

Structure of B.Sc. Life Sciences under CBCS

Year	Discipline Specific Courses (12)	Specific	Skill Enhancement Courses (SEC) (4)	Discipline Specific Elective DSE (6)
I	DSC-Botany I Biodiversity (Microbes, Algae, Fungi and Archegoniates) (BOTA 101)	i. Environment Science ENVS 1AECC 02 ii. English ENGL 103 /Hindi/SKT		
	DSC-Zoology I Animal Diversity ZOOL 101 TH ZOOL 101 PR			
	DSC-Chemistry I Atomic structure, Bonding, General Organic Chemistry and Aliphatic Hydrocarbons CHEM 101 TH CHEM 101 IA CHEM 101 PR			
	DSC-Botany II Plant Ecology and Taxonomy (BOTA 102)			
	DSC-Zoology II Comparative Anatomy & Developmental Biology of Vertebrates ZOOL 102 TH ZOOL 102 PR			
	DSC-Chemistry II States of Matter, Chemical Kinetics & Functional Organic Chemistry CHEM 102 TH, CHEM 102 IA, CHEM 102 PR			

Year	Discipline Specific Course (12)	Ability Enhancement Compulsory Courses (2)	Skill Enhancement Courses (SEC) (4)	Discipline Specific Elective DSE (6)
II	DSC-Botany III Plant Anatomy and Embryology BOTA 201		SEC-I Bio-Fertilizers (BOTA 203) OR Medical Diagnostics ZOOLOGY 203 TH	
	DSC-Zoology III Physiology & Biochemistry ZOOLOGY 201 TH ZOOLOGY 201 PR			
	DSC-Chemistry III Solutions, Phase Equilibrium, Conductance, Electrochemistry & Organic Chemistry CHEM 201 TH CHEM 201 IA CHEM 201 PR		Basic Analytical Chemistry CHEM203TH CHEM203IA OR Fuel Chemistry and Chemistry of Cosmetics and Perfumes CHEM204TH; CHEM204IA	
	DSC-Botany IV Plant Physiology and Metabolism (BOTA202)			
	DSC-Zoology IV Genetics & Evolutionary Biology ZOOLOGY 202 TH ZOOLOGY 202 PR		SEC-II Gardening and Floriculture (BOT A 204) OR Apiculture ZOOLOGY 204 TH	
	DSC-Chemistry IV Chemistry of main group elements, chemical Energetics and equilibria CHEM202TH; CHEM202IA;CHEM202PR			

III			<p>SEC-III Medicinal Botany and Ethnobotany (BOTA 306)</p> <p>OR Sericulture ZOOLOGY 303 TH</p>	<p>DSE-Botany I Economic Botany & Biotechnology (BOT A301) or Analytical Techniques in Plant Sciences (BOTA 302)</p> <p>DSE-Zoology I</p> <p>1. Applied Zoology ZOOLOGY 301 (A) TH ZOOLOGY 301 (A) TH OR 2. Animal Biotechnology ZOOLOGY 301 (B) TH ZOOLOGY 301 (B) PR OR 3. Aquatic Biology ZOOLOGY 301 (C) TH ZOOLOGY 301 (C) PR</p> <p>DSE2A: Chemistry I Polynuclear hydrocarbons, Dyes, Heterocyclic compounds and spectroscopy(UV,IR,NMR) CHEM301TH; CHEM301PR; CHEM 301IA OR Industrial Chemical And environment CHEM302TH; CHEM302IA; CHEM302PR OR Quantum Chemistry , Spectroscopy and Photochemistry CHEM 303TH; CHEM303IA; CHEM303PR</p>
-----	--	--	---	--

			<p style="text-align: center;">SEC-IV</p> <p>Mushroom Cultivation Technology (BOTA 307) OR</p> <p>Aquarium Fish Keeping ZOOLOGY 304 (A) TH OR</p> <p>Research Methodology ZOOLOGY 304 (B) TH</p> <p>Chemical Technology & Society and Business Skills for Chemistry CHEM307 OR</p> <p>Pesticide chemistry & Pharmaceutical chemistry CHEM308</p>	<p>DSE-Botany II Cell and Molecular Biology (BOTA303) OR</p> <p>2. Bioinformatics (BOTA 304) OR</p> <p>DSE-Zoology II 1. Insect, Vector and Diseases ZOOLOGY 302 (A) TH ZOOLOGY 302 (A) PR</p> <p style="text-align: center;">OR</p> <p>2 Immunology ZOOLOGY 302 (B) TH ZOOLOGY 302 (B) PR OR</p> <p>4. Reproductive Biology ZOOLOGY 302 (C) TH ZOOLOGY 302 (C) PR</p> <p>DSE2B: Chemistry II Chemistry of Transition and inner transition elements, coordination chemistry, organometallics, acids & Bases : CHEM 304 TH; CHEM304 IA CHEM 304 PR OR</p> <p>Polymer Chemistry CHEM305TH CHEM305IA; CHEM305PR OR</p> <p>Molecules of Life CHEM 306TH; CHEM306 IA; CHEM 306PR</p>
--	--	--	---	---

Details of Courses**Discipline Specific Courses –Botany**

- | | | |
|----|--|----------|
| 1. | Biodiversity (Microbes, Algae, Fungi and Archegoniate) | BOTA 101 |
| 2. | Plant Ecology and Taxonomy | BOTA 102 |
| 3. | Plant Anatomy and Embryology | BOT A201 |
| 4. | Plant Physiology and Metabolism | BOTA 202 |

Discipline Specific Electives-Botany (Any two)

- | | | |
|----|---|----------|
| 1. | Economic Botany and Biotechnology | BOTA 301 |
| 2. | Analytical Techniques in Plant Sciences | BOTA 302 |
| 3. | Cell and Molecular Biology | BOT A303 |
| 4. | Bioinformatics | BOTA 304 |

