

Structure of B.Sc. Life Sciences under CBCS

	CORE COURSE(12)	Ability Enhancement Compulsory Courses (2)	Skill Enhancement Courses (SEC) (4)	Discipline Elective DSE (6)	Specific
I	CC-Botany I Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101)	(English/Hindi/MI L Communication)/ Environmental Science			
	CC-Zoology I Animal Diversity ZOOL 101 ZOOL 101				
	CC-Chemistry I Atomic structure, Bonding, General Organic Chemistry and Hydrocarbons CHEM CC 101				
II	CC-Botany II Plant Ecology and Taxonomy (BOTA 201)	(English/Hindi/MI L Communication)/ Environmental Science			
	CC-Zoology II Comparative Anatomy & Developmental Biology of Vertebrates ZOOL 201 ZOOL 201				
	CC-Chemistry II Chemical Energetic, Equilibrium & Functional Group Organic Chemistry CHEM CC 202				

III	CC-Botany III1 Plant Anatomy and Embryology (BOTA 301)	SEC-I Bio-Fertilizers (BOTA 302) or Herbal Technology (BOTA 303) or Medical Diagnostics ZOOLOGY 302 Basic Analytical Chemistry CHEM SEC 301 OR Fuel Chemistry and Chemistry of Cosmetics and Perfumes CHEM SEC 302
	CC-Zoology III Physiology & Biochemistry ZOOLOGY 301 ZOOLOGY 301	
	CC-Chemistry III Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC 303	

IV	CC-Botany IV Plant Physiology and Metabolism (BOTA401)	SEC-II Nursery and Gardening (BOT A402) or Floriculture (BOTA 403) or Apiculture ZOOLOGY 402
	CC-Zoology IV Genetics & Evolutionary Biology ZOOLOGY 401 TH ZOOLOGY 401 PR	
	CC-Chemistry IV Coordination chemistry, States of Matter & Chemical Kinetics CHEM CC 404	

V			SEC-III Medicinal Botany (BOTA 503) or Ethnobotany (BOTA 504) or Sericulture ZOOL 504	DSE-Botany I 1. Economic Botany & Biotechnology (BOT A501) or 2. Analytical Techniques in Plant Sciences (BOTA 502)
VI			SEC-IV Plant Diversity and Human Welfare (BOT A604) or Mushroom Cultivation Technology (BOTA 605) or Intellectual Property rights	DSE-Zoology I 1. Applied Zoology ZOOL 501 04 ZOOL 501 02 OR 2. Animal Biotechnology ZOOL 502 04 ZOOL 502 02 OR 3. Aquatic Biology ZOOL 503 04 ZOOL 503 02
				DSE-3 Chemistry I Polymer Chemistry CHEM DSE COURSE 501 Or Industrial Chemical And environment CHEM DSE COURSE 502 OR Quantum Chemistry , Spectroscopy and Photochemistry CHEM DSE COURSE 503
				DSE-Botany II 1. Cell and Molecular Biology (BOTA601) or 2. Bioinformatics (BOTA 602) or 3. Research Methodology (BOTA 603)
				DSE-Zoology II 1. Insect, Vector and Diseases ZOOL 601 ZOOL 601

			<p>(BOTA606)</p> <p>Aquarium Fish Keeping</p> <p>ZOOL 604TH</p> <p>or</p> <p>Research Methodology</p> <p>ZOOL 605TH Chemical Techniques and Society and Bus. Skills for Chemistry CHEM SEC 603 OR Pesticide chemistry and Pharmaceutic al chemistry CHEM SEC 604</p>	<p>OR</p> <p>2. Immunology ZOOL 602 ZOOL 602</p> <p>OR</p> <p>3. Reproductive Biology ZOOL 603 ZOOL 603</p> <hr/> <p>DSE-3 Chemistry II Chemistry of Main group elements, Theories of acids and Bases CHEM DSE COURSE 604 Or Organometallic, Bioinorganic chemistry polynuclear hydrocarbons and UV, IR spectroscopy CHEM DSE COURSE 605 or Molecules of Life CHEM DSE COURSE 606</p>
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Details of Courses
Core Courses –Botany

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| 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)

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| 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 ZOOLOGY 101 ; ZOOLOGY 101
2. Comparative Anatomy and Developmental Biology of Vertebrates ZOOLOGY 201 ; ZOOLOGY 201
3. Physiology and Biochemistry ZOOLOGY 301 ; ZOOLOGY 301
4. Genetics and Evolutionary Biology ZOOLOGY 401 ; ZOOLOGY 401

Discipline Specific Electives: Zoology (Any two)

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

Core Courses-Chemistry

1. Atomic Structure, Bonding, General Organic Chemistry and Hydrocarbon
2. Chemical Energetics, 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

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|--------------------------------------|----------|
| 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

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| 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

