

**UNIVERSITY OF JAMMU**  
**SYLLABI FOR BACHELOR DEGREE PROGRAMME**  
**IN BOTANY**

The following Courses of Study are prescribed for I to VI Semester/s Bachelor Degree (UG) Programme under CBCS in the Subject of BOTANY

Semester	Course No.	Title	Credits	Nature of Course
I	UBOTC101	Diversity of microbes and Cryptogams	4	CORE
	UBOPC102	Diversity of microbes and Cryptogams	2	CORE (Practicals)
II	UBOTC201	Characteristics and Systematics of seed plants	4	CORE
	UBOPC202	Characteristics and Systematics of seed plants	2	CORE (Practicals)
III	UBOTC301	Plant Anatomy, Embryology and Ecology	4	CORE
	UBOPC302	Plant Anatomy, Embryology and Ecology	2	CORE (Practicals)
	UBOTS303	Nursery, Gardening and Floriculture	4	SKILL ENHANCEMENT
IV	UBOTC401	Plant Physiology and Metabolism	4	CORE
	UBOPC402	Plant Physiology and Metabolism	2	CORE (Practicals)
	UBOTS403	Ethnobotany	4	SKILL ENHANCEMENT
V	UBOTE501	Cell Biology and Genetics	4	DSE/GE
	UBOPE502	Cell Biology and Genetics	2	DSE/GE (Practicals)
	UBOTS503	Mushroom Cultivation Technology	4	SKILL ENHANCEMENT
VI	UBOTE601	Economic Botany and Biotechnology	4	DSE/GE
	UBOPE602	Economic Botany and Biotechnology	2	DSE/GE (Practicals)
	UBOTS603	Biofertilizers	4	SKILL ENHANCEMENT

**BOTANY**  
**(Semester-III)**

**(For examinations to be held in the years Dec 2017, 2018, 2019)**

**Course No: UBOTC301**                      **Title: Plant Anatomy, Embryology and Ecology (Theory)**  
**Maximum Marks: 100**

**Duration of Exam: 2.5hrs**

**Credits: 04**                                      **External Examination: 80 Marks**  
**Internal Assessment: 20 Marks**

***Objectives:***

*Seed bearing plants represent the most advanced groups of plant kingdom. Proper knowledge about their structure, functions, mechanisms of multiplication and their interactions with the biotic and abiotic components of the ecosystems will assist in manipulating these for better human utility. This course will create awareness among students about proper utilization of important plant parts.*

**UNIT-I: Plant, Structure and Organization.**

- 1.1 Meristems: concept and types; structure and organization of RAM and SAM
- 1.2 Anatomy of primary root and primary stem (both monocots and dicots)
- 1.3 Vascularisation of primary shoot in monocotyledons and dicotyledons, leaf traces and leaf gaps; branch traces and branch gaps.
- 1.4 Epidermal modifications in monocots and dicots (trichomes and stomata), their structural organization and systematic value.

**UNIT-II: Primary and Secondary Structures**

- 2.1 Vascular and cork cambium: structure and derivatives; lenticels
- 2.2 Structure of secondary xylem and secondary phloem
- 2.3 Secondary growth – a general account; growth rings; heartwood, sapwood
- 2.4 Leaf : origin, development and vascularisation; Internal structure of monocot and dicot leaf, concept of senescence and abscission.

**UNIT-III Embryology**

- 3.1 Flower structure and functions; Structure of anther, male gametophyte and microsporogenesis; Structure of pistil, ovule, female gametophyte and megasporogenesis.
- 3.2 Pollination: Types, attractants and rewards for pollinators; pollen-pistil interaction; self-incompatibility.
- 3.3 Double fertilization, embryo and endosperm development, types, cytology and functions of endosperm; formation of fruit.
- 3.4 Seed formation and seed dispersal strategies.

## **Unit-IV           Plants and Environment**

- 4.1    Atmosphere- Stratification and gaseous composition; Carbon and hydrological cycle and their significance, greenhouse gases and climate change.
- 4.2    Soil structure, soil profiles and development; soil types in India.
- 4.3    Concept of ecology, ecosystem: structure, abiotic and biotic components, food chain, food web, ecological pyramids and energy flow.
- 4.4    Community ecology: Community characteristics, frequency, density cover, life forms, biological spectrum.