Discipline Specific Courses: Zoology

1. Animal Diversity ZOO 101 TH ; OOL 101PR
2. Comparative Anatomy and Developmental Biology of Vertebrates ZOO 102 TH; ZOO 102 PR
3. Physiology and Biochemistry ZOO 201 TH ; ZOO 201 PR
4. Genetics and Evolutionary Biology ZOO 202 TH ; ZOO 202 PR

Discipline Specific Electives: Zoology (Any two)

1. Applied Zoology ZOO 301 (A) TH; ZOO 301 (A) PR
2. Animal Biotechnology ZOO 301 (B) TH; ZOO 301 (B) PR
3. Aquatic Biology ZOO 301 (C) TH; ZOO 301(C) PR
4. Insect, Vector and Diseases ZOO 302 (A) TH; ZOO 302 (A) PR
5. Immunology ZOO 302 (B) TH; ZOO 302 (B) PR
6. Reproductive Biology ZOO 302 (C) TH; ZOO 302 (C) PR

Discipline Specific Courses -Chemistry

1. Atomic Structure, Bonding, General Organic Chemistry and Hydrocarbon
2. States of matter, Chemical Kinetics & Functional organic Chemistry
3. Solutions, Phase Equilibrium, conductance, Electrochemistry & Organic Chemistry
4. Chemistry of main group elements, chemical energetics and equilibria.

Discipline Specific Electives-Chemistry (Any two)

1. Polynuclear hydrocarbons, Dyes, Heterocyclic compounds and spectroscopy (UV,IR, NMR) OR
2. Industrial chemical and Environment.OR
3. Quantum Chemistry, Spectroscopy & photochemistry
4. Chemistry of transition and inner transition elements, coordination chemistry, organometallics, acids and bases. OR
5. Polymer Chemistry OR
6. Molecules of Life

Ability Enhancement Compulsory Courses

1. Environment Science
2. English/Hindi/SKT

Skill Enhancement Courses (Any four) Botany

- | | |
|-------------------------------------|----------|
| 1. Biofertilizers | BOTA 203 |
| 2. Gardening and Floriculture | BOT A204 |
| 3. Medicinal Botany and Ethnobotany | BOTA 306 |
| 4. Mushroom Cultivation Technology | BOTA 307 |

Chemistry

- | | |
|---|----------|
| 1. Basic Analytical Chemistry | CHEM203 |
| OR | |
| 2. Fuel Chemistry & Chemistry of Cosmetics and Perfumes | CHEM 204 |
| 3. Chemical Technology & Society and Bus Skills for Chemistry | CHEM 307 |
| OR | |
| 4. Pesticide Chemistry and Pharmaceutical Chemistry | CHEM 308 |

Zoology

- | | |
|-------------------------|-----------------|
| 1. Medical Diagonistics | ZOOL 203 TH |
| 2. Apiculture | ZOOL 204 TH |
| 3 Sericulture | ZOOL 303 TH |
| 4 Aquarium Fish Keeping | ZOOL 304 (A) TH |
| 5. Research Methodology | ZOOOL |

YEAR	COURSE OPTED	COURSE NAME	Credits
I	Ability Enhancement Compulsory Course	i. Environmental Science ii. English/Hindi/SKT	2×4 =8
	Discipline Specific Courses Botany I	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101)	4
	Botany I Practical	Biodiversity (Microbes, Algae, Fungi and Archegoniate) (BOTA 101)	2
	Discipline Specific Courses Zoology I	Biodiversity- Animals ZOOLOGY 101TH	4
	Discipline Specific Courses Zoology I Practical	Biodiversity- Animals ZOOLOGY 101PR	2
	Discipline Specific Courses Chemistry I	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon CHEM CC 101	4
	Discipline Specific Courses Chemistry I Practical	Atomic Structure, bonding, General Organic Chemistry and Hydrocarbon CHEM CC 101	2

Discipline Specific Courses Botany -II	Plant Ecology and Taxonomy (BOTA 102)	4
Discipline Specific Courses Botany -II Practical	Plant Ecology and Taxonomy (BOTA 102)	2
Discipline Specific Courses Zoology II	Comparative Anatomy and Developmental Biology of Vertebrates ZOO 102 TH	4
Discipline Specific Courses Zoology II Practical	Comparative Anatomy and Developmental Biology of Vertebrates ZOO 102 PR	2
Discipline Specific Courses Chemistry II	Chemical Energetics, Equilibria & Functional Group Organic Chemistry CHEM CC	4
Discipline Specific Courses Chemistry Practical	Chemical Energetics, Equilibria & Functional Group Organic Chemistry Lab CHEM CC	2

II	Discipline Specific Courses Botany III	Anatomy and Embryology of Angiosperms (BOTA 201)	4
	Discipline Specific Courses Botany III Practical	Anatomy and Embryology of Angiosperms (BOTA 201 PR)	2
	Discipline Specific Courses Zoology III	Physiology Biochemistry ZOOL 201 TH	4
	Discipline Specific Courses Zoology III Practical	Physiology Biochemistry ZOOL 201 PR	2
	Discipline Specific Courses Chemistry III	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC	4
	Discipline Specific Courses Chemistry III Practical	Solutions, Phase Equilibria, Conductance, Electrochemistry & Organic Chemistry CHEM CC	2

Skill Enhancement Course-I	SEC-I	4
Discipline Specific Courses Botany IV	Plant Physiology and Metabolism (BOTA 202 TH)	4
Discipline Specific Courses Botany IV Practical	Plant Physiology and Metabolism (BOTA 202 PR)	2
Discipline Specific Courses Zoology IV	Genetics and Evolutionary Biology ZOOL 202 TH	4
Discipline Specific Courses Zoology Practical IV	Genetics Evolutionary Biology ZOOL 202 PR	2
Discipline Specific Courses Chemistry IV	Coordination chemistry, states of matter & Chemical Kinetics CHEM CC	4
Discipline Specific Courses Chemistry Practical	Coordination chemis states of matter & Kinetics CHEM CC	2
Skill Enhancement Course-II	SEC-II	4