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|-------------------------|----------|
| 1. Medical Diagonistics | ZOOL 302 |
| 2. Apiculture | ZOOL 402 |
| 3 Sericulture | ZOOL 504 |
| 4 Aquarium Fish Keeping | ZOOL 604 |
| 5 Research Methodology | ZOOL 605 |

SEMESTER	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course-I	English/Hindi/ MIL Communication/ Environmental Science	4
	Core Course Botany I	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101 TH)	4
	Core Course Botany I Practical	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101 PR)	2
	Core Course Zoology I	Biodiversity- Animals ZOOL 101TH	4
	Core Course Zoology I Practical	Biodiversity- Animals ZOOL 101PR	2
	Core course Chemistry I	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon CHEM CC 101	4
	Core Course Chemistry I Practical	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon Lab CHEM CC 101 P	2

II	Ability Enhancement Compulsory Course-II	English/Hindi/ MIL Communication/ Environmental Science	4
	Core course Botany II	Plant Ecology and Taxonomy (BOTA 201 TH)	4

	Core Course Botany -II Practical	Plant Ecology and Taxonomy (BOTA 201 PR)	2
	Core Course Zoology II	Comparative Anatomy and Developmental Biology of Vertebrates ZOOL201TH	4
	Core Course Zoology II Practical	Comparative Anatomy and Developmental Biology of Vertebrates ZOOL201PR	2
	Core Course Chemistry II	Chemical Energitics, Equilibria & Functional Group Organic Chemistry CHEM CC 202	4
	Core Course Chemistry II Practical	Chemical Energitics, Equilibria & Functional Group Organic Chemistry Lab CHEM CC 202 P	2

III	Core Course Botany III	Anatomy and Embryology of Angiosperms (BOT A301 TH)	4
	Core Course Botany III Practical	Anatomy and Embryology of Angiosperms (BOT A301 PR)	2
	Core Course Zoology III	Physiology and Biochemistry ZOOL 301 TH	4
	Core Course Zoology III Practical	Physiology and Biochemistry ZOOL 301 PR	2
	Core Course Chemistry III	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC 303	
	Core Course Chemistry III Practical	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry Lab CHEM CC 303	2

IV	Skill Enhancement Course-I	SEC-I	4
	Core Course Botany IV	Plant Physiology and Metabolism (BOTA 401 TH)	4
	Core Course Botany –IV Practical	Plant Physiology and Metabolism (BOTA 401 PR)	2
	Core Course Zoology IV	Genetics and Evolutionary Biology ZOOL 401 TH	4
	Core Course Zoology IV Practical	Genetics Evolutionary Biology ZOOL 401 PR	2
	Core Course Chemistry IV	Coordination chemistry, states of matter & Chemical Kinetics CHEM CC 404	4
	Core Course Chemistry IV Practical	Coordination chemis states of matter & Cl Kinetics CHEM CC 404	2
	Skill Enhancement Course-II	SEC-II	4
V	Discipline Specific Elective Botany -I	DSE Botany 1 Economic Botany and Biotechnology (BOTA 501TH) or Analytical Techniques in Plant Sciences (BOTA 502TH)	4
	Discipline Specific Elective Botany I Practical	DSE Botany 1 Economic Botany and Biotechnology (BOTA 501PR)	2

	Life Sciences (BOTA 502PR)	
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Discipline Zoology I	Specific	Discipline	DSE Zoology I			
		Zoology I Practical	1. Applied Zoology ZOO 501 TH OR			
		Discipline	2. Animal Biotechnology ZOO 502TH OR	DSE	Chemistry I	4
		Chemistry I	3. Aquatic Biology ZOO 503TH	DSE	Chemistry I	2
		Discipline	Chemistry I Practical			
		Skill Enhancement Course -III		SEC-III		4
	Specific	Elective	DSE Zoology I		2	

VI	Discipline Specific Botany -II	Elective	DSE Botany II Cell and Molecular Biology (BOTA601TH) or Bioinformatics (BOTA602TH) or Research Methodology (BOTA603TH)	4
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	Discipline Specific Botany II Practical	Elective	DSE Botany II Cell and Molecular Biology (BOTA601PR) or Bioinformatics (BOTA602PR) or Research Methodology (BOTA603PR)	2
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	Discipline Specific Zoology II	Elective	DSE-Zoology II 1. Insect, Vector and Diseases ZOOL 601 TH OR 2. Immunology ZOOL 602TH OR 3. Reproductive Biology ZOOL 603TH	4
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	Discipline Specific Zoology II Practical	Elective	DSE Zoology II 1. Insect, Vector and Diseases ZOOL 601 PR OR 2. Immunology ZOOL 602PR OR 3. Reproductive Biology ZOOL 603PR	2
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	Discipline Specific	Elective	DSE Chemistry II	4
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	Chemistry III		
	Discipline Specific Elective Chemistry III Practical	DSE Chemistry II	2
	Skill Enhancement Course -IV	SEC-IV	4
			Total: 132

