance of bryophytes with special mention of Sphagnum.

Unit 6: Pteridophytes (8 Lectures)
General characteristics, classification, Early land plants (Cooksonia and Rhynia). Classification (up to
family), morphology, anatomy and reproduction of Selaginella, Equisetum and Adiantum. (Developmental details not to be included). Heterospory and seed habit, stelar evolution. Ecological and economical importance of Pteridophytes.

Unit 7: Gymnosperms (6 Lectures)
General characteristics, Classification (up to family), morphology, anatomy and reproduction of Cycas and Pinus. (Developmental details not to be included). Ecological and economical importance.

Practical (BOTA 101 PR)

7. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
8. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
9. Gram staining
10. Study of vegetative and reproductive structures of Nostoc, Chlamydomonas (electron micrographs), Oedogonium, Vaucheria, Ectocarpus and Polysiphonia through temporary preparations and permanent slides.
11. Phytophthora, Rhizopus and Penicillium: Asexual stage from temporary mounts and sexual structures through permanent slides.
12. Venturia: Specimens/photographs
13. Puccinia: Herbarium specimens of Black Stem Rust of Wheat and infected Barberry leaves; section/tease mounts of spores on Wheat and permanent slides of both the hosts.
14. Agaricus: Specimens of button stage and full grown mushroom; Sectioning of gills of Agaricus.
15. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
16. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
17. Marchantia- morphology of thallus, w.m. rhizoids and scales, v.s. thallus through gemma cup, w.m. gemmae (all temporary slides), v.s. antheridiophore, archegoniophore, l.s. sporophyte (all permanent slides).
18. Funaria- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.
19. Selaginella- morphology, w.m. leaf with ligule, t.s. stem, w.m. strobilus, w.m. microsporophyll and megasporophyll (temporary slides), l.s. strobilus (permanent slide).
20. Equisetum- morphology, t.s. internode, l.s. strobilus, t.s. strobilus, w.m. sporangiophore, w.m. spores (wet and dry)(temporary slides); t.s rhizome (permanent slide).
21. Adiantum- morphology, t.s. rachis, v.s. sporophyll, w.m. sporangium, w.m. spores (temporary slides), t.s. rhizome, w.m. prothallus with sex organs and young sporophyte (permanent slide).
22. Cycas- morphology (coralloid roots, bulbil, leaf), t.s. coralloid root, t.s. rachis, v.s. leaflet, v.s.
microsporophyll, w.m. spores (temporary slides), l.s. ovule, t.s. root (permanent slide).

3. **Pinus**- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarf shoot, t.s. needle, t.s. stem, l.s./t.s. male cone, w.m. microsporophyll, w.m. microspores (temporary slides), l.s. female cone, t.l.s. & r.l.s. stem (permanent slide).

**Suggested Readings**

Semester II

Core Course Botany – Paper II
Plant Ecology and Taxonomy

(BOTA 201 TH)

(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Introduction (2 Lectures)

Unit 2: Ecological factors (10 Lectures)

Unit 3: Plant communities (6 Lectures)
Characters; Ecotone and edge effect; Succession; Processes and types (Hydrosere and Xerosere)

Unit 4: Ecosystem (8 Lectures)
Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling; Cycling of carbon, nitrogen and Phosphorous

Unit 5: Phytogeography (4 Lectures)
Principle biogeographical zones; Endemism

Unit 6 Introduction to plant taxonomy (2 Lectures)
Identification, Classification, Nomenclature.

Unit 7 Identification (4 Lectures)
Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 8 Taxonomic evidences from palynology, cytology, phytochemistry and molecular data. (6 Lectures)

Unit 9 Taxonomic hierarchy (2 Lectures)
Ranks, categories and taxonomic groups

Unit 10 Botanical nomenclature (6 Lectures)
Principles and rules (ICN); ranks and names; binomial system, typification, author citation, valid publication, rejection of names, principle of priority and its limitations.

Unit 11 Classification (6 Lectures)
Types of classification-artificial, natural and phylogenetic. Bentham and Hooker (upto series), Engler and Prantl (upto series), Angiosperm Phylogeny Group (APG) - general introduction

Unit 12 Biometrics, numerical taxonomy and cladistics (4 Lectures)
Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical (BOTA 201 PR)

5  Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
6  Determination of pH, and analysis of two soil samples for carbonates, chlorides, nitrates, sulphates, organic matter and base deficiency by rapid field test.
7  Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
8  (a) Study of morphological adaptations of hydrophytes and xerophytes (four each). 
(b)Study of biotic interactions of the following: Stem parasite (Cuscuta), Root parasite (Orobanche), Epiphytes, Predation (Insectivorous plants)
9  Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)
10 Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer’s frequency distribution law
11 Study of vegetative and floral characters of the following families (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker’s system of classification): Brassicaceae - Brassica, Alyssum / Iberis; Asteraceae - Sonchus/Launaea, Vernonia/Ageratum, Eclipta/Tridax; Solanaceae - Solanum nigrum, Withania; Lamiaceae -Salvia, Ocimum; Liliaceae - Asphodelus / Lilium / Allium.
12 Mounting of a properly dried and pressed specimen of any wild plant with herbarium label (to be submitted in the record book).

Suggested Readings
Semester III

Core Course Botany – Paper III
Plant Anatomy and Embryology
(BOTA 301 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Meristematic and permanent tissues
(8 Lectures)
Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs
(6 Lectures)
Structure of dicot and monocot root stem and leaf.

Unit 3: Secondary Growth
(8 Lectures)

Unit 4: Adaptive and protective systems
(8 Lectures)
Epidermis, cuticle, stomata; General account of adaptations in xerophytes and hydrophytes.

Unit 5: Structural organization of flower
(12 Lectures)
Flower- a modified shoot, Function of floral parts; Structure of anther and pollen; Microsporogenesis, Male gametophyte, Structure and types of ovules; Megasporangium, Types of embryo sacs, organization and ultra structure of mature embryo sac.

Unit 6: Pollination and fertilization
(8 Lectures)
Pollination mechanisms and adaptations; Double fertilization; Seed-structure appendages and dispersal mechanisms.

Unit 7: Embryo and endosperm
(6 Lectures)
Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship.

Unit 8: Apomixis and polyembryony
(4 Lectures)
Definition, types and practical applications.
Practical (BOTA 301 PR)

1. Study of meristems through permanent slides and photographs.
2. Tissues (parenchyma, collenchyma and sclerenchyma); Macerated xylary elements, Phloem (Permanent slides, photographs)
5. Leaf: Dicot and Monocot leaf (only Permanent slides).
6. Adaptive anatomy: Xerophyte (*Nerium* leaf); Hydrophyte (*Hydrilla* stem).
7. Structure of anther (young and mature), tapetum (amoeboid and secretory) (Permanent slides).
8. Types of ovules: anatropous, orthotropous, circinotropous, amphitropous/campylotropous.
10. Ultrastructure of mature egg apparatus cells through electron micrographs.
11. Pollination types and seed dispersal mechanisms (including appendages, aril, caruncle) (Photographs and specimens).
12. Dissection of embryo/endosperm from developing seeds.
13. Calculation of percentage of germinated pollen in a given medium.