	Skill Enhancement Course-III	SEC-III	4
III	Discipline Specific Elective Botany 1	DSE Botany 1 Economic Botany and Biotechnology (BOTA 301) OR Analytical Techniques in Plant Sciences (BOTA 302)	4
	Discipline Specific Elective Botany 1 Practical	DSE Botany 1 Economic Botany and Biotechnology (BOTA 301) OR Analytical Techniques in Plant Sciences (BOTA 302)	2
	Discipline Specific Elective Zoology 1	DSE-Zoology I 1.Applied Zoology ZOOL 301(A) TH OR 2.Animal Biotechnology ZOOL 301 (B) TH OR 3.Aquatic Biology ZOOL 301 (C) TH	4
	Discipline Specific Elective Zoology 1 Practical	1.Applied Zoology ZOOL 301 (A) PR OR 2.Animal Biotechnology ZOOL 301 (B) PR OR 3.Aquatic Biology ZOOL 301 (C) PR	2

	Discipline Specific Elective Chemistry 1 Practical	DSE-3 Chemistry I Polymer Chemistry CHEM DSE COURSE OR Industrial Chemical And environment CHEM DSE COURSE OR Quantum Chemistry , Spectroscopy and Photochemistry CHEM DSE COURSE	4
	Discipline Specific Elective Chemistry 1	DSE- Chemistry I Polymer Chemistry CHEM DSE COURSE OR Industrial Chemical And environment CHEM DSE COURSE OR Quantum Chemistry , Spectroscopy and Photochemistry CHEM DSE COURSE	2
	Skill Enhancement Course- IV	SEC- IV	4
	Discipline Specific Elective Botany 1I	DSE-Botany II Cell and Molecular Biology (BOTA 303) OR Bioinformatics (BOTA 304)	4
	Discipline Specific Elective Botany 1I Practical	Cell and Molecular Biology (BOTA 303) OR Bioinformatics (BOTA 304)	2
	Discipline Specific Elective Zoology 1I	1.Insect, Vector and Diseases ZOOL 302 (A) TH OR 2. Immunology ZOOL 302 (B) TH OR 3.Reproductive Biology ZOOL 302 (C)TH	4

	<p>Discipline Specific Elective Zoology 1I Practical</p>	<p>1. Insect, Vector and Diseases ZOOL 302(A) PR OR 2. Immunology ZOOL 302 (B) PR OR 3. Reproductive Biology ZOOL 302 (C) PR</p>	2
	<p>Discipline Specific Elective Chemistry 1I</p>	<p>DSE-3 Chemistry II Chemistry of Main group elements, Theories of acids and Bases CHEM DSE COURSE OR Organometallic, Bioinorganic chemistry polynuclear hydrocarbons and UV, IR spectroscopy CHEM DSE COURSE OR Molecules of Life CHEM DSE COURSE</p>	4
	<p>Discipline Specific Elective Chemistry 1I Practical</p>	<p>DSE-3 Chemistry II Chemistry of Main group elements, Theories of acids and Bases CHEM DSE COURSE OR Organometallic, Bioinorganic chemistry polynuclear hydrocarbons and UV, IR spectroscopy CHEM DSE COURSE OR Molecules of Life CHEM DSE COURSE</p>	2

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 annually 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** (12 courses for Life Sciences; and 6 discipline specific papers) will be of 6-credits each including 2 credits assigned to the practical component. Thus a candidate will have to pass 12 courses for earning $12 \times 6 = 72$ 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]: 50 marks; Practical [P]: 20 marks and Internal Assessment [IA]: 30.

 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 6 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 Life Sciences 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 Life Sciences 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:	4 marks
Write up of Practical II:	4 marks
Performance of any one of these practicals:	4 marks
Practical record/ notebook:	4 marks
Viva voce:	4 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.

I Year

DSC: Botany Paper I
Biodiversity (Microbes, Algae, Fungi and Archegoniates)
(BOTA 101) (Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

Unit 1: Microbes **(7 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; Brief account of classification of algae; Morphology and life-cycles of the following: *Nostoc*, *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.

Unit 4: Bryophytes **(9 Lectures)**

General characteristics, adaptations to land habit, 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 5: Pteridophytes **(10 Lectures)**

General characteristics, 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.

Unit 6: Gymnosperms**(10 Lectures)**

General characteristics, Classification (up to family), Morphology, anatomy and reproduction of *Cycas* and *Pinus* (Developmental details not to be included).
Economic importance.

NOTE: The question paper will be divided into four sections as follows:

Section A: Algae, Section B- Fungi, Section C – Microbes and Bryophytes and Section D- Pteridophytes and Gymnosperms.

Practical (BOTA 101)

1. EMs/Models of viruses – T-Phage and TMV, Line drawing/Photograph of Lytic and Lysogenic Cycle.
2. Types of Bacteria from temporary/permanent slides/photographs; EM bacterium; Binary Fission; Conjugation; Structure of root nodule.
3. Gram staining
4. Study of vegetative and reproductive structures of *Nostoc*, *Chlamydomonas* (electron micrographs), *Oedogonium*, *Vaucheria*, *Ectocarpus* and *Polysiphonia* through temporary preparations and permanent slides.
5. *Phytophthora*, *Rhizopus* and *Penicillium*: Asexual stage from temporary mounts and sexual structures through permanent slides.
6. *Venturia*: Specimens/photographs
7. *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.
8. *Agaricus*: Specimens of button stage and full grown mushroom; Sectioning of gills of *Agaricus*.
9. Lichens: Study of growth forms of lichens (crustose, foliose and fruticose)
10. Mycorrhiza: ecto mycorrhiza and endo mycorrhiza (Photographs)
11. *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).
12. *Funaria*- morphology, w.m. leaf, rhizoids, operculum, peristome, annulus, spores (temporary slides); permanent slides showing antheridial and archegonial heads, l.s. capsule and protonema.

13. *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).
14. *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).
15. *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).
16. *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).
17. *Pinus*- morphology (long and dwarf shoots, w.m. dwarf shoot, male and female), w.m. dwarfshoot, 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).