HIMACHAL PRADESH UNIVERSITY

SUMMER-HILL, SHIMLA-171005

B.Sc. Life Sciences

GENERAL INSTRUCTIONS/ GUIDELINES FOR EXECUTION OF CURRICULUM

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 $14 \times 6 = 84$ 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 $14 \times 6 = 84$ 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 $4 \times 6 = 24$ 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 $4 \times 6 = 24$ 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 $4 \times 4 = 16$ credits could be accumulated under these courses during the Life Sciences degree program *i.e.* $4 \times 2 = 8$ credits for AECC, and $4 \times 2 = 8$ 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:

≥ 75% but < 80%	1 marks
≥ 80% but <85%	2 marks
≥ 85 but <90%	3 marks
≥ 90% but < 95%	4 marks
≥ 95% TO 100%	5 marks

- 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 produced 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

Semester I

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 archegoniate, 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

1. Alexopoulos, C.J., Mims, C.W., Blackwell, M. (1996). Introductory Mycology, John Wiley and Sons (Asia), Singapore. 4th edition.
2. Bhatnagar, S.P. and Moitra, A. (1996). Gymnosperms. New Age International (P) Ltd Publishers, New Delhi, India.
3. Kumar, H.D. (1999). Introductory Phycology. Affiliated East-West. Press Pvt. Ltd. Delhi. 2nd edition.
4. Parihar, N.S. (1991). An introduction to Embryophyta. Vol. I. Bryophyta. Central Book Depot, Allahabad.
5. Raven, P.H., Johnson, G.B., Losos, J.B., Singer, S.R., (2005). Biology. Tata McGraw Hill, Delhi, India.
6. Sethi, I.K. and Walia, S.K. (2011). Text book of Fungi & Their Allies, MacMillan Publishers Pvt. Ltd., Delhi.
7. Thakur, A.K. and Bassi, S.K. (2008). Diversity of Microbes and Cryptogams. S. Chand & Co., Delhi.
8. Tortora, G.J., Funke, B.R., Case, C.L. (2010). Microbiology: An Introduction, Pearson Benjamin Cummings, U.S.A. 10th edition.
9. Vashishta, P.C., Sinha, A.K., Kumar, A., (2010). Pteridophyta, S. Chand. Delhi, India.

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)
Soil: Origin, formation, composition, soil profile. Water: States of water in the environment, precipitation types. Light and temperature: Variation Optimal and limiting factors; Shelford law of tolerance. Adaptation of hydrophytes and xerophytes.
- 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; binominal 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 (Orobanchae), 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

1. Kormondy, E.J. (1996). Concepts of Ecology. Prentice Hall, U.S.A. 4th edition.
2. Sharma, P.D. (2010) Ecology and Environment. Rastogi Publications, Meerut, India. 8th edition.
3. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
4. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

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)
Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).
- 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)
3. Stem: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
4. Root: Monocot: *Zea mays*; Dicot: *Helianthus*; Secondary: *Helianthus* (only Permanent slides).
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.
9. Female gametophyte: *Polygonum* (monosporic) type of Embryo sac Development (Permanent slides/photographs).
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

5. Bhojwani, S.S. & Bhatnagar, S.P. (2011). Embryology of Angiosperms. Vikas Publication House Pvt. Ltd. New Delhi. 5th edition.
6. Mauseth, J.D. (1988). Plant Anatomy. The Benjamin/Cummings Publisher, USA.

Semester IV

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.
14. Demonstration of Hill reaction.
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 O₂ evolution in photosynthesis.
17. Comparison of the rate of respiration in any two parts of a plant.
18. Separation of amino acids by paper chromatography.

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

1. Taiz, L., Zeiger, E., (2010). Plant Physiology. Sinauer Associates Inc., U.S.A. 5th Edition.
2. Hopkins, W.G., Huner, N.P., (2009). Introduction to Plant Physiology. John Wiley & Sons, U.S.A. 4th Edition.
3. Bajracharya, D., (1999). Experiments in Plant Physiology- A Laboratory Manual. Narosa Publishing House, New Delhi.

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 *Cathranthus* (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

1. Kochhar, S.L. (2011). Economic Botany in the Tropics, MacMillan Publishers India Ltd., New Delhi. 4th edition.
2. Bhojwani, S.S. and Razdan, M.K., (1996). Plant Tissue Culture: Theory and Practice. Elsevier Science Amsterdam. The Netherlands.
3. Glick, B.R., Pasternak, J.J. (2003). Molecular Biotechnology- Principles and Applications of recombinant DNA. ASM Press, Washington.

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, CsCl₂ 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

1. Plummer, D.T. (1996). An Introduction to Practical Biochemistry. Tata McGraw-Hill Publishing Co. Ltd. New Delhi. 3rd edition.
2. Ruzin, S.E. (1999). Plant Microtechnique and Microscopy, Oxford University Press, New York. U.S.A.
3. Ausubel, F., Brent, R., Kingston, R. E., Moore, D.D., Seidman, J.G., Smith, J.A., Struhl, K. (1995). Short Protocols in Molecular Biology. John Wiley & Sons. 3rd edition.
4. Zar, J.H. (2012). Biostatistical Analysis. Pearson Publication. U.S.A. 4th edition.