## **Unit-V Population, community and natural resources**

- 5.1    Ecological succession: Concept, process and its types; climax communities.
- 5.2    Population ecology, growth curves; Ecotypes and ecads.
- 5.3    Ecotone and edge effect-concept and types.
- 5.4    Phytogeographical regions of India

### **Note for paper setters**

#### **External End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

##### **The question paper will have 3 sections.**

**Section I:** Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)

**Section II:** Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)

**Section III:** Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.

#### **Internal Assessment (Total Marks: 20) Time duration: 1 hr.**

##### **The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at least one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

## SUGGESTED READING

1. Bhojwani, S.S and Bhatnagar, S.P. 2000. The Embryology of Angiosperms. 4<sup>th</sup> Edn. Vikas Publishing House, Delhi.
2. Cutter, E.G. 1969. Plant Anatomy: Experiment and Interpretation. Part-I: Cells and Tissues. Edward Arnold, London
3. Cutter, E.G. 1970. Plant Anatomy: Experiment and Interpretation. Part-II: Organs. Edward Arnold London.
4. Esau, K. 1977. Anatomy of Seed Plants. 2<sup>nd</sup> Edn. John Wiley and Sons, New York.
5. Chapman, J.L. and Reiss, M.J. 2000. Ecology: Principles and Applications. 2<sup>nd</sup> Edn., Cambridge University Press , U.K.
6. Kebs, C.J. 1989. Ecological Methodology. Harper and Row, New York, USA.
7. Kormondy, E.J. 1996. Concepts of Ecology. Prentice- Hall of India Pvt. Ltd. New Delhi.
8. Ludwist. J.A. and Reynolds, J.F. 1988. Statistical Ecology. Wiley, New York.
9. Misra, R. 1988. Ecology Work Book. Oxford and IBH, New Delhi.
10. Moore. P.W. and Chapman, S.B. 1986. Methods in Plant Ecology. Blackwell Scientific Publications.
11. Odum, E.P. 1983. Basic Ecology. Saunders, Philadelphia.
12. Sharma, P. D. 2010. Ecology and Environment. 10<sup>th</sup> Edn. Rastogi Publications, Merut. India
13. Townsend, C.R., Begon, M. and Harper, J.L. 2008. Essentials of Ecology. 3<sup>rd</sup> Edn. Blackwell publishing. U.K.
14. Underwood, A.J. 1977. Experiments in Ecology: Their logical design and interpretation using analysis of variance. Cambridge University Press.
15. APHA-Standard methods for the examination of water and waste water, American Public Health Association, Washington.
16. Faegri, K and Vander Pijl. 1979. The Principles of Pollination Ecology. 2<sup>nd</sup> Edn. Pergamon Press, Oxford.
17. Fahn, A. 1974. Plant Anatomy. 2<sup>nd</sup> Edn. Pergamon Press.
18. Kind, J. 1997. Reaching for the sun: How Plants work. Cambridge University Press, Cambridge, U.K.
19. Mauseth, J.D. 1988. Plant Anatomy. The Benjamin Cummings Publishing Company, Menio Park, California, USA.
20. Proctor, M and Yeo, P. 1973. The Pollination of Flowers. William Collins Sons, London.
21. Raven, P.H., Evert, R.F. and Eichhorn, S.E. 1999. Biology of Plants, 5<sup>th</sup> Edn. W.H. Freeman and Co. Worth Publishers, New York.
22. Thomas, P. 2000. Trees: Their Natural History. Cambridge University Press, Cambridge.