18. Field visits

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.

DSC Botany –Paper II**Plant Ecology and Taxonomy
(BOTA 102)****(Credits: Theory-4, Practicals-2)****THEORY Lectures: 60
Section A****Unit 1: Introduction (2 Lecture)****Unit 2: Ecological Factors (13 Lectures)**

Soil: Origin, formation, composition, soil profile. **Water:** States of water in the environment, precipitation types. **Light and temperature,** Shelford law of tolerance. General account of adaptations in xerophytes and hydrophytes.

Section B**Unit 3: Plant communities (5 Lectures)**

Characters; Ecotone and edge effect; Succession; Processes and types (Hydrosere and Xerosere)

Unit 4: Ecosystem (10 Lectures)

Structure; energy flow trophic organisation; Food chains and food webs, Ecological pyramids production and productivity; Biogeochemical cycling- Cycling of Nitrogen and Phosphorus.

Section C

Unit 5: Introduction to plant taxonomy**(3 Lectures)**

Identification, Classification, Nomenclature.

Unit 6 : Identification**(5 Lectures)**

Functions of Herbarium, important herbaria and botanical gardens of the world and India; Documentation: Flora, Keys: single access and multi-access

Unit 7 : Taxonomic evidences from cytology, phytochemistry and molecular data. **6 Lectures****Unit 8: Taxonomic hierarchy****(2 Lectures)**

Ranks, categories and taxonomic groups

Section D**Unit 9: 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 10: Classification (5 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 11: Biometrics, numerical taxonomy and cladistics**(3 Lectures)**

Characters; variations; OTUs, character weighting and coding; cluster analysis; phenograms, cladograms (definitions and differences).

Practical (BOTA 102 PR)

- 1.Study of instruments used to measure microclimatic variables: Soil thermometer, maximum and minimum thermometer, anemometer, psychrometer/hygrometer, rain gauge and lux meter.
- 2.Determination of pH, and analysis of two soil samples for carbonates, organic matter.
- 3.Comparison of bulk density, porosity and rate of infiltration of water in soil of three habitats.
- 4.(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)

5. Determination of minimal quadrat size for the study of herbaceous vegetation in the college campus by species area curve method. (species to be listed)

6. Quantitative analysis of herbaceous vegetation in the college campus for frequency and comparison with Raunkiaer's frequency distribution law

7. Study of vegetative and floral characters of the following flowers (Description, V.S. flower, section of ovary, floral diagram/s, floral formula/e and systematic position according to Bentham & Hooker's system of classification):

- i. Ranunculaceae: *Ranunculus/Delphinium*
- ii. Brassicaceae: *Brassica/Alyssum/Iberis*
- iii. Malvaceae: *Hibiscus/Abutilon*
- iv. Asteraceae: *Helianthus/sonchus*
- v. Fabaceae: *Lathyrus/Pisum*
- vi. Rosaceae: *Rosa/Prunus*
- vii. Apiaceae: *Coriandrum*
- viii. Apocynaceae: *Vinca/Nerium*
- ix. Solanaceae: *Solanum/ Petunia*
- x. Lamiaceae: *Ocimum/Salvia*
- xi. Liliaceae: *Asparagus/Allium*
- xii. Poaceae: *Zea mays/Triticum aestivum*

8. Field visit/ Visit to nearby Botanical Garden

9. Mounting of a properly dried and pressed specimen of any wild angiosperm with herbarium label.

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.
2. Simpson, M.G. (2006). *Plant Systematics*. Elsevier Academic Press, San Diego, CA, U.S.A.
3. Singh, G. (2012). *Plant Systematics: Theory and Practice*. Oxford & IBH Pvt. Ltd., New Delhi. 3rd edition.

DSC Botany –Paper III
Plant Anatomy and Embryology
(BOTA 201)
(Credits: Theory-4, Practicals-2)
THEORY Lectures: 60

SECTION A

Unit 1: Meristematic and permanent tissues (7 Lectures)

Root and shoot apical meristems; Simple and complex tissues.

Unit 2: Organs (7 Lectures)

Structure of dicot and monocot root stem and leaf.

Unit 3: Adaptive and protective systems (4 Lectures)

Epidermis, cuticle, stomata;

SECTION B

Unit 4: Secondary Growth (8 Lectures)

Vascular cambium – structure and function, seasonal activity. Secondary growth in root and stem, Wood (heartwood and sapwood).

Unit 5: Anomalous Secondary Growth (4 Lectures)

Boerhaavia (Dicot) and *Dracaena* (Monocot)

SECTION C

Unit 6: Structural organization of flower (13 Lectures)

Flower- a modified shoot, Function of floral parts; Structure of anther and pollen; Microsporogenesis, Male gametophyte, Structure and types of ovules; gasporangium, Types of embryo sacs, organization and ultra structure of mature embryo sac.

Unit 7: Pollination (4 Lectures)

Pollination mechanisms and adaptations.

SECTION D

Unit 8: Fertilization (7 Lectures)

Double fertilization; Seed-structure, appendages and dispersal mechanisms.

Unit 9: Embryo and endosperm (6 Lectures)

Endosperm types, structure and functions; Dicot and monocot embryo; Embryo-endosperm relationship, polyembryony

Practical (BOTA 201 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. Study of various types of pollen grains.

Suggested Readings

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

DSC Botany –Paper IV**Plant Physiology and Metabolism****(BOTA 202****(Credits: Theory-4, Practicals-2)****THEORY Lectures: 60****SECTION A****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.

SECTION B**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.**SECTION C****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.

SECTION D**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 applications of vernalization and photoperiodism

Practical (BOTA 202)

1. Determination of osmotic potential of plant cell sap by plasmolytic method.
2. Demonstration of transpiration with the help of photometers.
3. Calculation of stomatal index and stomatal frequency of a mesophyte and a xerophyte.
4. Demonstration of activity of catalase and study of effect of pH and enzyme concentration.
5. To study the effect of light intensity and bicarbonate concentration on O₂ evolution in photosynthesis.
6. Comparison of the rate of respiration in any two parts of a plant.
7. Separation of photosynthetic pigments by paper chromatography.
8. To determine the RQ of different respiratory substances.