Suggested Readings

Core Course Botany – Paper IV
Plant Physiology and Metabolism
(BOTA 401 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Introduction
Applications of plant physiology in agriculture & horticulture.
Plant-water relations (8 Lectures)
Importance of water, Diffusion. Osmosis, water potential and its components; Transpiration and its significance; Factors affecting transpiration; Root pressure and guttation, Mechanism of Stomatal movements.

Unit 2: Mineral nutrition (8 Lectures)
Essential elements, macro and micronutrients; Criteria of essentiality of elements; Role of essential elements; Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.

Unit 3: Translocation in phloem (4 Lectures)
Composition of phloem sap, girdling experiment; Pressure flow model; Phloem loading and unloading.

Unit 4: Photosynthesis (12 Lectures)
Photosynthetic Pigments (Chl a, b, xanthophylls, carotene); Photosystem I and II, reaction center, antenna molecules; Electron transport and mechanism of ATP synthesis; C₃, C₄ and CAM pathways of carbon fixation; Photorespiration.

Unit 5: Respiration (8 Lectures)
Glycolysis, anaerobic respiration, TCA cycle; Oxidative phosphorylation, Glyoxylate, Oxidative Pentose Phosphate Pathway.

Unit 6: Enzymes (4 Lectures)
Structure and properties; Mechanism of enzyme catalysis and enzyme inhibition.

Unit 7: Nitrogen metabolism (4 Lectures)
Biological nitrogen fixation; Nitrate and ammonia assimilation.

Unit 8: Plant growth regulators (6 Lectures)
Discovery and physiological roles of auxins, gibberellins, cytokinins, ABA, ethylene.

Unit 9: Plant response to light and temperature (6 Lectures)
Photoperiodism (SDP, LDP, Day neutral plants); Phytochrome (discovery and structure), red and far red light responses on photomorphogenesis; Vernalization.

**Practical (BOTA 401 PR)**

11. Determination of osmotic potential of plant cell sap by plasmolytic method.
12. To study the effect of two environmental factors (light and wind) on transpiration by excised twig.
13. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
15. Demonstrate the activity of catalase and study the effect of pH and enzyme concentration.
16. To study the effect of light intensity and bicarbonate concentration on O\textsubscript{2} evolution in photosynthesis.
17. Comparison of the rate of respiration in any two parts of a plant.

**Demonstration experiments (any four)**

2. Bolting.
3. Effect of auxins on rooting.
4. Suction due to transpiration.
5. R.Q.
6. Respiration in roots.

**Suggested Readings**

Discipline Specific Elective Botany
Economic Botany and Biotechnology
(BOTA 501 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Cultivated Plants (4 Lectures)
Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov’s work

Unit 2: Cereals (6 Lectures)
Wheat and Rice - Origin, morphology, uses

Unit 3: Pulses & Vegetables (4 Lectures)
General account with special reference to Gram, soybean and Potato

Unit 4: Spices (3 Lectures)
General account with special reference to clove, black pepper, cinnamon, Ginger and Turmeric (Botanical name, family, part used, morphology and uses)

Unit 5: Beverages (4 Lectures)
Tea and Coffee (morphology, processing, uses)

Unit 6: Oils and Sugar (4 Lectures)
General description with special reference to groundnut and sugarcane

Unit 7: Fibre Yielding Plants (4 Lectures)
General description with special reference to Cotton (Botanical name, family, part used, morphology and uses)

Unit 8: Medicinal Plants
Brief account of Ocimum, Tinospora, Aloe, Rauwolfia, Emblica and Catharanthus (3 Lecture)

Unit 9: Introduction to Biotechnology (10 Lectures)
Tissue culture techniques, Micropropagation; haploid production through androgenesis and gynogenesis; brief account of embryo & endosperm culture; Applications of plant tissue culture in agriculture, horticulture and forestry.

Unit 10: Biotechnological Techniques
Introduction to r-DNA, Cloning vehicles, Gene transfer techniques in plants, Transgenic plants,
Agarose electrophoresis, Blotting techniques: Northern, Southern and Western Blotting, DNA Fingerprinting; Molecular DNA markers i.e. RAPD, RFLP, SNPs; DNA sequencing, PCR and Reverse Transcriptase-PCR. ELISA.
(18 Lectures)
Practical (BOTA 501PR)

1. Study of economically important plants: Wheat, Rice, Gram, Soybean, Potato, Black pepper, Clove, Cinnamon, Ginger, Turmeric, Tea, Coffee, Cotton, Groundnut, Sugarcane and Medicinal plants through specimens or photographs, sections and microchemical tests.

2. Familiarization with basic equipments in tissue culture.

3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.

4. Study of molecular techniques: PCR, Blotting techniques, AGE and PAGE.

Suggested Readings


Discipline Specific Elective Botany

Analytical Techniques in Plant Sciences
(BOTA 502 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Imaging and related techniques (15 Lectures)
Principles of microscopy; Light microscopy; Fluorescence microscopy; Confocal microscopy; Use of fluorochromes: (a) Flow cytometry (FACS); (b) Applications of fluorescence microscopy: Chromosome banding, FISH, chromosome painting; Transmission and Scanning electron microscopy – sample preparation for electron microscopy, cryofixation, negative staining, shadow casting, freeze fracture, freeze etching.

Unit 2: Cell fractionation (8 Lectures)
Centrifugation: Differential and density gradient centrifugation, sucrose density gradient, CsCl gradient, analytical centrifugation, ultracentrifugation, marker enzymes.

Unit 3: Radioisotopes
Use in biological research, auto-radiography, pulse chase experiment. (4 Lectures)

Unit 4: Spectrophotometry
Principle and its application in biological research. (4 Lectures)

Unit 5: Chromatography (8 Lectures)
Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ion-exchange chromatography; Molecular sieve chromatography; Affinity chromatography.

Unit 6: Characterization of proteins and nucleic acids (6 Lectures)
Mass spectrometry; X-ray diffraction; X-ray crystallography; Characterization of proteins and nucleic acids; Electrophoresis: AGE, PAGE, SDS-PAGE

Unit 7: Biostatistics (15 Lectures)
Statistics, data, population, samples, parameters; Representation of Data: Tabular, Graphical; Measures of central tendency: Arithmetic mean, mode, median; Measures of dispersion: Range, mean deviation, variation, standard deviation; Chi-square test for goodness of fit.
Practicals  (BOTA 502 PR)

1. Study of Blotting techniques: Southern, Northern and Western, DNA fingerprinting, DNA sequencing, PCR through photographs.

2. Demonstration of ELISA.

3. To separate nitrogenous bases by paper chromatography.

4. To separate sugars by thin layer chromatography.

5. Isolation of chloroplasts by differential centrifugation.

6. To separate chloroplast pigments by column chromatography.

7. To estimate protein concentration through Lowry’s methods.

8. To separate proteins using PAGE.

9. To separate DNA (marker) using AGE.

10. Study of different microscopic techniques using photographs/micrographs (freeze fracture, freeze etching, negative staining, positive staining, fluorescence and FISH).

11. Preparation of permanent slides (double staining).

Suggested Readings


Discipline Centric Elective Botany

Cell and Molecular Biology
(BOTA 601 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Techniques in Biology (8 Lectures)
Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Confocal microscopy; Sample Preparation for light microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample Preparation for electron microscopy; X-ray diffraction analysis.

Unit 2: Cell as a unit of Life (2 Lectures)
The Cell Theory; Prokaryotic and eukaryotic cells; Cell size and shape; Eukaryotic Cell components.