**BOTANY**  
**(Semester-III)**

**(For examinations to be held in the years Dec 2017, 2018, 2019)**

**Course No: UBOPC302**

**Title: Plant Anatomy, Embryology and Ecology (Practical)**  
**Maximum Marks: 50**

**Duration of Exam: 3 hrs**

**Credits: 02**

**External Examination: 25 Marks**  
**Internal Assessment: 25 Marks**

1. To study shoot and root tip with emphasis on cyto-histological zonation.
  2. Anatomy of primary and secondary growth in monocots and dicots using hand sections and prepared slides. Structure of secondary phloem and xylem. Growth rings in wood, Microscopic study of wood in T.S., T.L.S., and R.L.S.
  3. Study of diversity in leaf shape, size, thickness, surface properties; internal structure of leaf, structure and type of stomata and trichomes (using epidermal peels of leaf).
  4. Anatomy of the root; primary and secondary structure.
  5. Examination of wide range of flowers available in the locality and methods of their pollination.
  6. Structure of anther, microsporogenesis (using slides) and pollen grains (using whole mounts). Pollen viability using *in vitro* pollen germination.
  7. Structure and types of ovule.
  8. Endosperm and embryo development in monocots and dicots (using slides and dissections).
  9. To determine the minimum requisite size of the quadrat for phytosociological studies.
  10. To determine the frequency, density, abundance, basal area and importance value index of herbaceous and tree flora.
1. To determine the different life forms of the plant species of the grassland ecosystem and prepare a biological spectrum by comparing with Raunkiaer's normal spectrum.
  2. To study the various soil horizons for drawing the soil profile diagram.
  3. To determine the bulk density, water holding capacity and porosity of forest and grassland ecosystems.
  4. To measure pH and dissolved oxygen contents in different water ecosystems.

**Note for distribution of 50 Marks in Practical Examination ( 50% internal and 50% external)**

**I. Internal Assessment**

- |    |   |   |          |
|----|---|---|----------|
| 1. | Attendance                                      | : | 5 Marks  |
| 2. | Practical Test:                                 |   | 5 Marks  |
| 3. | Daily performance based on practical work done: |   | 10 Marks |
| 4. | Viva-voce                                       |   | 5 Marks  |

**II. External Assessment**

- |    |                                |  |          |
|----|--------------------------------|--|----------|
| 1. | External practical examination |  | 20 Marks |
| 2. | Viva-voce                      |  | 5 Marks  |

**BOTANY**  
**(Semester-III)**

(For examinations to be held in the years Dec 2017, 2018, 2019)

**SKILL ENHANCEMENT COURSE**

**Course No: UBOTS 303**                      **Title: NURSERY, GARDENING AND FLORICULTURE (Theory)**  
**Duration of Exam: 2.5hrs**              **Maximum Marks: 100**

**Credits: 04**                                      **End Semester Examination: 80 Marks**  
**Assessment test: 20 Marks**

**UNIT-I INTRODUCTION TO NURSERY AND GARDENING:**

- 1.1 Definition and types of Nurseries. Physical resources for nurseries.
- 1.2 Selection of Nursery Site, Ecological Facts, Equipments and Implements used in nurseries and gardening, important nursery operations.
- 1.3 Definition and components of gardens, types of gardening (landscape and home gardening), gardening operations (soil laying, manuring and watering).
- 1.4 Scope and objective of gardening. Some famous gardens with specific reference to Kew Botanical garden and BSI, Kolkata.

**UNIT-II PLANT PROPAGATION METHODS:**

- 2.1 Sowing/raising of seeds and seedlings, transplanting of seedlings, causes and methods of breaking seed dormancy; seed germination, types and factors affecting it.
- 2.2 Vegetative propagation, artificial and natural methods; concept of hydroponics and aeroponics.
- 2.3 Concept of micro-propagation, hardening of nursery plants. Scope and importance of plant propagation in nurseries.
- 2.4 Packing, transport and marketing of nursery plants.

**UNIT-III PLANT NUTRITION AND PLANT PROTECTION IN NURSERIES AND GARDENS:**

- 3.1 Plant nutrition, micro and macronutrients. Role and deficiency symptoms of N, P and K.
- 3.2 Inorganic fertilizers, manures, Biofertilizers.
- 3.3 Pest management, pesticides, biopesticides, advantages and disadvantages.
- 3.4 Cultural and chemical methods of controlling fungal disease and weeds.