Demonstration experiments (any four)

1. Bolting.
2. Effect of auxins on rooting.
3. Hydroponics

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 301)

(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Cultivated Plants (3 Lectures)

Introduction, Research centres, Concept of centres of origin, their importance with reference to Vavilov's work

Unit 2: Cereals (5 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)

SECTION B

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 (3 Lecture)

Brief account of *Ocimum*, *Tinospora*, *Aloe*, *Rauwolfia*, *Emblica* and *Cathranthus*

SECTION C

Unit 9: Introduction to Biotechnology (15 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.

SECTION D

Unit 10: Biotechnological Techniques**(15 Lectures)**

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, Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Unit 10: Biotechnological Techniques**(15 Lectures)**

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, Hybridoma and monoclonal antibodies, ELISA and Immunodetection. Molecular diagnosis of human disease, Human gene Therapy.

Practical (BOTA 301)

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, sections and microchemical tests
2. Familiarization with basic equipment used in tissue culture through videos, images or visit to nearby research Institute.
3. Study through photographs: Anther culture, somatic embryogenesis, endosperm and embryo culture; micropropagation.
4. Study of equipments used in PCR, Blotting techniques and PAGE with the help of photographs or videos.

Suggested Readings

1. Kochhar, S.L. (2017). Economic Botany, Cambridge University Press.
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
Analytical Techniques in Plant Sciences
(BOTA 302)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

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.

SECTION B

Unit 2: Cell fractionation

(5 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.

(6 Lectures)

Unit 4: Spectrophotometry

Principle and its application in biological research.

(6 Lectures)

SECTION C

Unit 5: Chromatography (8 Lectures)

Principle; Paper chromatography; Column chromatography, TLC, GLC, HPLC, Ionexchange chromatography; Molecular sieve chromatography; Affinity chromatography.

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

SECTION D

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 302)

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 Specific Elective Botany
Cell and Molecular Biology
(BOTA 303)
(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

Unit 1: Techniques in Biology **(8 Lectures)**

Principles of microscopy; Light Microscopy; Phase contrast microscopy; Fluorescence microscopy; Electron microscopy (EM)- Scanning EM and Scanning Transmission EM (STEM); Sample ; 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.

SECTION B

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.

SECTION C

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.

A replication in prokaryotes and eukaryotes – bidirectional replication, semi-conservative, semi discontinuous RNA priming, θ theta mode of replication, replication of linear, ds-DNA, replicating the end of linear chromosome including replication enzymes.

SECTION D

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 303)

- 1.To study prokaryotic cells (bacteria), viruses, eukaryotic cells with the help of light and electron micrographs.
- 2.Study of the photomicrographs of cell organelles
- 3.To study the structure of plant cell through temporary mounts.
- 4.Study of mitosis and meiosis (temporary mounts and permanent slide)
- 5.Study the effect of temperature, organic solvent on semi permeable membrane.
- 6.Demonstration of dialysis of starch and simple sugar.
- 7.Study of plasmolysis and deplasmolysis on *Rhoeo* leaf.

8..Measure the cell size (either length or breadth/diameter) by micrometry.

9.Study the structure of nuclear pore complex by photograph (from Gerald Karp)Study of special chromosomes (polytene & lampbrush) either by slides or photographs.

10.Study DNA packaging by micrographs.

11.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 Specific Elective Botany

Bioinformatics

(BOTA 304)

(Credits: Theory-4, Practicals-2)

THEORY Lectures: 60

SECTION A

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.

SECTION B

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.

SECTION C

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.

SECTION D

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 304)

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. WileyBlackwell.

3. Campbell A. M., Heyer L. J. (2006) Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings.

Discipline Specific Elective Botany

Genetics and Plant Breeding

(BOTA 305)

(Credits: Theory-4, Practical-2)

THEORY Lectures: 60

SECTION A

Unit 1: Heredity (20 Lectures)

Brief life history of Mendel

1. Terminologies

2. Laws of Inheritance

3. Modified Mendelian Ratios: 2:1- lethal Genes; 1:2:1- Co- dominance, incomplete dominance; 9:7; 9:4:3; 13:3; 12:3:1.

1. Chi Square

2. Pedigree Analysis

3. Cytoplasmic Inheritance: Shell Coiling in Snail, Kappa particles in Paramecium, leaf variegation in *Mirabilis jalapa*, Male sterility.

4. Multiple allelism

5. Pleiotropism

6. Chromosome theory of Inheritance.

SECTION B

Unit 2: Sex-determination and Sex-linked Inheritance

(4 Lectures)

Unit 3: Linkage and Crossing over

(8 Lectures)

Linkage: concept & history, complete & incomplete linkage, bridges experiment, coupling & repulsion, recombination frequency, linkage maps based on two and three factor crosses. Crossing over: concept and significance, cytological proof of crossing over.

Unit 4: Mutations and Chromosomal Aberrations

(4 Lectures)

Types of mutations, effects of physical & chemical mutagens. Numerical chromosomal changes: Euploidy, Polyploidy and Aneuploidy ; Structural chromosomal changes: Deletions, Duplications, Inversions & Translocations.

SECTION C

Unit 5: Plant Breeding**(4 lectures)**

Introduction and objectives. Breeding systems: modes of reproduction in crop plants. Important achievements and undesirable consequences of plant breeding.

Unit 6: Methods of crop improvement**(8 lectures)**

Introduction: Centres of origin and domestication of crop plants, plant genetic resources; Acclimatization; Selection methods: For self pollinated, cross pollinated and vegetatively propagated plants; Hybridization: For self, cross and vegetatively propagated plants – Procedure, advantages and limitations.

Unit 7: Quantitative inheritance**(4 lectures)**

Concept, mechanism, examples. Monogenic vs polygenic Inheritance.