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, θ (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.
14. Study of mitosis and meiosis (temporary mounts and permanent slides).
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

1. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
2. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
3. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
4. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009. The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.

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.
5. Construction of phylogenetic tree.

Suggested Readings

1. Ghosh Z. and Bibekanand M. (2008) Bioinformatics: Principles and Applications. Oxford University Press.
2. Pevsner J. (2009) Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell.
3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

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)

Common calculations in botany laboratories. Understanding the details on the label of reagent bottles. Molarity and normality of common acids and bases. Preparation of solutions. Dilutions. Percentage solutions. Molar, molal and normal solutions. Technique of handling micropipettes; Knowledge about common toxic chemicals and safety measures in their handling.

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

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Ruzin, S.E. (1999). Plant microtechnique and microscopy. Oxford University Press, New York, U.S.A.

**COURSE ZOOLOGY I
ANIMAL DIVERSITY
ZOOLOGY 101 TH**

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 Nematelminthes

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	4
General features and Classification up to orders; Parental care	
Unit 14: Reptiles	4
General features and Classification up to orders; Poisonous and non-poisonous snakes, Biting mechanism in snakes	
Unit 15: Aves	5
General features and Classification up to orders; Flight adaptations in birds	
Unit 17: Mammals	5
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”

ANIMAL DIVERSITY

ZOOL 101 PR

PRACTICAL

(CREDITS 2)

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, Julus, 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, Ichthyophis/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

- Ruppert and Barnes, R.D. (2006). *Invertebrate Zoology*, VIII Edition. Holt Saunders International Edition.
- Barnes, R.S.K., Calow, P., Olive, P.J.W., Golding, D.W. and Spicer, J.I. (2002). *The Invertebrates: A New Synthesis*, III Edition, Blackwell Science
- Young, J. Z. (2004). *The Life of Vertebrates*. III Edition. Oxford university press.
- Pough H. *Vertebrate life*, VIII Edition, Pearson International.
- Hall B.K. and Hallgrimsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

CORE COURSE ZOOLOGY II

COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF VERTEBRATES

ZOOL 201 TH

THEORY

(CREDITS 4)

Unit 1: Integumentary System

4

Derivatives of integument w.r.t. glands and digital tips

Unit 2: Skeletal System

3

Evolution of visceral arches

Unit 3: Digestive System

4

Brief account of alimentary canal and digestive glands

Unit 4: Respiratory System

5

Brief account of Gills, lungs, air sacs and swim bladder

Unit 5: Circulatory System

4

Evolution of heart and aortic arches

Unit 6: Urinogenital System

4

Succession of kidney, Evolution of urinogenital ducts

Unit 7: Nervous System

3

Comparative account of brain

Unit 8: Sense Organs

3

Types of receptors

Unit 9: Early Embryonic Development

12

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

10

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

8

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

(CREDITS 2)

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

- Kardong, K.V. (2005) *Vertebrates' Comparative Anatomy, Function and Evolution*. IV Edition. McGraw-Hill Higher Education.
- Kent, G.C. and Carr R.K. (2000). *Comparative Anatomy of the Vertebrates*. IX Edition. The McGraw-Hill Companies.
- Hilderbrand, M and Gaslow G.E. *Analysis of Vertebrate Structure*, John Wiley and Sons.
- Walter, H.E. and Sayles, L.P; *Biology of Vertebrates*, Khosla Publishing House.
- Gilbert, S. F. (2006). *Developmental Biology*, VIII Edition, Sinauer Associates, Inc., Publishers, Sunderland, Massachusetts, USA.
- Balinsky, B.I. (2008). *An introduction to Embryology*, International Thomson Computer Press.
- Carlson, Bruce M (1996). *Patten's Foundations of Embryology*, McGraw Hill, Inc.

**CORE COURSE ZOOLOGY III
PHYSIOLOGY AND BIOCHEMISTRY**

ZOOLOGY 301 TH

THEORY

(CREDITS 4)

Unit 1: Nerve and muscle	8
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	5
Physiology of digestion in the alimentary canal; Absorption of carbohydrates, proteins, lipids	
Unit 3: Respiration	5
Pulmonary ventilation, Respiratory volumes and capacities, Transport of Oxygen and carbon dioxide in blood	
Unit 4: Excretion	5
Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism	
Unit 5: Cardiovascular system	6
Composition of blood, Hemostasis, Structure of Heart, Origin and conduction of the cardiac impulse, Cardiac cycle	
Unit 6: Reproduction and Endocrine Glands	7
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	8
Glycolysis, Krebs Cycle, Pentose phosphate pathway, Gluconeogenesis, Glycogen metabolism, Review of electron transport chain	
Unit 8: Lipid Metabolism	5
Biosynthesis and β oxidation of palmitic acid	
Unit 9: Protein metabolism	5
Transamination, Deamination and Urea Cycle	
Unit 10: Enzymes	6
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