Unit 3: Cell Organelles (20 Lectures)
Mitochondria: Structure, marker enzymes, composition; Semiautonomous nature; Symbiont hypothesis; Proteins synthesized within mitochondria; mitochondrial DNA.
Chloroplast Structure, marker enzymes, composition; semiautonomous nature, chloroplast DNA.
ER, Golgi body & Lysosomes: Structures and roles.
Peroxisomes and Glyoxisomes: Structures, composition, functions in animals and plants and biogenesis.
Nucleus: Nuclear Envelope- structure of nuclear pore complex; chromatin; molecular organization, DNA packaging in eukaryotes, euchromatin and heterochromatin, nucleolus and ribosome structure (brief).

Unit 4: Cell Membrane and Cell Wall (6 Lectures)
The functions of membranes; Models of membrane structure; The fluidity of membranes; Membrane proteins and their functions; Carbohydrates in the membrane; Faces of the membranes; Selective permeability of the membranes; Cell wall.

Unit 5: Cell Cycle (6 Lectures)
Overview of Cell cycle, Mitosis and Meiosis; Molecular controls.

**Unit 6: Genetic material**  
(6 Lectures)

DNA: Miescher to Watson and Crick- historic perspective, Griffith’s and Avery’s transformation experiments, Hershey-Chase bacteriophage experiment, DNA structure, types of DNA, types of genetic material.

DNA replication (Prokaryotes and eukaryotes): bidirectional replication, semi-conservative, semi discontinuous RNA priming, \( \Theta \) (theta) mode of replication, replication of linear, ds-DNA, replicating the 5’ end of linear chromosome including replication enzymes.

**Unit 7: Transcription (Prokaryotes and Eukaryotes)**  
(6 Lectures)

Types of structures of RNA (mRNA, tRNA, rRNA), RNA polymerase- various types; Translation (Prokaryotes and eukaryotes), genetic code.

**Unit 8: Regulation of gene expression**  
(6 Lectures)

Prokaryotes: Lac operon and Tryptophan operon; and in Eukaryotes.

**Practical (BOTA 601 PR)**

8. To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
9. Study of the photomicrographs of cell organelles
10. To study the structure of plant cell through temporary mounts.
11. To study the structure of animal cells by temporary mounts-squamous epithelial cell and nerve cell.
12. Preparation of temporary mounts of striated muscle fiber
13. To prepare temporary stained preparation of mitochondria from striated muscle cells /cheek epithelial cells using vital stain Janus green.
15. Study the effect of temperature, organic solvent on semi permeable membrane.
16. Demonstration of dialysis of starch and simple sugar.
17. Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.
18. Measure the cell size (either length or breadth/diameter) by micrometry.
19. Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.
20. Study DNA packaging by micrographs.
21. Preparation of the karyotype and ideogram from given photograph of somatic metaphase chromosome.
Suggested Readings

Discipline Centric Elective Botany

Bioinformatics
(BOTA 602 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Introduction to Bioinformatics (5 Lectures)
Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics.

Unit 2: Databases in Bioinformatics (5 Lectures)
Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

Unit 3: Biological Sequence Databases (25 Lectures)
National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database.
EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools.
DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ.
Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR.
Swiss-Prot: Introduction and Salient Features.

Unit 4: Sequence Alignments (10 Lectures)
Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Scoring Matrices, Percent Accepted Mutation (PAM), Blocks of Amino Acid Substitution Matrix (BLOSUM).

Unit 5: Molecular Phylogeny (8 Lectures)
Methods of Phylogeny, Software for Phylogenetic Analyses, Consistency of Molecular Phylogenetic Prediction.

Unit 6: Applications of Bioinformatics (7 Lectures)
Structural Bioinformatics in Drug Discovery, Quantitative structure-activity relationship (QSAR) techniques in Drug Design, Microbial genome applications, Crop improvement.

**Practical (BOTA 602 PR)**

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.

**Suggested Readings**

Discipline Specific Elective Botany

Research Methodology
(BOTA 603 TH)
(Credits: Theory-4, Practicals-2)

THEORY
Lectures: 60

Unit 1: Basic concepts of research (10 Lectures)
Research-definition and types of research (Descriptive vs analytical; applied vs fundamental; quantitative vs qualitative; conceptual vs empirical). Research methods vs methodology. Literature-review and its consolidation; Library research; field research; laboratory research.

Unit 2: General laboratory practices (12 Lectures)

Unit 3: Data collection and documentation of observations (6 Lectures)
Maintaining a laboratory record; Tabulation and generation of graphs. Imaging of tissuespecimens and application of scale bars. The art of field photography.

Unit 4: Overview of Biological Problems (6 Lectures)
History; Key biology research areas, Model organisms in biology (A Brief overview): Genetics, Physiology, Biochemistry, Molecular Biology, Cell Biology, Genomics, Proteomics-Transcriptional regulatory network.

Unit 5: Methods to study plant cell/tissue structure (6 Lectures)
Whole mounts, peel mounts, squash preparations, clearing, maceration and sectioning; Tissue preparation: living vs fixed, physical vs chemical fixation, coagulating fixatives, non-coagulant fixatives; tissue dehydration using graded solvent series; Paraffin and plastic infiltration; Preparation of thin and ultrathin sections.

Unit 6: Plant microtechniques (12 Lectures)
Staining procedures, classification and chemistry of stains. Staining equipment. Reactive
dyes and fluorochromes (including genetically engineered protein labeling with GFP and other tags). Cytogenetic techniques with squashed plant materials.

**Unit 7: The art of scientific writing and its presentation** (8 Lectures)

Numbers, units, abbreviations and nomenclature used in scientific writing. Writing references. Powerpoint presentation. Poster presentation. Scientific writing and ethics, Introduction to copyright-academic misconduct/plagiarism.

**Practical (BOTA 603 PR)**

1. Experiments based on chemical calculations.
2. Plant microtechnique experiments.
3. The art of imaging of samples through microphotography and field photography.
4. Poster presentation on defined topics.
5. Technical writing on topics assigned.

**Suggested Readings**

THEORY

(CREDITS 4)

Unit 1: Kingdom Protista  4
General characters and classification up to classes; Locomotory Organelles and locomotion in Protozoa

Unit 2: Phylum Porifera  3
General characters and classification up to classes; Canal System in Sycon

Unit 3: Phylum Cnidaria  3
General characters and classification up to classes; Polymorphism in Hydrozoa

Unit 4: Phylum Platyhelminthes  3
General characters and classification up to classes; Life history of Taenia solium

Unit 5: Phylum Nemathelminthes  5
General characters and classification up to classes; Life history of Ascaris lumbricoides and its parasitic adaptations

Unit 6: Phylum Annelida  3
General characters and classification up to classes; Metamerism in Annelida

Unit 7: Phylum Arthropoda  5
General characters and classification up to classes; Vision in Arthropoda, Metamorphosis in Insects

Unit 8: Phylum Mollusca  4
General characters and classification up to classes; Torsion in gastropods

Unit 9: Phylum Echinodermata  4
General characters and classification up to classes; Water-vascular system in Asteroidea

Unit 10: Protochordates  2
General features and Phylogeny of Protochordata

Unit 11: Agnatha  2
General features of Agnatha and classification of cyclostomes up to classes

Unit 12: Pisces  4
General features and Classification up to orders; Osmoregulation in Fishes
Unit 13: Amphibia
General features and Classification up to orders; Parental care