SECTION D**Unit 8: Inbreeding depression and heterosis****(4 lectures)**

History, genetic basis of inbreeding depression and heterosis; Applications.

Unit 9: Crop improvement and breeding**(4 lectures)**

Role of mutations; Polyploidy; Distant hybridization and role of biotechnology in crop improvement.

Practical (BOTA 305)

1. Mendel's laws through seed ratios. Laboratory exercises in probability and chi-square.
2. Chromosome mapping using point test cross data.
3. Pedigree analysis for dominant and recessive autosomal and sex linked traits.
4. Incomplete dominance and gene interaction through seed ratios (9:7, 9:6:1, 13:3, 15:1, 12:3:1, 9:3:4).
5. Study of aneuploidy Down's, Klinefelter's and Turner's syndromes through photographs.
6. Photographs/Permanent Slides showing Translocation Ring, Laggards and Inversion Bridge.
7. Hybridization techniques - Emasculation, Bagging (For demonstration only).
8. Induction of polyploidy conditions in plants (For demonstration only).

Suggested Readings

1. Gardner EJ, Simmons MJ, Snustad DP (2008). Principles of Genetics. 8th Ed. Wiley-India.
2. Snustad, D.P. and Simmons, M.J. (2010). Principles of Genetics, John Wiley & Sons Inc., India. 5 edition.
3. Klug WS, Cummings MR, Spencer, C, Palladino, M (2011). Concepts of Genetics, 10th Ed., Benjamin Cummings

- 4.Griffiths, A.J.F., Wessler, S.R., Carroll, S.B., Doebley, J. (2010). Introduction to th Genetic Analysis. W. H. Freeman and Co., U.S.A. 10th edition.
5. Pierce BA (2011) Genetics: A Conceptual Approach, 4th Ed., Macmillan Higher Education Learning
- 6.Singh, B.D. (2005). Plant Breeding: Principles and Methods. Kalyani Publishers. 7th edition.
- 7.Chaudhari, H.K. (1984). Elementary Principles of Plant Breeding. Oxford – IBH. 2nd edition.

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

Section A

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 <i>Sycon</i>	
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 <i>Taenia solium</i>	
Unit 5: Phylum Nematelminthes	5
General characters and classification up to classes; Life history of <i>Ascaris lumbricoides</i> and its parasitic adaptations	
Section B	
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

Section C

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

Section D

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. . 1982). *Invertebrate Zoology*, V Edition”

ANIMAL DIVERSITY

ZOOLOGY 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 Hallgrímsson B. (2008). *Strickberger's Evolution*. IV Edition. Jones and Bartlett Publishers Inc.

DSC ZOOLOGY II
COMPARATIVE ANATOMY AND DEVELOPMENTAL BIOLOGY OF
VERTEBRATES

ZOOL 102 TH

THEORY **Section A** **(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

Section B

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

Section C

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.

Section D

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.

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

4 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.

DSC ZOOLOGY III**PHYSIOLOGY AND BIOCHEMISTRY**

ZOOLOGY 201 TH

THEORY (CREDITS 4)**Section A****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

Section B**Unit 4: Excretion****5**

Structure of nephron, Mechanism of Urine formation, Counter-current Mechanism **43**

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

Section C

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

Section D

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 201 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)
- 5 Estimation of total protein in given solutions by Lowry's method

6 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. □

DSC ZOOLOGY IV GENETICS AND EVOLUTIONARY BIOLOGY

ZOOL 202 TH

THEORY

(CREDITS 4)

Section A

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 codominance, Multiple alleles, Lethal alleles, Epistasis, Pleiotropy, sex linked inheritance, extra-chromosomal inheritance

Section B

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

Section C

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

Section D

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 202 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 301(A)TH

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 301 (A) PR

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*, *Pyrrilla 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 301(B) TH

THEORY**(Credits 4)****Unit 1: Introduction****8**

Concept and scope of biotechnology

Unit 2: Molecular Techniques in Gene manipulation

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

Restriction enzymes: Nomenclature, detailed study of Type II.

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 301(B) PR

PRACTICAL

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 1 AQUATIC BIOLOGY
ZOOLOGY 301(C) 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 301 (C) 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 bioreserve/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 II
INSECT, VECTORS AND DISEASES
ZOOL 302 (A) 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

ZOOLOGY 302(A) 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 II IMMUNOLOGY
ZOOLOGY 302 (B) 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
ZOOLOGY 302 PR**

PRACTICAL

(CREDITS 2)

1*. Demonstration of lymphoid organs

2. Histological study of spleen, thymus and lymph nodes through slides/ photographs
- 2 . 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) EISA 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 Lichtman H. Andrew (2003.) *Cellular and Molecular Immunology*. V Edition. Saunders Publication. □

DSE II REPRODUCTIVE BIOLOGY

ZOOL 302 (C) 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 302(C) 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. Ovaryectomy, 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 COURSES

Biofertilizers (BOTA 203)

(Credits 4)

Lectures: 45

SECTION A

Unit 1: Fertilizers:

Introduction, Types of fertilizers and their advantages and disadvantages, Brief account of microbes used as biofertilizer, Marketable forms of biofertilizers. **(5 Lectures)**

Unit 2. *Rhizobium*: General account, Isolation, Identification, Mass multiplication, Carrier based inoculants, Application, Crop response **(5 Lectures)**

Unit 3. Actinorrhizal Symbiosis- *Frankia*, Host-microsymbiont relationship, Isolation, Culture, Application and Advantages **(2 Lectures)**

SECTION B

Unit 4: *Azospirillum*: Isolation and mass multiplication, Carrier based inoculant, Crop response **(4 Lectures)**

Unit 5: *Azotobacter*: Characteristics, Isolation and mass multiplication, Application and Crop response. **(4 Lectures)**

Unit 6: Phosphate Solubilizing Organisms (Microorganism): Introduction, Isolation, Culture and Applications. **(3 Lectures)**

SECTION C

Unit 7: 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 8: Mycorrhizal Association: Types of mycorrhizal association, Taxonomy, Occurrence and distribution, Phosphorus nutrition, Growth and yield; VAM – Isolation and inoculum production, Influence on growth and yield of crop plants.