- Tortora, G.J. and Derrickson, B.H. (2009). *Principles of Anatomy and Physiology*, XII Edition, John Wiley & Sons, Inc.
- Widmaier, E.P., Raff, H. and Strang, K.T. (2008) *Vander's Human Physiology*, XI Edition., McGraw Hill
- Guyton, A.C. and Hall, J.E. (2011). *Textbook of Medical Physiology*, XII Edition, Harcourt Asia Pvt. Ltd/ W.B. Saunders Company
- Berg, J. M., Tymoczko, J. L. and Stryer, L. (2006). *Biochemistry*. VI Edition. W.H Freeman and Co.
- Nelson, D. L., Cox, M. M. and Lehninger, A.L. (2009). *Principles of Biochemistry*. IV Edition. W.H. Freeman and Co.
- Murray, R.K., Granner, D.K., Mayes, P.A. and Rodwell, V.W. (2009). *Harper's Illustrated Biochemistry*. XXVIII Edition. Lange Medical Books/Mc Graw3Hill.

**CORE COURSE ZOOLOGY IV
GENETICS AND EVOLUTIONARY BIOLOGY**

ZOOLOGY 401 TH

THEORY

(CREDITS 4)

Unit 1: Introduction to Genetics

3

Mendel's work on transmission of traits, Genetic Variation, Molecular basis of Genetic Information

Unit 2: Mendelian Genetics and its Extension

8

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

9

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

7

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

Unit 5: Sex Determination

2

Chromosomal mechanisms, dosage compensation

Unit 6: History of Life

2

Major Events in History of Life

Unit 7: Introduction to Evolutionary Theories

4

Lamarckism, Darwinism, Neo-Darwinism

Unit 8: Direct Evidences of Evolution

4

Types of fossils, Incompleteness of fossil record, Dating of fossils, Phylogeny of horse

Unit 9: Processes of Evolutionary Change

8

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

Unit 10: Species Concept

5

Biological species concept (Advantages and Limitations); Modes of speciation (Allopatric, Sympatric)

Unit 11: Macro-evolution

4

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

Unit 12: Extinction

4

Mass extinction (Causes, Names of five major extinctions, K-T extinction in detail), Role of extinction in evolution

GENETICS AND EVOLUTIONARY BIOLOGY

ZOOL 401 PR

PRACTICAL

(CREDITS 2)

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.
3. Study of Human Karyotypes (normal and abnormal).
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

- Gardner, E.J., Simmons, M.J., Snustad, D.P. (2008). *Principles of Genetics*. VIII Edition. Wiley India.
- Snustad, D.P., Simmons, M.J. (2009). *Principles of Genetics*. V Edition. John Wiley and Sons Inc.
- Klug, W.S., Cummings, M.R., Spencer, C.A. (2012). *Concepts of Genetics*. X Edition. Benjamin Cummings.
- Russell, P. J. (2009). *Genetics- A Molecular Approach*. III Edition. Benjamin Cummings.
- Griffiths, A.J.F., Wessler, S.R., Lewontin, R.C. and Carroll, S.B. *Introduction to Genetic Analysis*. IX Edition. W. H. Freeman and Co.
- Ridley, M. (2004). *Evolution*. III Edition. Blackwell Publishing
- Barton, N. H., Briggs, D. E. G., Eisen, J. A., Goldstein, D. B. and Patel, N. H. (2007). *Evolution*. Cold Spring, Harbour Laboratory Press.
- Hall, B. K. and Hallgrimsson, B. (2008). *Evolution*. IV Edition. Jones and Bartlett Publishers
- Campbell, N. A. and Reece J. B. (2011). *Biology*. IX Edition, Pearson, Benjamin, Cummings.
- Douglas, J. Futuyma (1997). *Evolutionary Biology*. Sinauer Associates.

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 <i>Rickettsia prowazekii</i> , <i>Borrelia recurrentis</i> and <i>Treponema pallidum</i>	
Unit 4: Parasitic Protozoa	8
Life history and pathogenicity of <i>Entamoeba histolytica</i> , <i>Plasmodium vivax</i> and <i>Trypanosoma gambiense</i>	
Unit 5: Parasitic Helminthes	5
Life history and pathogenicity of <i>Ancylostoma duodenale</i> and <i>Wuchereria bancrofti</i>	
Unit 6: Insects of Economic Importance	8
Biology, Control and damage caused by <i>Helicoverpa armigera</i> , <i>Pyrilla perpusilla</i> and <i>Papilio demoleus</i> , <i>Callosobruchus chinensis</i> , <i>Sitophilus oryzae</i> and <i>Tribolium castaneum</i>	
Unit 7: Insects of Medical Importance	8
Medical importance and control of <i>Pediculus humanus corporis</i> , <i>Anopheles</i> , <i>Culex</i> , <i>Aedes</i> , <i>Xenopsylla cheopis</i>	
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.
2. Study of arthropod vectors associated with human diseases: *Pediculus*, *Culex*, *Anopheles*, *Aedes* and *Xenopsylla*.
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