Unit 14: Reptiles
General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes

Unit 15: Aves
General features and Classification up to orders; Flight adaptations in birds

Unit 17: Mammals
Classification up to orders; Origin of mammals

Note: Classification of Unit 1-9 to be followed from “Barnes, R.D. (1982). Invertebrate Zoology, V Edition”
1. Study of the following specimens:
   Amoeba, Euglena, Plasmodium, Paramecium, Sycon, Hyalonema, and Euplectella,
   Obelia, Physalia, Aurelia, Tubipora, Metridium, Taenia solium, Male and female Ascaris
   lumbricoides, Aphrodite, Nereis, Pheretima, Hirudinaria, Palaemon, Cancer, Limulus,
   Palamnaeus, Scolopendra, Julius, Periplaneta, Apis, Chiton, Dentalium, Pila, Unio,
   Loligo, Sepia, Octopus, Pentaceros, Ophiura, Echinus, Cucumaria and Antedon,
   Balanoglossus, Herdmania, Branchiostoma, Petromyzon, Sphyrna, Pristis, Torpedo,
   Labeo, Exocoetus, Anguilla, Ichthyophilis/Ureotyphlus, Salamandra, Bufo, Hyla, Chelone,
   Hemidactylus, Chamaeleon, Draco, Vipera, Naja, Crocodylus, Gavialis, Any six
   common birds from different orders, Sorex, Bat, Funambulus, Loris

2. Study of the following permanent slides:
   T.S. and L.S. of Sycon, Study of life history stages of Taenia, T.S. of Male and female
   Ascaris

3. Key for Identification of poisonous and non-poisonous snakes

   An “animal album” containing photographs, cut outs, with appropriate write up about the
   above mentioned taxa. Different taxa/topics may be given to different sets of students for
   this purpose.

SUGGESTED READINGS

  Bartlett Publishers Inc.
Unit 1: Integumentary System 
Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System 
Evolution of visceral arches

Unit 3: Digestive System 
Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System 
Brief account of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System 
Evolution of heart and aortic arches

Unit 6: Urinogenital System 
Succession of kidney, Evolution of urinogenital ducts

Unit 7: Nervous System 
Comparative account of brain

Unit 8: Sense Organs 
Types of receptors

Unit 9: Early Embryonic Development 
Gametogenesis: Spermatogenesis and oogenesis w.r.t. mammals, vitellogenesis in birds; Fertilization: external (amphibians), internal (mammals), blocks to polyspermy; Early development of frog and humans (structure of mature egg and its membranes, patterns of cleavage, fate map, up to formation of gastrula); types of morphogenetic movements; Fate of germ layers; Neurulation in frog embryo.

Unit 10: Late Embryonic Development 
Implantation of embryo in humans, Formation of human placenta and functions, other types of placenta on the basis of histology; Metamorphic events in frog life cycle and its hormonal regulation.

Unit 11: Control of Development
Fundamental processes in development (brief idea) – Gene activation, determination, induction, Differentiation, morphogenesis, intercellular communication, cell movements and cell death
COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

ZOOL 201 PR

PRACTICAL

1. Osteology:
   a) Disarticulated skeleton of fowl and rabbit
   b) Carapace and plastron of turtle/tortoise
   c) Mammalian skulls: One herbivorous and one carnivorous animal.

2. Frog - Study of developmental stages - whole mounts and sections through permanent slides – cleavage stages, blastula, gastrula, neurula, tail bud stage, tadpole external and internal gill stages.

3. Study of the different types of placenta- histological sections through permanent slides or photomicrographs.

4. Study of placental development in humans by ultrasound scans.

5. Examination of gametes - frog/rat - sperm and ova through permanent slides or photomicrographs.

SUGGESTED READINGS

Unit 1: Nerve and muscle  
Structure of a neuron, Resting membrane potential, Graded potential, Origin of Action potential and its propagation in myelinated and non-myelinated nerve fibres, Ultra-structure of skeletal muscle, Molecular and chemical basis of muscle contraction

Unit 2: Digestion  
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids

Unit 3: Respiration  
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood

Unit 4: Excretion  
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism

Unit 5: Cardiovascular system  
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle

Unit 6: Reproduction and Endocrine Glands  
Physiology of male reproduction: hormonal control of spermatogenesis; Physiology of female reproduction: hormonal control of menstrual cycle
Structure and function of pituitary, thyroid, Parathyroid, pancreas and adrenal

Unit 7: Carbohydrate Metabolism  
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain

Unit 8: Lipid Metabolism  
Biosynthesis and β oxidation of palmitic acid

Unit 9: Protein metabolism  
Transamination, Deamination and Urea Cycle

Unit 10: Enzymes  
Introduction, Mechanism of action, Enzyme Kinetics, Inhibition and Regulation
PHYSIOLOGY AND BIOCHEMISTRY
ZOOL 301 PR

PRACTICAL

(CREDITS 2)

1. Preparation of hemin and hemochromogen crystals
2. Study of permanent histological sections of mammalian pituitary, thyroid, pancreas, adrenal gland
3. Study of permanent slides of spinal cord, duodenum, liver, lung, kidney, bone, cartilage
4. Qualitative tests to identify functional groups of carbohydrates in given solutions (Glucose, Fructose, Sucrose, Lactose)
2. Estimation of total protein in given solutions by Lowry’s method.
3. Study of activity of salivary amylase under optimum conditions

SUGGESTED READINGS

Unit 1: Introduction to Genetics
Mendel’s work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension
Principles of Inheritance, Chromosome theory of inheritance, Incomplete dominance and co-dominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Unit 3: Linkage, Crossing Over and Chromosomal Mapping
Linkage and crossing over, Recombination frequency as a measure of linkage intensity, two factor and three factor crosses, Interference and coincidence, Somatic cell genetics - an alternative approach to gene mapping

Unit 4: Mutations
Chromosomal Mutations: Deletion, Duplication, Inversion, Translocation, Aneuploidy and Polyploidy; Gene mutations: Induced versus Spontaneous mutations, Back versus Suppressor mutations,

Unit 5: Sex Determination
Chromosomal mechanisms, dosage compensation

Unit 6: History of Life
Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories
Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution
Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change
Organic variations; Isolating Mechanisms; Natural selection (Example: Industrial melanism); Types of natural selection (Directional, Stabilizing, Disruptive), Artificial selection

Unit 10: Species Concept
Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)
Unit 11: Macro-evolution

Macro-evolutionary Principles (example: Darwin’s Finches)

Unit 12: Extinction

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution
1. Study of Mendelian Inheritance and gene interactions (Non Mendelian Inheritance) using suitable examples. Verify the results using Chi-square test.
2. Study of Linkage, recombination, gene mapping using the data.
4. Study of fossil evidences from plaster cast models and pictures
5. Study of homology and analogy from suitable specimens/ pictures
6. Charts:
   a) Phylogeny of horse with diagrams/ cut outs of limbs and teeth of horse ancestors
   b) Darwin’s Finches with diagrams/ cut outs of beaks of different species
7. Visit to Natural History Museum and submission of report

SUGGESTED READINGS

DSE 2
APPLIED ZOOLOGY
ZOOL 501TH

THEORY (CREDITS 4)

Unit 1: Introduction to Host-parasite Relationship 3
Host, Definitive host, Intermediate host, Parasitism, Symbiosis, Commensalism, Reservoir, Zoonosis