**UNIT-IV MANAGEMENT PROCEDURES IN NURSERIES AND GARDENS.**

- 4.1 Water management, irrigation system, types.
- 4.2 Sanitation, drainage and its types, trimming, pruning and thinning.
- 4.3 Potting, Repotting, Depotting and mulching.
- 4.4 Plant growth regulators; Definition, types, Role and auxins methods of application in plant propagation.

**UNIT-V FLORICULTURE**

- 5.1 Concept and scope of floriculture, factors affecting flower production, packaging of cutflowers; methods to prolong vase life of flowers.
- 5.2 Botany of some ornamental perennial plants- *Cycas*, *Areca Palm* *Raphis palm* and *Crysalidocarpus palm*, *Dracaena*, *Nolina*, *Thuja*, *Phoenix*.

- 5.3 Botanical names and methods of propagation of important flowers (Dahlia, Chrysanthemum, Rose, Gladiolus, Marigold, Carnation and Gerbera).
- 5.4 Botanical names and methods of propagation of some common ornamental Cacti and Succulents, concept of Bonsai.

**Pattern of examination (Internal)**

**I. End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

**The question paper will have 3 sections.**

**Section I: Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)**

**Section II: Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)**

**Section III: Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.**

**II. Assessment Test (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

**References:**

Floriculture in India by G.S. Randhava and Amitabha Mukhopadhyay Allied Publishers, PVT. Ltd. 1986.

Plant Propagation Principles and Practices by Hartman H.T. Prentice-Hall International: London, 1959.

Encyclopedia of Gardening by Christopher Brukell. Dorling Kindersley, Ltd. 2007.

Propagation Hand Book; basic Techniques for Gardeners Mechanicsburg, Pas; stackpok Books, 1995.

Horticulture, Principles and Practices by George Acquaah. 4<sup>th</sup> edition, Pearson Publisher, Prentice Hall, 2009.

Gardening in India by Bose, T.K and Mukerjee, D. New Delhi Oxford & IBH Pub. Co. Pvt. Ltd, 1977.

Textbook of Horticulture by Mani Bhushan Rao. Macmillan India Ltd. 2005 (2<sup>nd</sup> edition).

Introduction to Horticulture by Kumar, N. 7<sup>th</sup> edition, Oxford & IBH Publishing Company Pvt. Ltd. 2010.

Introduction to ornamental Horticulture by J.S. Arora, 1999. Kalyani Publishers, Ludhiana, India.

Plant propagation by Sandhu M.K. New Age International Publishers Ltd. 1989.

Ornamental plants and Garden design in Tropics and Subtropics (Vol 1 & 2) by T.K. Bose, L.J. Singh, M.K. Sandhu and T.K Maity. Publisher: Daya Publishing House; A division of Astral International Pvt. Ltd. 2015.



**BOTANY**  
**(Semester-IV)**

**(For examinations to be held in the years May 2018, 2019, 2020)**

**Course No: UBOTC401**

**Title: Plant Physiology and Metabolism (Theory)**

**Maximum Marks: 100**

**Duration of Exam: 2.5hrs**

**Credits: 04**

**External Examination: 80 Marks**

**Internal Assessment: 20 Marks**

***Objectives:***

*The course is designed to make students appreciate the various mechanisms underlying the important activities of plants as absorption of water and minerals, solute transport, transpiration, flowering, nitrogen metabolism etc. Another aim is to impart students knowledge regarding the stresses that plants face and methods adopted by them to tackle/overcome these stresses.*

**Unit-I Enzymes and water relations in plants**

- 1.1 Discovery and nomenclature of enzymes, characteristics of enzymes, concept of holoenzyme, apoenzyme, co-enzyme and co-factors.
- 1.2 Regulation of enzyme activity; mechanism of enzyme action.
- 1.3 Diffusion of water, osmosis, water potential, absorption and transport of water through xylem.
- 1.4 Types and mechanism of transpiration and mechanism of opening and closing of stomata.

**Unit-II Mineral nutrition and phloem translocation**

- 1.3 Concept of macro-and micro-elements and mineral uptake; Importance of Ca, N, P, K, Mg to the plants and their deficiency symptoms.
- 1.4 Transport of ions across cell membrane, active and passive transport, carriers, channels and pumps.
- 1.5 Translocation in phloem; composition of phloem sap; girdling experiment, pressure flow model, phloem loading and unloading.
- 1.6 Source-Sink relationship, factors affecting phloem translocation.