- Park, K. (2007). *Preventive and Social Medicine*. XVI Edition. B.B Publishers.
- Arora, D. R and Arora, B. (2001). *Medical Parasitology*. II Edition. CBS Publications and Distributors.
- Kumar and Corton. *Pathological Basis of Diseases*.
- Atwal, A.S. (1986). *Agricultural Pests of India and South East Asia*, Kalyani Publishers.
- Dennis, H. (2009). *Agricultural Entomology*. Timber Press (OR).
- Hafez, E. S. E. (1962). *Reproduction in Farm Animals*. Lea & Fabiger Publisher
- Dunham R.A. (2004). *Aquaculture and Fisheries Biotechnology Genetic Approaches*. CABI publications, U.K.
- Pedigo, L.P. (2002). *Entomology and Pest Management*, Prentice Hall.

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

ANIMAL BIOTECHNOLOGY

ZOOL 502 PR

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

- Brown, T.A. (1998). *Molecular Biology Labfax II: Gene Cloning and DNA Analysis*. II Edition, Academic Press, California, USA.
- Glick, B.R. and Pasternak, J.J. (2009). *Molecular Biotechnology - Principles and Applications of Recombinant DNA*. IV Edition, ASM press, Washington, USA.
- Griffiths, A.J.F., J.H. Miller, Suzuki, D.T., Lewontin, R.C. and Gelbart, W.M. (2009). *An Introduction to Genetic Analysis*. IX Edition. Freeman and Co., N.Y., USA.
- Snustad, D.P. and Simmons, M.J. (2009). *Principles of Genetics*. V Edition, John Wiley and Sons Inc.
- Watson, J.D., Myers, R.M., Caudy, A. and Witkowski, J.K. (2007). *Recombinant DNA- Genes and Genomes- A Short Course*. III Edition, Freeman and Co., N.Y., USA.
- Beauchamp, T.I. and Childress, J.F. (2008). *Principles of Biomedical Ethics*. VI Edition, Oxford University Press.

DCE 3
AQUATIC BIOLOGY
ZOOL 503 TH

THEORY (Credits 4)

UNIT 1: Aquatic Biomes **15**

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 **20**

Lakes: Origin and classification, Lake as an Ecosystem, Lake morphometry, Physico-chemical Characteristics: Light, Temperature, Thermal stratification, Dissolved Solids, Carbonate, Bicarbonates, Phosphates and Nitrates, Turbidity; dissolved gases (Oxygen, Carbon dioxide). Nutrient Cycles in Lakes-Nitrogen, Sulphur and Phosphorous.

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

UNIT 3: Marine Biology **10**

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

UNIT 4: Management of Aquatic Resources **15**

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

ZOOL 503 PR

PRACTICAL

(Credits 2)

1. Determine the area of a lake using graphimetric and gravimetric method.
2. Identify the important macrophytes, phytoplanktons and zooplanktons present in a lake ecosystem.
3. Determine the amount of Turbidity/transparency, Dissolved Oxygen, Free Carbon dioxide, Alkalinity (carbonates & bicarbonates) in water collected from a nearby lake/ water body.
4. 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: Hemiptera 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

(CREDITS 2)

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*, *Phthirus 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

- Imms, A.D. (1977). *A General Text Book of Entomology*. Chapman & Hall, UK
- Chapman, R.F. (1998). *The Insects: Structure and Function*. IV Edition, Cambridge University Press, UK
- Pedigo L.P. (2002). *Entomology and Pest Management*. Prentice Hall Publication
- Mathews, G. (2011). *Integrated Vector Management: Controlling Vectors of Malaria and Other Insect Vector Borne Diseases*. Wiley-Blackwell

DSE 4
IMMUNOLOGY
ZOOL 602 TH

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

Haematopoiesis, 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

IMMUNOLOGY
ZOOL 602 PR

PRACTICAL

(CREDITS 2)

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

(*Subject to UGC guidelines)

SUGGESTED READINGS

- Kindt, T. J., Goldsby, R.A., Osborne, B. A. and Kuby, J (2006). *Immunology*, VI Edition. W.H. Freeman and Company.
- David, M., Jonathan, B., David, R. B. and Ivan R. (2006). *Immunology*, VII Edition, Mosby, Elsevier Publication.
- Abbas, K. Abul and Lechtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication.