Unit 2: Epidemiology of Diseases 7
Transmission, Prevention and control of diseases: Tuberculosis, typhoid

Unit 3: Rickettsiae and Spirochaetes 6
Brief account of Rickettsia prowazekii, Borrelia recurrentis and Treponema pallidum

Unit 4: Parasitic Protozoa 8
Life history and pathogenicity of Entamoeba histolytica, Plasmodium vivax and Trypanosoma gambiense

Unit 5: Parasitic Helminthes 5
Life history and pathogenicity of Ancylostoma duodenale and Wuchereria bancrofti

Unit 6: Insects of Economic Importance 8
Biology, Control and damage caused by Helicoverpa armigera, Pyrilla perpusilla and Papilio demoleus, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum

Unit 7: Insects of Medical Importance 8
Medical importance and control of Pediculus humanus corporis, Anopheles, Culex, Aedes, Xenopsylla cheopis

Unit 8: Animal Husbandry 5
Preservation and artificial insemination in cattle; Induction of early puberty and synchronization of estrus in cattle

Unit 9: Poultry Farming 5
Principles of poultry breeding, Management of breeding stock and broilers, Processing and preservation of eggs

Unit 10: Fish Technology 5
Genetic improvements in aquaculture industry; Induced breeding and transportation of fish seed
APPLIED ZOOLOGY

ZOOL 501PR

PRACTICAL (CREDITS 2)

1. Study of Plasmodium vivax, Entamoeba histolytica, Trypanosoma gambiense, Ancylostoma duodenale and Wuchereria bancrofti and their life stages through permanent slides/photomicrographs or specimens.
3. Study of insect damage to different plant parts/stored grains through damaged products/photographs.
4. Identifying feature and economic importance of Helicoverpa (Heliothis) armigera, Papilio demoleus, Pyrilla perpusilla, Callosobruchus chinensis, Sitophilus oryzae and Tribolium castaneum
5. Visit to poultry farm or animal breeding centre. Submission of visit report
6. Maintenance of freshwater aquarium

SUGGESTED READINGS

- Kumar and Corton. Pathological Basis of Diseases.
- Hafez, E. S. E. (1962). Reproduction in Farm Animals. Lea & Fabiger Publisher
DISCIPLINE CENTRIC ELECTIVE COURSES

DSE 1
ANIMAL BIOTECHNOLOGY
ZOOL 502 TH

THEORY (Credits 4)

Unit 1: Introduction 8
Concept and scope of biotechnology

Unit 2: Molecular Techniques in Gene manipulation 24
Cloning vectors: Plasmids, Cosmids, Phagemids, Lambda Bacteriophage, M13, BAC, YAC, MAC and Expression vectors (characteristics)
Restriction enzymes: Nomenclature, detailed study of Type II.
Transformation techniques: Calcium chloride method and electroporation.
Construction of genomic and cDNA libraries and screening by colony and plaque hybridization
Southern, Northern and Western blotting; DNA sequencing: Sanger method
Polymerase Chain Reaction, DNA Finger Printing and DNA micro array

Unit 3: Genetically Modified Organisms 18
Production of cloned and transgenic animals: Nuclear Transplantation, Retroviral Method, DNA microinjection
Applications of transgenic animals: Production of pharmaceuticals, production of donor organs, knockout mice.
Production of transgenic plants: Agrobacterium mediated transformation.
Applications of transgenic plants: insect and herbicide resistant plants.

Unit 4: Culture Techniques and Applications 10
Animal cell culture, Expressing cloned genes in mammalian cells, Molecular diagnosis of genetic diseases (Cystic fibrosis, Sickle cell anemia)
Recombinant DNA in medicines: Recombinant insulin and human growth hormone, Gene therapy
PRACTICAL (Credits 2)

1. Genomic DNA isolation from *E. coli*
2. Plasmid DNA isolation (pUC 18/19) from *E. coli*
3. Restriction digestion of plasmid DNA.
4. Construction of circular and linear restriction map from the data provided.
5. Calculation of transformation efficiency from the data provided.
6. To study following techniques through photographs
   a) Southern Blotting
   b) Northern Blotting
   c) Western Blotting
   d) DNA Sequencing (Sanger's Method)
   e) PCR
   f) DNA fingerprinting
7. Project report on animal cell culture

SUGGESTED READINGS

DCE 3
AQUATIC BIOLOGY
ZOOL 503 TH

THEORY (Credits 4)

UNIT 1: Aquatic Biomes

Brief introduction of the aquatic biomes: Freshwater ecosystem (lakes, wetlands, streams and rivers), estuaries, intertidal zones, oceanic pelagic zone, marine benthic zone and coral reefs.

UNIT 2: Freshwater Biology


Streams: Different stages of stream development, Physico-chemical environment, Adaptation of hill-stream fishes.

UNIT 3: Marine Biology

Salinity and density of Sea water, Continental shelf, Adaptations of deep sea organisms, Coral reefs, Sea weeds.

UNIT 4: Management of Aquatic Resources

Causes of pollution: Agricultural, Industrial, Sewage, Thermal and Oil spills, Eutrophication, Management and conservation (legislations), Sewage treatment Water quality assessment- BOD and COD.
PRACTICAL

1. Determine the area of a lake using graphimetric and gravimetric method.

2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.

3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.

4. Instruments used in limnology (Secchi disc, Van Dorn Bottle, Conductivity meter, Turbidity meter, PONAR grab sampler) and their significance.

5. A Project Report on a visit to a Sewage treatment plant/Marine bio-reserve/Fisheries Institutes.

SUGGESTED READINGS

- **Anathakrishnan**: Bioresources Ecology 3rd Edition
- **Goldman**: Limnology, 2nd Edition
- **Odum and Barrett**: Fundamentals of Ecology, 5th Edition
- **Pawlowski**: Physicochemical Methods for Water and Wastewater Treatment, 1st Edition
- **Wetzel**: Limnology, 3rd edition
- **Trivedi and Goyal**: Chemical and biological methods for water pollution studies
- **Welch**: Limnology Vols. I-II
DSE 6
INSECT, VECTORS AND DISEASES
ZOOL 601 TH

THEORY

(Credits 4)

Unit I: Introduction to Insects  6
General Features of Insects, Morphological features, Head – Eyes, Types of antennae, Mouth parts w.r.t. feeding habits

Unit II: Concept of Vectors  6
Brief introduction of Carrier and Vectors (mechanical and biological vector), Reservoirs, Host-vector relationship, Vectorial capacity, Adaptations as vectors, Host Specificity

Unit III: Insects as Vectors  8
Classification of insects up to orders, detailed features of orders with insects as vectors – Diptera, Siphonaptera, Siphunculata, Hemiptera

Unit IV: Dipteran as Disease Vectors  24
Dipterans as important insect vectors – Mosquitoes, Sand fly, Houseflies;
Study of mosquito-borne diseases – Malaria, Dengue, Chikungunya, Viral encephalitis, Filariasis; Control of mosquitoes
Study of sand fly-borne diseases – Visceral Leishmaniasis, Cutaneous Leishmaniasis, Phlebotomus fever; Control of Sand fly
Study of house fly as important mechanical vector, Myiasis, Control of house fly

Unit IV: Siphonaptera as Disease Vectors  6
Fleas as important insect vectors; Host-specificity, Study of Flea-borne diseases – Plague, Typhus fever; Control of fleas