**Unit-III Photosynthesis and Respiration**

- 3.1 Photosynthesis – a general account of photosynthetic pigments, red drop and enhancement effect; concept of photosystems, PSI and PSII; cyclic and non-cyclic photophosphorylation.
- 3.2 Carbon fixation- Calvin cycle, C<sub>4</sub>, Crassulacean Acid Metabolism and photorespiratory pathways and their significance.

- 3.3 Respiration- Glycolytic pathway, Krebs's cycle, Pentose phosphate pathway.
- 3.4 Electron transport mechanism and oxidative phosphorylation, mechanism of synthesis of ATP (Chemi-osmotic theory).

#### **Unit-IV Nitrogen fixation, secondary metabolism and abiotic stress**

- 4.1 Biological nitrogen fixation-symbiotic and asymbiotic nitrogen fixation; nitrate and ammonium assimilation.
- 4.2 Biosynthesis and functions of phospholipids;  $\beta$ -oxidation pathway.
- 4.3 Secondary metabolism, concept and role; Phenylpropanoid pathway, Shikimic acid pathway.
- 4.4 Abiotic stress – types of stresses (drought, heavy metal, pH and salinity); reactive oxygen species (production and management); physiological responses to drought, heavy metal and salinity stress.

#### **Unit-V Physiology of growth and flowering**

- 5.1 Plant growth and development - phases and kinetics of growth; seed dormancy and germination - general account, factors affecting seed dormancy and germination.
- 5.2 Physiology of flowering - florigen concept, photoperiodism, vernalization.
- 5.3 Phytochromes - their discovery, physiological role and mechanism of action.
- 5.4 Plant hormones - auxins, gibberellins, cytokinins, abscissic acid and ethylene, their role and mode of action

#### **Note for paper setters**

**External End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

**The question paper will have 3 sections.**

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**Section II:** Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)

**Section III:** Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.

**Internal Assessment (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

### **Suggested Reading**

1. Buchanan, B.B., Gruissen, W. and James, R.L. 2000. Biochemistry and Molecular Biology of Plants. I.K. International Pvt. Ltd. New Delhi.
2. Galston, A.W. 1989. Life Process in Plants. Scientific American Library, Springer-Verlag ,New York, USA.
3. Hopkins, W.G. 2008. Introduction to Plant Physiology. John Wiley and Sons, Inc. New York, USA.
4. Taiz, L and Zeiger, E. 2006. Plant Physiology. 4<sup>th</sup> Edn., Sinauer Associates, Inc Publishers, Massachusetts, USA.

**BOTANY**  
**(Semester-IV)**

**(For examinations to be held in the years May 2018, 2019, 2020)**

**Course No: UBOPC402**

**Title: Plant Physiology and Metabolism (Practical)**  
**Maximum Marks: 50**

**Duration of Exam: 3 hrs**

**Credits: 02**

**External Examination: 25 Marks**  
**Internal Assessment: 25 Marks**

1. Estimation of inorganic phosphate in plant tissue.
2. To study the permeability of plasma membrane using different concentrations of organic solvents.
3. To study the effect of temperature on permeability of plasma membrane.
4. To prepare the standard curve of protein and determine the protein content in unknown samples by Lowry's and methods.
5. To study the enzyme activity of catalase and peroxidase as influenced by pH and temperature.
6. Comparison of the rate of respiration in germinating seeds.
7. Separation of chloroplast pigments by solvent partitioning/paper chromatography/TLC methods.
8. Determining the osmotic potential of vacuolar sap by plasmolytic method.
9. Determining the water potential of potato tubers.
10. Separation of amino acids in a mixture by paper chromatography and their identification by comparison with standards.
11. Demonstration of rate of transpiration by cobalt chloride method.
12. Demonstration of stomatal movements.
13. Demonstration of osmosis by using potato tuber.
14. Demonstration of plasmolysis and deplasmolysis.