DSE 5

REPRODUCTIVE BIOLOGY

ZOOL 603 TH

THEORY

(CREDITS 4)

Unit 1: Reproductive Endocrinology

15

Gonadal hormones and mechanism of hormone action, steroids, glycoprotein hormones, and prostaglandins, hypothalamo – hypophyseal – gonadal axis, regulation of gonadotrophin secretion in male and female; Reproductive System: Development and differentiation of gonads, genital ducts, external genitalia, mechanism of sex differentiation.

Unit 2: Functional anatomy of male reproduction

15

Outline and histological of male reproductive system in rat and human; Testis: Cellular functions, germ cell, stem 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

ZOOL 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.
3. Surgical techniques: principles of surgery in endocrinology. Ovariectomy, hysterectomy, castration and vasectomy in rats.
4. Examination of histological sections from photomicrographs/ permanent slides of rat/human: testis, epididymis and accessory glands of male reproductive systems; Sections of ovary, fallopian tube, uterus (proliferative and secretory stages), cervix and vagina.
5. Human vaginal exfoliate cytology.
6. Sperm count and sperm motility in rat
7. Study of modern contraceptive devices

SUGGESTED READINGS

- Austin, C.R. and Short, R.V. reproduction in Mammals. Cambridge University Press.
- Degroot, L.J. and Jameson, J.L. (eds). Endocrinology. W.B. Saunders and Company.
- Knobil, E. et al. (eds). The Physiology of Reproduction. Raven Press Ltd.
- Hatcher, R.A. et al. The Essentials of Contraceptive Technology. Population Information Programme.

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)

Unit 4: Mycorrhizal association, types of mycorrhizal association, taxonomy, 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.

(12 Lectures)

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

Suggested Readings

1. Dubey, R.C., 2005 A Text book of Biotechnology S.Chand & 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. Subha 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 Akta Prakashan, Nadiad

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 and 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

1. Glossary of Indian medicinal plants, R.N.Chopra, S.L.Nayar and I.C.Chopra, 1956. C.S.I.R, New Delhi.
2. The indigenous drugs of India, Kanny, Lall, Dey and Raj Bahadur, 1984. International Book Distributors.
3. Herbal plants and Drugs Agnes Arber, 1999. Mangal Deep Publications.
4. Ayurvedic drugs and their plant source. V.V. Sivarajan and Balachandran Indra 1994. Oxford IBH publishing Co.
5. Ayurveda and Aromatherapy. Miller, Light and Miller, Bryan, 1998. Banarsidass, Delhi.
6. Principles of Ayurveda, Anne Green, 2000. Thomsons, London.
7. Pharmacognosy, Dr.C.K.Kokate et al. 1999. Nirali Prakashan.

**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. **(9Lectures)**

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

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.
2. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
3. Kumar, N., 1997, Introduction to Horticulture, Rajalakshmi Publications, Nagercoil.
4. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
5. Agrawal, P.K. 1993, Hand Book of Seed Technology, Dept. of Agriculture and Cooperation, National Seed Corporation Ltd., New Delhi.
6. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.

**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, Liliium, Orchids). **(8 Lectures)**

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

Suggested Readings

1. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.

**Skill Enhancement Course
Botany**

**Medicinal Botany
(BOTA 503)**

(Credits 4; 3 Theory + 1 Tutorial)

Lectures: 45

Unit 1: History, Scope and Importance of Medicinal Plants. Indigenous Medicinal Sciences; Definition and Scope-Ayurveda: History, origin, panchamahabhutas, saptadhatu and tridosha concepts, Rasayana, plants used in ayurvedic treatments, Siddha: Origin of Siddha medicinal systems, Basis of Siddha system, plants used in Siddha medicine. Unani: History, concept: Umoor-e- tabiya, tumors treatments/ therapy, polyherbal formulations. **(15 Lectures)**

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

1. Trivedi P C, 2006. Medicinal Plants: Ethnobotanical Approach, Agrobios, India.
2. Purohit and Vyas, 2008. Medicinal Plant Cultivation: A Scientific Approach, 2nd edn. Agrobios, India.

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 ethnobotanical practices (along with their habitat and morphology) a) *Azadirachta 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 *Rauwolfia serpentina*, *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

1. S.K. Jain, Manual of Ethnobotany, Scientific Publishers, Jodhpur, 1995.
2. S.K. Jain (ed.) Glimpses of Indian. Ethnobotny, Oxford and I B H, New Delhi – 1981
3. Lone et al., Palaeoethnobotany
4. S.K. Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.
5. S.K. Jain, 1990. Contributions of Indian ethnobotny. Scientific publishers, Jodhpur.
6. Colton C.M. 1997. Ethnobotany – Principles and applications. John Wiley and sons – Chichester
7. Rama Ro, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Andhra Pradesh, India. Botanical Survey of India. Howrah. 8) Rajiv K. Sinha – Ethnobotany The Renaissance of Traditional Herbal Medicine – INA –SHREE Publishers, Jaipur-1996 9)