Unit V: Siphunculata as Disease Vectors  4
Human louse (Head, Body and Pubic louse) as important insect vectors; Study of louse-borne diseases –Typhus fever, Relapsing fever, Trench fever, Vagabond’s disease, Phthiriasis; Control of human louse

Unit VI: Hemptera as Disease Vectors  6
Bugs as insect vectors; Blood-sucking bugs; Chagas disease, Bed bugs as mechanical vectors, Control and prevention measures
INSECT VECTORS AND DISEASES

ZOOL 601 PR

PRACTICAL

1. Study of different kinds of mouth parts of insects

2. Study of following insect vectors through permanent slides/photographs: *Aedes, Culex, Anopheles, Pediculus humanus capitis, Pediculus humanus corporis, Phithirus pubis, Xenopsylla cheopis, Cimex lectularius, Phlebotomus argentipes, Musca domestica*, through permanent slides/photographs

3. Study of different diseases transmitted by above insect vectors

Submission of a project report on any one of the insect vectors and disease transmitted

SUGGESTED READINGS


THEORY

(CREDITS 4)

Unit 1: Overview of the Immune System 10
Introduction to basic concepts in immunology, components of immune system, principles of innate and adaptive immune system

Unit 2: Cells and Organs of the Immune System 8
Haematopoeisis, Cells of immune system and organs (primary and secondary lymphoid organs) of the immune system

Unit 3: Antigens 8
Basic properties of antigens, B and T cell epitopes, haptens and adjuvants

Unit 4: Antibodies 8
Structure, classes and function of antibodies, monoclonal antibodies, antigen antibody interactions as tools for research and diagnosis

Unit 5: Working of the immune system 12
Structure and functions of MHC, exogenous and endogenous pathways of antigen presentation and processing, Basic properties and functions of cytokines, Complement system: Components and pathways.

Unit 6: Immune system in health and disease 10
Gell and Coombs’ classification and brief description of various types of hypersensitivities, Introduction to concepts of autoimmunity and immunodeficiency,

Unit 7: Vaccines 4
General introduction to vaccines, Various types of vaccines
1*. Demonstration of lymphoid organs
2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
3. Preparation of stained blood film to study various types of blood cells.
5. ABO blood group determination.
6*. Cell counting and viability test from splenocytes of farm bred animals/cell lines.
7. Demonstration of
   a) ELISA
   b) Immuneelectrophoresis

(*Subject to UGC guidelines)

SUGGESTED READINGS


DSE 5

REPRODUCTIVE BIOLOGY

ZOOL 603 TH

THEORY (CREDITS 4)

Unit 1: Reproductive Endocrinology 15


Unit 2: Functional anatomy of male reproduction 15

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, system cell renewal; Spermatogenesis: kinetics and hormonal regulation; Androgen synthesis and metabolism; Epididymal function and sperm maturation; Accessory glands functions; Sperm transportation in male tract

Unit 3: Functional anatomy of female reproduction 20

Outline and histological of female reproductive system in rat and human; Ovary: folliculogenesis, ovulation, corpus luteum formation and regression; Steroidogenesis and secretion of ovarian hormones; Reproductive cycles (rat and human) and their regulation, changes in the female tract; Ovum transport in the fallopian tubes; Sperm transport in the female tract, fertilization; Hormonal control of implantation; Hormonal regulation of gestation, pregnancy diagnosis, foeto – maternal relationship; Mechanism of parturition and its hormonal regulation; Lactation and its regulation

Unit 4: Reproductive Health 10

Infertility in male and female: causes, diagnosis and management; Assisted Reproductive Technology: sex selection, sperm banks, frozen embryos, in vitro fertilization, ET, EFT, IUT, ZIFT, GIFT, ICSI, PROST; Modern contraceptive technologies; Demographic terminology used in family planning
REPRODUCTIVE BIOLOGY
ZOOI 603 PR

PRACTICAL (CREDITS 2)

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

2. Examination of vaginal smear rats from live animals.


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

5. Human vaginal exfoliate cytology.

6. Sperm count and sperm motility in rat

7. Study of modern contraceptive devices

SUGGESTED READINGS


- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.

Skill Enhancement Course

Botany

Biofertilizers
(BOTA 302)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: General account about the microbes used as biofertilizer – Rhizobium – isolation, identification, mass multiplication, carrier based inoculants, Actinorrhizal symbiosis.

(6 Lectures)

Unit 2: Azospirillum: isolation and mass multiplication – carrier based inoculant, associative effect of different microorganisms. Azotobacter: classification, characteristics – crop response to Azotobacter inoculum, maintenance and mass multiplication. (12 Lectures)

Unit 3: Cyanobacteria (blue green algae), Azolla and Anabaena azollae association, nitrogen fixation, factors affecting growth, blue green algae and Azolla in rice cultivation.

(6 Lectures)


(12 Lectures)

Unit 5: Organic farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes – biocompost making methods, types and method of vermicomposting – field Application. (9 Lectures)

Suggested Readings

Skill Enhancement Course

Herbal Technology
(BOTA 303)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Herbal medicines: history and scope - definition of medical terms - role of medicinal plants in Siddha systems of medicine; cultivation - harvesting - processing - storage - marketing and utilization of medicinal plants. (9 Lectures)

Unit 2: Pharmacognosy - systematic position medicinal uses of the following herbs in curing various ailments; Tulsi, Ginger, Fenugreek, Indian Goose berry and Ashoka. (9 Lectures)

Unit 3: Phytochemistry - active principles and methods of their testing - identification and utilization of the medicinal herbs; Catharanthus roseus (cardiotonic), Withania somnifera (drugs acting on nervous system), Clerodendron phlomoides (anti-rheumatic) and Centella asiatica (memory booster). (9 Lectures)

Unit 4: Analytical pharmacognosy: Drug adulteration - types, methods of drug evaluation - Biological testing of herbal drugs - Phytochemical screening tests for secondary metabolites (alkaloids, flavonoids, steroids, triterpenoids, phenolic compounds) (12 Lectures)

Unit 5: Medicinal plant banks micro propagation of important species (Withania somnifera, neem and tulsi- Herbal foods-future of pharmacognosy) (6 Lectures)

Suggested Readings


Skill Enhancement Course
Botany

Nursery and Gardening
(BOTA 402)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Nursery: definition, objectives and scope and building up of infrastructure for nursery, planning and seasonal activities – Planting – direct seeding and transplants. (8 Lectures)

Unit 2: Seed: Structure and types – Seed dormancy; causes and methods of breaking dormancy – Seed storage: Seed banks, factors affecting seed viability, genetic erosion – Seed production technology – seed testing and certification. (9 Lectures)

Unit 3: Vegetative propagation: air-layering, cutting, selection of cutting, collecting season, treatment of cutting, rooting medium and planting of cuttings – Hardening of plants – green house – mist chamber, shed root, shade house and glass house. (9 Lectures)

Unit 4: Gardening: definition, objectives and scope – different types of gardening – landscape and home gardening – parks and its components – plant materials and design – computer applications in landscaping – Gardening operations: soil laying, manuring, watering, management of pests and diseases and harvesting. (12 Lectures)

Unit 5: Sowing/raising of seeds and seedlings – Transplanting of seedlings – Study of cultivation of different vegetables: cabbage, brinjal, lady’s finger, onion, garlic, tomatoes, and carrots – Storage and marketing procedures (9 Lectures)