**Note for distribution of 50 Marks in Practical Examination ( 50% internal and 50% external)**

**I. Internal Assessment**

- |    |   |   |          |
|----|---|---|----------|
| 1. | Attendance                                      | : | 5 Marks  |
| 2. | Practical Test:                                 |   | 5 Marks  |
| 3. | Daily performance based on practical work done: |   | 10 Marks |
| 4. | Viva-voce                                       |   | 5 Marks  |

**II. External Assessment**

- |    |                                |  |          |
|----|--------------------------------|--|----------|
| 3. | External practical examination |  | 20 Marks |
| 4. | Viva-voce                      |  | 5 Marks  |

**BOTANY**  
**(Semester-IV)**  
**(For examinations to be held in the years May 2018, 2019, 2020)**  
**SKILL ENHANCEMENT COURSE**

**Course No: UBOTS 403**                      **Title: ETHNOBOTANY (Theory)**  
**Duration of Exam: 2.5hrs**              **Maximum Marks: 100**

**Credits: 04**                                      **End Semester Examination: 80 Marks**  
**Assessment Test : 20 Marks**

**UNIT-I ETHNOBOTANY AND RELATED ISSUES**

- 1.1 Concept of ethnobotany
- 1.2 Ethnobotany as an interdisciplinary Science and its importance.
- 1.3 Major ethnic groups or tribals of India with special reference to Jammu & Kashmir.
- 1.4 Major issues related to ethnobotany (Ethical, Cultural, Social etc.)

**UNIT-II METHODOLOGY OF ETHNOBOTANICAL STUDIES**

- 2.1 Field work and collection of data.
- 2.2 Herbarium preparation and identification of plants.
- 2.3 Source of data and methods of study: Fossils, archaeological resources and ancient literature.
- 2.4 Temples and sacred places as sources of data and plant conservation.

**UNIT-III ROLE OF ETHNOBOTANY IN MODERN MEDICINE**

- 3.1 Medico-ethnobotanical sources of India, a general account.
- 3.2 Significance of the following plants in ethnobotanical practices (along with their habitat and morphology) (a) *Azadiracta indica* (b) *Ocimum sanctum* (c) *Vitex negundo* (d) *Gloriosa superba* (e) *Tribulus terrestris* (f) *Pongamia pinnata*.
- 3.3 Role of ethnobotany in modern medicine with special reference to *Rauwolfia serpentina*, *Artemisia* and *Withania*,
- 3.4 Role of ethnic groups and sacred grooves in conservation of plant genetic resources.

**UNIT-IV LEGAL ASPECTS IN ETHNOBOTANY**

- 4.1 Concept of RET taxa.
- 4.2 Role of IUCN and BSI in conservation.
- 4.3 Biopiracy, Intellectual Property Rights and Traditional Knowledge. Biodiversity laws in India.

**Pattern of examination (Internal)**

**I. End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

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## **II. Assessment Test (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

### **Suggested Readings:**

S.K.Jain, (1995) Manual of Ethnobotany, Scientific Publishers, Jodhpur.

S.K. Jain (ed.) (1981). Glimpses of Indian- Ethnobotany, Oxford and IBH, New Delhi.

S.K. Jain and V.Mudgal, (1999). A Handbook of Ethnobotany, BSMPS, Dehradun

S.K.Jain (ed.) 1989. Methods and approaches in ethnobotany. Society of ethnobotanists, Lucknow, India.

S.K.Jain , 1990. Contributions of Indian- ethnobotany. Scientific publishers, Jodhpur.

Colton C.M. 1997. Ethnobotany- Principles and applications. John Wiley and sons- Chichester.

Rama Rao, N and A.N. Henry (1996). The Ethnobotany of Eastern Ghats in Ahdhra Pradesh, India. Botanical Survey of India. Howrah.

Rajiv K. Sinha, (1996). Ethnobotany the Renaissance of Traditional Herbal Medicine-INA-SHREE Publishers, Jaipur-1996.