**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

1. Krishnamurthy, K.V. (2004). An Advanced Text Book of Biodiversity - Principles and Practices. Oxford and IBH Publications Co. Pvt. Ltd. New Delhi

**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 *Volvoriella 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, pickles, 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

1. Marimuthu, T. Krishnamoorthy, A.S. Sivaprakasam, K. and Jayarajan. R (1991) Oyster Mushrooms, Department of Plant Pathology, Tamil Nadu Agricultural University, Coimbatore.
2. Swaminathan, M. (1990) Food and Nutrition. Bappco, The Bangalore Printing and Publishing Co. Ltd., No. 88, Mysore Road, Bangalore - 560018.
3. Tewari, Pankaj Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.
4. Nita Bahl (1984-1988) Hand book of Mushrooms, II Edition, Vol. I & Vol. II.

**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)

Objectives, Rights, Patent Act 1970 and its amendments. Procedure of obtaining patents, Working of patents. Infringement.

Unit 3: Copyrights (4 Lectures)

Introduction, Works protected under copyright law, Rights, Transfer of Copyright, Infringement.

Unit4: 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

protection in India. Rights of farmers, Breeders and Researchers. National gene bank, Benefit sharing. Protection of Plant Varieties and Farmers' Rights Act, 2001.

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

1. N.K. Acharya: Textbook on intellectual property rights, Asia Law House (2001).
2. Manjula Guru & M.B. Rao, Understanding Trips: Managing Knowledge in Developing Countries, Sage Publications (2003).
3. P. Ganguli, Intellectual Property Rights: Unleashing the Knowledge Economy, Tata McGraw-Hill (2001).
4. Arthur Raphael Miller, Micheal H. Davis; Intellectual Property: Patents, Trademarks and Copyright in a Nutshell, West Group Publishers (2000).
5. Jayashree Watal, Intellectual property rights in the WTO and developing countries, Oxford University Press, Oxford.

fuel from waste, synthetic fuels (gaseous and liquids), clean fuels. Petrochemicals: Vinyl acetate, Propylene oxide, Isoprene, Butadiene, Toluene and its derivatives Xylene.

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

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

Reference Books:

- Stocchi, E. *Industrial Chemistry*, Vol-I, Ellis Horwood Ltd. UK (1990).
 - Jain, P.C. & Jain, M. *Engineering Chemistry* Dhanpat Rai & Sons, Delhi.
 - Sharma, B.K. & Gaur, H. *Industrial Chemistry*, Goel Publishing House, Meerut (1996).
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SKILL ENHANCEMENT COURSES

Zoology
SEC 1
MEDICAL DIAGNOSTICS

Code: ZOOL 302 TH

THEORY

(Credits 4)

(3+01)

Unit 1: Introduction to Medical Diagnostics and its Importance

2

Unit 2: Diagnostics Methods Used for Analysis of Blood

15

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 3: Diagnostic Methods Used for Urine Analysis

6

Urine Analysis: Physical characteristics; Abnormal constituents

Unit 4: Non-infectious Diseases

10

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: Infectious Diseases

6

Causes, types, symptoms, diagnosis and prevention of Tuberculosis and Hepatitis

Unit 6: Tumours

6

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

SUGGESTED READINGS

- Park, K. (2007), *Preventive and Social Medicine*, B.B. Publishers
- Godkar P.B. and Godkar D.P. *Textbook of Medical Laboratory Technology*, II Edition, Bhalani Publishing House
- 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
- Robbins and Cortan, *Pathologic Basis of Disease*, VIII Edition, Saunders
- Prakash, G. (2012), *Lab Manual on Blood Analysis and Medical Diagnostics*, S. Chand and Co. Ltd.

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

- Prost, P. J. (1962). *Apiculture*. Oxford and IBH, New Delhi.
- 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)

Unit1: Introduction to Aquarium Fish Keeping

10

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

Unit 2: Biology of Aquarium Fishes

15

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

Unit 3: Food and feeding of Aquarium fishes

6

Use of live fish feed organisms. Preparation and composition of formulated fish feeds

Unit 4: Fish Transportation

8

Live fish transport - Fish handling, packing and forwarding techniques.

Unit 5: Maintenance of Aquarium

6

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 **5**

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

Unit 2: Research Design **8**

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

Unit 3: Data Collection, Analysis and Report Writing **12**

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

Unit 4: Ethical Issues **5**

Intellectual property Rights, Commercialization, Copy Right, Royalty, Patent law, Plagiarism, Citation, Acknowledgement

SUGGESTED READINGS

- Anthony, M, Graziano, A.M. and Raulin, M.L. 2009. Research Methods: A Process of Inquiry, Allyn and Bacon.
- Walliman, N. 2011. Research Methods- The Basics. Taylor and Francis, London, New York.
- Wadhwa, 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
- Coley, S.M. and Scheinberg, C.A. 1990, "Proposal writing". Stage Publications

**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 + Practical + 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
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