Suggested Readings

Skill Enhancement Course  
Botany  

Floriculture  
(BOTA 403)  

(Credits 4; 3 Theory + 1 Tutorial)  

Lectures: 45  

Unit 1: Introduction: History of gardening; Importance and scope of floriculture and landscape gardening. (2 Lectures)  

Unit 2: Nursery Management and Routine Garden Operations: Sexual and vegetative methods of propagation; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Wintering; Mulching; Topiary; Role of plant growth regulators. (8 Lectures)  

Unit 3: Ornamental Plants: Flowering annuals; Herbaceous perennials; Divine vines; Shade and ornamental trees; Ornamental bulbous and foliage plants; Cacti and succulents; Palms and Cycads; Ferns and Selaginellas; Cultivation of plants in pots; Indoor gardening; Bonsai. (14 Lectures)  

Unit 4: Principles of Garden Designs: English, Italian, French, Persian, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Water garden. Some Famous gardens of India. (6 Lectures)  

Unit 5: Landscaping Places of Public Importance: Landscaping highways and Educational institutions. (4 Lectures)  

Unit 6: Commercial Floriculture: Factors affecting flower production; Production and packaging of cut flowers; Flower arrangements; Methods to prolong vase life; Cultivation of Important cut flowers (Carnation, Aster, Chrysanthemum, Dahlia, Gerbera, Gladiolous, Marigold, Rose, Lilium, Orchids). (8 Lectures)  

Unit 7: Diseases and Pests of Ornamental Plants. (3 Lectures)  

Suggested Readings  

Skill Enhancement Course
Botany

Medicinal Botany
(BOTA 503)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45


Unit 2: Conservation of endangered and endemic medicinal plants. Definition: endemic and endangered medicinal plants, Red list criteria; In situ conservation: Biosphere reserves, sacred groves, National Parks; Ex situ conservation: Botanic Gardens, Ethnomedicinal plant Gardens. Propagation of Medicinal Plants: Objectives of the nursery, its classification, important components of a nursery, sowing, pricking, use of green house for nursery production, propagation through cuttings, layering, grafting and budding. (15 Lectures)

Unit 3: Ethnobotany and Folk medicines. Definition; Ethnobotany in India: Methods to study ethnobotany; Applications of Ethnobotany: National interacts, Palaeo-ethnobotany, folk medicines of ethnobotany, ethnomedicine, ethnoecology, ethnic communities of India. Application of natural products to certain diseases- Jaundice, cardiac, infertility, diabetics, Blood pressure and skin diseases. (15 Lectures)

Suggested Readings


Skill Enhancement Course
Botany

Ethnobotany
(BOTA 504)
(Credits 4; 3 Theory + 1 Tutorial
Lectures: 45

Unit 1: Ethnobotany
Introduction, concept, scope and objectives; Ethnobotany as an interdisciplinary science. The relevance of ethnobotany in the present context; Major and minor ethnic groups or Tribals of India, and their life styles. Plants used by the tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. (9 Lectures)

Unit 2: Methodology of Ethnobotanical studies
a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. (9 Lectures)

Unit 3: Role of ethnobotany in modern Medicine
Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) Azadiractha indica b) Ocimum sanctum c) Vitex negundo. d) Gloriosa superba e) Tribulus terrestris f) Pongamia pinnata g) Cassia auriculata h) Indigofera tinctoria. Role of ethnobotany in modern medicine with special example Rauvolfia sepentina, Trichopus zeylanicus, Artemisia, Withania.
Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). (15 Lectures)

Unit 4: Ethnobotany and legal aspects
Ethnobotany as a tool to protect interests of ethnic groups. Sharing of wealth concept with few examples from India. Biopiracy, Intellectual Property Rights and Traditional Knowledge. (12 Lectures)

Suggested Readings
3. Lone et al., Palaeoethnobotany
Skill Enhancement Course  
Botany  

Plant Diversity and Human Welfare  
(BOTA 604)  
(Credits 4; 3 Theory + 1 Tutorial)  

Lectures: 45  

**Unit 1:** Plant diversity and its scope- Genetic diversity, Species diversity, Plant diversity at the ecosystem level, Agrobiodiversity and cultivated plant taxa, wild taxa. Values and uses of Biodiversity: Ethical and aesthetic values, Precautionary principle, Methodologies for valuation, Uses of plants, Uses of microbes. (**12 Lectures**)  

**Unit 2:** Loss of Biodiversity: Loss of genetic diversity, Loss of species diversity, Loss of ecosystem diversity, Loss of agrobiodiversity, Projected scenario for biodiversity loss, Management of Plant Biodiversity: Organizations associated with biodiversity management-Methodology for execution-IUCN, UNEP, UNESCO, WWF, NBPGR; Biodiversity legislation and conservations, Biodiversity information management and communication. (**12 Lectures**)  

**Unit 3:** Conservation of Biodiversity: Conservation of genetic diversity, species diversity and ecosystem diversity, *In situ* and *ex situ* conservation, Social approaches to conservation, Biodiversity awareness programmes, Sustainable development. (**12 Lectures**)  

**Unit 4:** Role of plants in relation to Human Welfare; a) Importance of forestry their utilization and commercial aspects b) Avenue trees, c) Ornamental plants of India. d) Alcoholic beverages through ages. Fruits and nuts: Important fruit crops their commercial importance. Wood and its uses. (**9 Lectures**)  

**Suggested Readings**  

Skill Enhancement Course
Botany

Mushroom Cultivation Technology
(BOTA 605)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Introduction, history. Nutritional and medicinal value of edible mushrooms; Nutrition and nutraceuticals – Proteins, amino acids, mineral elements nutrition, carbohydrates, crude fibre content, vitamins; Poisonous mushrooms. (5 Lectures)

Unit 2: Cultivation Technology: Infrastructure: substrates (locally available) Polythene bag, vessels, Inoculation hook, inoculation loop, low cost stove, sieves, culture rack, mushroom unit (Thatched house) water sprayer, tray, small polythene bag. Pure culture: Medium, sterilization, preparation of spawn, multiplication. (12 Lectures)

Unit 3: Cultivation practices of Agaricus bisporus, Pleurotus sp. and Volvoriea volvacea. Composting technology in mushroom production, Low cost technology, Mushroom bed preparation - paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation. (12 Lectures)

Unit 4: Storage: Short-term storage (Refrigeration - upto 24 hours) Long term Storage (canning, pickels, papads), drying, storage in salt solutions. (6 Lectures)

Unit 5: Food Preparation: Types of foods prepared from mushroom. Research Centres - National level and Regional level. Cost benefit ratio - Marketing in India and abroad, Export Value (5 Lectures)

Unit 6: Diseases and pests of mushrooms (5 Lectures)

Suggested Readings

Skill Enhancement Course
Botany

Intellectual Property Rights
(BOTA 606)
(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: Introduction to intellectual property right (IPR) (3 lectures)
Concept and kinds. Economic importance. IPR in India and world: Genesis and scope, some important examples. IPR and WTO (TRIPS, WIPO).

Unit 2: Patents (5 Lectures)

Unit 3: Copyrights (4 Lectures)
Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit 4: Trademarks (5 Lectures)
Objectives, Types, Rights, Protection of goodwill, Infringement, Passing off, Defences, Domain name.