(6 Lectures)

SECTION D

Unit 9: Organic Farming – Green manuring and organic fertilizers, Recycling of biodegradable municipal, agricultural and Industrial wastes; Biocompost making methods, Types and method of vermicomposting, field Application. **(10 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. Thakur, A.K., Bassi, S.K. and Singh, K.J. 2017. Biofertilizers. S. Dinesh & Co., Jalandhar.
7. Vayas, S.C, Vayas, S. and Modi, H.A. 1998. Biofertilizers and Organic Farming Akta Prakashan, Nadiad

Gardening and Floriculture

(BOTA 204)

(Credits 4)

Lectures: 45

SECTION A

Unit 1: Landscape Gardening and Floriculture: Definitions of Landscape Gardening and Floriculture, history of gardening, importance, status and scope of Floriculture and Landscaping; landscaping of homes, educational institutions, highways and public parks. **(6 Lectures)**

Unit 2: Gardening operations: Soil laying, Manuring, Watering, Management of pests and diseases; Soil sterilization; Seed sowing; Pricking; Planting and transplanting; Shading; Stopping or pinching; Defoliation; Mulching; Pruning, Topiary making. **(4 Lectures)**

SECTION B

Unit 3: Garden Designs, Principles, Types and Features:

Principles and Elements of Garden Designs, Formal and Informal gardens, English, Mughal and Japanese gardens; Features of a garden (Garden wall, Fencing, Steps, Hedge, Edging, Lawn, Flower beds, Shrubbery, Borders, Rock garden, Water garden. Some Famous gardens of India.

(7 Lectures)

Unit 4: Propagation of Garden Plants: Sexual and vegetative methods of propagation; Role of plant growth regulators. **(5 Lectures)**

SECTION C

Unit 5: Ornamental Plants: Flowering annuals; Herbaceous perennials; Shrubs, Climbers; Ornamental trees; Ornamental bulbous plants; Palms and Cycads; Potted plants and indoor gardening; Bonsai. **(10 Lectures)**

SECTION D

Unit 6: Commercial Floriculture: Factors affecting growth and flower production of ornamentals; Cultivation of Important flower crops (Carnation, Chrysanthemum, Gerbera, Gladiolus, Marigold, Rose, Liliium) **(9 Lectures)**

Unit 7. Post Harvest Management: Post- harvest handling of important flower crops, methods to prolong vase life, packaging, storage and transport of flower crops, Flower arrangements and other floral crafts. **(4 lectures)**

Suggested Readings

1. Bose T.K. & Mukherjee, D., 1972, Gardening in India, Oxford & IBH Publishing Co., New Delhi.

2. Edmond Musser & Andres, Fundamentals of Horticulture, McGraw Hill Book Co., New Delhi.
3. Janick Jules. 1979. Horticultural Science. (3rd Ed.), W.H. Freeman and Co., San Francisco, USA.
4. Hartmann and Kester, 2010. Plant Propagation: Principles and Practices. Pearson Publisher.
5. Randhawa, G.S. and Mukhopadhyay, A. 1986. Floriculture in India. Allied Publishers.
6. Sandhu, M.K., 1989, Plant Propagation, Wile Eastern Ltd., Bangalore, Madras.
7. Thakur, A.K., Kashyap, B., Bassi, S.K. and Sharma, M. 2018. Floriculture. S. Dinesh & Co., Jalandhar.

Medicinal Botany and Ethnobotany

(BOTA 306)

(Credits 4)

Lectures 45

SECTION A

Unit 1: Traditional Systems of Medicine:

Brief history of use of medicinal herbs; Introduction to indigenous systems of medicines- Ayurveda, Unani and Siddha system of medicine. **(5 Lectures)**

Unit 2: 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. **(5 Lectures)**

SECTION B

Unit 3: Plants Used by the Tribals: a) Food plants b) intoxicants and beverages c) Resins and oils and miscellaneous uses. d Sacred plants **(4 Lectures)**

Unit 4: Methodology of Ethnobotanical Studies: a) Field work b) Herbarium c) Ancient Literature d) Archaeological findings e) temples and sacred places. **(7 Lectures)**

SECTION C

Unit 5: Role of ethnobotany in modern Medicine

Medico-ethnobotanical sources in India; Significance of the following plants in ethno botanical practices (along with their habitat and morphology) a) *Azadiractha indica* b) *Ocimum sanctum* c) *Vitex negundo*. d) *Gloriosa superba* e) *Tribulus terrestris* f) *Pongamia pinnata* g) *Cassia auriculata* h) *Indigofera tinctoria*. Role of ethnobotany in modern medicine with special example *Rauwolfia serpentina*, *Taxus wallichiana*, *Trichopus zeylanicus*, *Artemisia*, *Withania*.

(13 Lectures)

SECTION D

Unit 6: Role of ethnic groups in conservation of plant genetic resources. Endangered taxa and forest management (participatory forest management). (3 Lectures)

Unit 7: 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. (8 Lectures)

Suggested Readings

1. Abdin, M.Z. and Y.P. Abrol, Y.P. 2006. Traditional Systems of Medicine. Narosa Publishing House, New Delhi.
2. Balick, M.J. and Cox, P.A. 1996. Plants, People and Culture: The Science of Ethnobotany. Scientific American Library.
3. Bera, S., Mukherji, D. and D'Rozario, A. 2004. A Hand Book of Ethnobotany. Kalyani Publishers.
4. Colton C.M. 1997. Ethnobotany: Principles and Applications. John Wiley and Sons.
5. Jain, S.K. (ed.) 1981. Glimpses of Indian. Ethnobotany. Oxford and I B H, New Delhi.
6. Jain, S.K. (ed.). 1989. Methods and Approaches in Ethnobotany. Society of Ethnobotanists, Lucknow.
7. Jain, S.K. 1990. Contributions to Indian Ethnobotany. Scientific publishers, Jodhpur.
8. Jain, S.K. 1995. Manual of Ethnobotany, Scientific Publishers, Jodhpur
9. Martin, G.J. 2008. Ethnobotany: A Methods Manual. Chapman and Hall

Mushroom Cultivation Technology

(BOTA 307)

(Credits 4)

Lectures: 45

SECTION A

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. **(10 Lectures)**

SECTION B

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)**

SECTION C

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)**

SECTION D

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

Unit: 6 Diseases and Pests of Mushrooms **(3 Lectures)**

Suggested Readings

1. Biswas, S., Datta, M. and Ngachan, S.V. 2012. Mushrooms: A Manual for Cultivation. PHI Learning Private Limited, New Delhi.

2. Kapoor, J.N. 2010. Mushroom Cultivation. ICAR, New Delhi.
3. Nita Bahl (2000) Hand book of Mushrooms. Oxford & IBH Publishing Co. Pvt. Ltd.
4. Singh, M., Vijay, B., Kamal, S. and Wakchaure (Eds.) 2011. Mushrooms: Cultivation, Marketing and Consumption. Directorate of Mushroom Research (ICAR), Solan
5. Tewari, Pankaj and Kapoor, S.C., (1988). Mushroom cultivation, Mittal Publications, Delhi.

SKILL ENHANCEMENT COURSES

Zoology

SEC 1 MEDICAL DIAGNOSTICS

Code: ZOOL 203 TH

THEORY

(Credits 4)

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. □

Skill Enhancement Course II Zoology

Apiculture ZOOLOGY 204 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.

SEC - III**SERICULTURE****Code: ZOOL 303 TH****(CREDITS 4)****Unit 1: Introduction****(8)**

Sericulture: Definition, history and present status; Silk route
 Types of silkworms, Distribution and Races
 Exotic and indigenous races
 Mulberry and non-mulberry Sericulture

Unit 2: Biology of Silkworm**(6)**

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

Unit 3: Rearing of Silkworms**(15)**

Selection of mulberry variety and establishment of mulberry garden
 Rearing house and rearing appliances
 Disinfectants: Formalin, bleaching powder, RKO
 Silkworm rearing technology: Early age and Late age rearing
 Types of mountages
 Spinning, harvesting and storage of cocoons

Unit 4: Pests and Diseases**(10)**

Pests of silkworm: Uzi fly, dermestid beetles and vertebrates
 Pathogenesis of silkworm diseases: Protozoan, viral, fungal and bacterial
 Control and prevention of pests and diseases

Unit 5: Entrepreneurship in Sericulture**(6)**

Prospectus of Sericulture in India: Sericulture industry in different states, employment, potential in mulberry and non-mulberry sericulture. Visit to various sericulture centres.

SUGGESTED READINGS

- Handbook of Practical Sericulture: S.R. Ullal and M.N. Narasimhanna CSB, Bangalore
- Appropriate Sericultural Techniques; Ed. M. S. Jolly, Director, CSR & TI, Mysore.
 - □ Handbook of Silkworm Rearing: Agriculture and Technical Manual-1, Fuzi
- Pub. Co. Ltd., Tokyo, Japan 1972. □
 - Manual of Silkworm Egg Production; M. N. Narasimhanna, CSB, Bangalore 1988. □
 - Silkworm Rearing; Wupang—Chun and Chen Da-Chung, Pub. By FAO, Rome 1988. □
 - A Guide for Bivoltine Sericulture; K. Sengupta, Director, CSR & TI, Mysore 1989. □
 - Improved Method of Rearing Young age silkworm; S. Krishnaswamy, reprinted CSB, Bangalore, 1986. □

Skill Enhancement Course Zoology

AQUARIUM FISH KEEPING

ZOOL 304 (A) TH

(CREDITS 4)

Unit 1: 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

OR

RESEARCH METHODOLOGY

ZOOL 304 (B)TH

CREDITS 4

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. □
 - Wadhera, B.L.: Law Relating to Patents, Trade Marks, Copyright Designs and □ Geographical Indications, 2002, Universal Law publishing □
 - C.R.Kothari: Research Methodology, New Age International, 2009 □ □ 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 | 20 Marks |
| 3. | Internal Assessment | 30 Marks |

Theory Paper + Practical + Internal Assessment **(50+20+ 30) =100 Marks**

Distribution of Internal Assessment /CCA:

- | | | |
|-------|---|------------|
| (i) | Class Attendance = 5 Marks | |
| (ii) | Class test to be taken on completion of 40% syllabus by the class teacher | = 5 Marks |
| (iii) | House test to be taken on completion of 75 % of Syllabus | = 10 Marks |
| (iv) | Assignment, tutorials, general behavior of students | = 10 Marks |

Marks for Class attendance

□ 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

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	20 Marks	Time 3 hrs
Internal Assessment	30 Marks	

Skill Enhancement Course & Ability Enhancement Compulsory Course: 100 Marks

Skill Enhancement Course = 100 Marks (Theory 70 + CCA 30)

Ability Enhancement Compulsory Course 1. Environment Science = 100 Marks 2. English/Hindi/SKT = 100 Marks (Theory 70 +CCA 30)

Instructions for Setting of Question Papers

I. Discipline Specific Courses and Discipline Specific Electives (Theory Papers) Max Marks: 50

1. Each question paper will contain 9 questions (divided into five parts A, B, C, D and E) of 10 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part. Each question may be divided into 2 parts.
4. Questions should be taken from the whole syllabus.

II. Skill Enhancement Courses (SEC) Max Marks: 70

1. Each question paper will contain 9 questions (divided into five Parts- A, B, C, D and E) of 14 marks each.
2. Question number 1 in Part A will be compulsory and will contain ten fill in the blanks, multiple choice questions, definitions or terms of one mark each.
3. Rest of the eight questions will be divided into four Parts (B, C, D and E containing questions from Section A, B, C and D of the syllabus) with each Part containing two questions. Students will be required to attempt only one question from each Part.
4. Questions should be taken from the whole syllabus.