Unit 5: Geographical Indications (4 Lectures)
Objectives, Justification, International Position, Multilateral Treaties, National Level, Indian Position.

Unit 6: Protection of Traditional Knowledge (6 Lectures)
Objective, Concept of Traditional Knowledge, Holders, Issues concerning, Bio-Prospecting and Bio-Piracy, Alternative ways, Protectability, need for a Sui-Generis regime, Traditional Knowledge on the International Arena, at WTO, at National level, Traditional Knowledge Digital Library.

Unit 7: Industrial Designs (3 Lectures)
Objectives, Rights, Assignments, Infringements, Defences of Design Infringement

Unit 8: Protection of Plant Varieties (3 Lectures)
Plant Varieties Protection-Objectives, Justification, International Position, Plant varieties

Unit 9: Information Technology Related Intellectual Property Rights (6 Lectures)

Computer Software and Intellectual Property, Database and Data Protection, Protection of Semi-conductor chips, Domain Name Protection

Unit 10: Biotechnology and Intellectual Property Rights (6 Lectures)

Patenting Biotech Inventions: Objective, Applications, Concept of Novelty, Concept of inventive step, Microorganisms, Moral Issues in Patenting Biotechnological inventions.

Suggested Readings


*Lubricants:* Classification of lubricants, lubricating oils (conducting and non-conducting) Solid and semisolid lubricants, synthetic lubricants.

Properties of lubricants (viscosity index, cloud point, pore point) and their determination.

**Reference Books:**
## SKILL ENHANCEMENT COURSES

**Zoology**

**SEC 1**

**MEDICAL DIAGNOSTICS**

**Code: ZOOL 302 TH**

### THEORY  

**Credits 4**

(3+01)

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<thead>
<tr>
<th>Unit</th>
<th>Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>1</td>
<td>Introduction to Medical Diagnostics and its Importance</td>
<td>2</td>
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<tr>
<td>2</td>
<td>Diagnostics Methods Used for Analysis of Blood</td>
<td>15</td>
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<td>3</td>
<td>Diagnostic Methods Used for Urine Analysis</td>
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<td>4</td>
<td>Non-infectious Diseases</td>
<td>10</td>
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<td>5</td>
<td>Infectious Diseases</td>
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<td>6</td>
<td>Tumours</td>
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**Unit 1:** Blood composition, Preparation of blood smear and Differential Leucocyte Count (D.L.C) using Leishman’s stain, Platelet count using haemocytometer, Erythrocyte Sedimentary Rate (E.S.R), Packed Cell Volume (P.C.V.)

**Unit 2:** Urine Analysis: Physical characteristics; Abnormal constituents

**Unit 4:** Causes, types, symptoms, complications, diagnosis and prevention of Diabetes (Type I and Type II), Hypertension (Primary and secondary), Testing of blood glucose using Glucometer/Kit

**Unit 5:** Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

**Unit 6:** Types (Benign/Malignant), Detection and metastasis; Medical imaging: X-Ray of Bone fracture, PET, MRI and CT Scan (using photographs).

### SUGGESTED READINGS

- Cheesbrough M., *A Laboratory Manual for Rural Tropical Hospitals, A Basis for Training Courses*
- Guyton A.C. and Hall J.E. *Textbook of Medical Physiology*, Saunders

**Tutorial – 01 Credit**
Skill Enhancement Course

Zoology

Apiculture

ZOOL 402 TH (CREDITS 4)

Unit 1: Biology of Bees (10)
History, Classification and Biology of Honey Bees
Social Organization of Bee Colony

Unit 2: Rearing of Bees (15)
Artificial Bee rearing (Apiary), Beehives – Newton and Langstroth
Bee Pasturage
Selection of Bee Species for Apiculture
Bee Keeping Equipment
Methods of Extraction of Honey (Indigenous and Modern)

Unit 3: Diseases and Enemies (8)
Bee Diseases and Enemies
Control and Preventive measures

Unit 4: Bee Economy (6)
Products of Apiculture Industry and its Uses (Honey, Bees Wax, Propolis), Pollen etc

Unit 5: Entrepreneurship in Apiculture (6)
Bee Keeping Industry – Recent Efforts, Modern Methods in employing artificial Beehives for cross pollination in horticultural gardens

SUGGESTED READINGS

- Bisht D.S., Apiculture, ICAR Publication.
- Singh S., Beekeeping in India, Indian council of Agricultural Research, NewDelhi.
Skill Enhancement Course

Zoology

AQUARIUM FISH KEEPING
ZOOL 604 TH

(CREDITS 4)

Unit 1: Introduction to Aquarium Fish Keeping
The potential scope of Aquarium Fish Industry as a Cottage Industry, Exotic and Endemic species of Aquarium Fishes

Unit 2: Biology of Aquarium Fishes
Common characters and sexual dimorphism of Fresh water and Marine Aquariumfishes such as Guppy, Molly, Sword tail, Gold fish, Angel fish, Blue morph, Anemone fish and Butterfly fish

Unit 3: Food and feeding of Aquarium fishes
Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation
Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium
General Aquarium maintenance – budget for setting up an Aquarium Fish Farm as a Cottage Industry

SUGGESTED READINGS

- Mary Bailey, Gina Sandford; *The Complete Guide to Aquarium Fish Keeping (Practical Handbook)* Publishers: Lorenz Books
- Mills, Dick; *Keeping Aquarium Fish (Teach Yourself General)* Publisher: Teach Yourself
Skill Enhancement Course

Zoology
RESEARCH METHODOLOGY
ZOOL 605TH

CREDITS 2

Unit 1: Foundations of Research
Meaning, Objectives, Motivation: Research Methods vs Methodology, Types of Research: Analytical vs Descriptive, Quantitative vs Qualitative, Basic vs Applied

5

Unit 2: Research Design
Need for research design: Features of good design, Important concepts related to good design- Observation and Facts, Prediction and Explanation, Development of Models. Developing a research plan: Problem identification, Experimentation, Determining experimental and sample designs

8

Unit 3: Data Collection, Analysis and Report Writing
Observation and Collection of Data-Methods of data collection- Sampling Methods, Data Processing and Analysis Strategies, Technical Reports and Thesis writing, Preparation of Tables and Bibliography. Data Presentation using digital technology

12

Unit 4: Ethical Issues
Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

5

SUGGESTED READINGS

- Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and Geographical Indications, 2002, Universal Law publishing
- C.R.Kothari: Research Methodology, New Age International, 2009
END SEMESTER EXAMINATION (ESE) OF LIFESCIENCES IN B.Sc. PROGRAMME
THEORY EXAMINATION

SCHEME OF EXAMINATION

1. English shall be the medium of instruction and examination.
2. Examinations shall be conducted at the end of each semester as per the Academic Calendar notified by Himachal Pradesh University.
3. Each course will carry 100 marks and will have following components

1. **Theory Paper End-Semester examination** 50 marks
2. **Practicals** 30 marks
3. **Internal Assessment** 20 Marks

Theory Paper + Practicals + Internal Assessment (50+30+ 20) =100 marks

Scheme of Examination for every course (Core Course, Discipline Specific Elective Course, Generic Elective Course):

End Semester Examination 50 marks Time 3 hrs
Practical for every course 30 marks Time 3 hrs
Internal Assessment 20 Marks

Skill Enhancement Course & Ability Enhancement Compulsory Course:

Theory Paper End Semester Examination 100 marks