**BOTANY**  
**(Semester-V)**

**(For examinations to be held in the years Dec 2018, 2019, 2020)**

**DISCIPLINE SPECIFIC ELECTIVE**

**Course No: UBOTE501**

**Course Title : Cell Biology and  
Genetics (Theory)**

**Duration of Exam: 2.5hrs**

**Maximum Marks: 100**

**Credits: 04**

**External Examination: 80 Marks**

**Internal Assessment: 20 Marks**

*Objectives: The course has been devised to acquaint the students with the structural and functional aspects of cell, chromosomes and genes and alterations generally found in these.*

**Unit-I Cell Structure.**

- 1.1 Cell wall; Primary cell wall, its structure, formation and function.
- 1.2 Plasma membrane; the lipid bilayer structure, fluid mosaic model; functions of plasma membrane.
- 1.3 Cell organelles; structure and functions of endoplasmic reticulum, golgi bodies, chloroplasts, mitochondria and ribosomes.
- 1.4 Ultrastructure of nuclear membrane, organization and function of nucleolus.

**Unit-II Chromosome structure and multiplication.**

- 2.1 Physical and chemical structure of chromosome; structure and importance of centromere and telomere; concept of sex chromosomes.
- 2.2 Reductional and equational divisions: Various stages; detailed structure of pairing and crossing over.
- 2.3 DNA: structure and replication; satellite and repetitive DNA.
- 2.4 Extranuclear genome: structure and function of mitochondrial and plastid DNA; Plasmids.

**Unit-III Genome Organization and function/Gene to protein.**

- 3.1 Organization of DNA in prokaryotic and eukaryotic genomes, role of proteins; nucleosome model.
- 3.2 Concept of gene; genetic code; structure and functions of mRNA and tRNA.
- 3.3 Protein synthesis; transcription; regulation of gene expression in prokaryotes and eukaryotes.
- 3.4 Protein synthesis: translation; primary, secondary and tertiary structure of proteins.

#### **Unit-IV Alterations of the genome.**

- 4.1 Structural alterations; types, effect and detection of intra-chromosomal alterations (deletions, duplications and inversions).
- 4.2 Mechanism, effect and detection of inter-chromosomal alterations (translocations).
- 4.3 Euploidy-types, origin and effect with suitable examples (wheat and cotton).
- 4.4 Aneuploidy-types, origin and effect with suitable examples.

#### **Unit-V Alterations in the basic unit of inheritance and inheritance patterns.**

- 5.1 Mutations-types, sources (spontaneous and induced), uses and mechanisms of induction.
- 5.2 Concept and salient features of transposable elements in prokaryotes (IS and Tn) and eukaryotes (Ac-Ds). DNA damage and repair mechanisms.
- 5.3 Mendelism, laws of segregation and independent assortment; allelic and non-allelic interactions.
- 5.4 Linkage and recombination, role of linkage in mapping of genes.

#### **Note for paper setters**

**External End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

#### **The question paper will have 3 sections.**

**Section I:** Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)

**Section II:** Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)

**Section III:** Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.

#### **Internal Assessment (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.



### **Suggested Readings:**

1. Albert B., Bray, D., Raff, M., Roberts, K and Watson J.D. 2004. Molecular Biology of Cell. 3<sup>rd</sup> Edn. Garland Science. New York, USA.
2. Atherly, A.G., Girton, J.R. and Mc.Donald, J.F. 1999. The Science of Genetics. Diane Publishing. Co. Fort Worth, USA.
3. Gupta, PK. 1999. A Text Book of Cell and Molecular Biology. Rastogi Publications, Meerut, India.
4. Kleinsmith, L J. And Kish, V. M. 1995. Principles of Cell and Molecular Biology. 2<sup>nd</sup> Edn. Harper Collins College Publishers, New York, USA.
5. Lodish, H., Berk, A., Zipursky, S.L., Matsudaria P., Baltimore, D and Darnell, J. 2000. Molecular Cell Biology. 5<sup>th</sup> Edn. W.H. Freeman & Co. New York, USA.
6. Russell, P J. 1998. Genetics. The Benjamin Cummings Publishing Co. Inc., USA.
7. Snustad, D.P. and Simmons, M.J. 2000. Principles of Genetics. John Wiley & sons, Inc. USA.
8. Wolfe, S.L. 1993. Molecular and Cell biology. Wadsworth Publishing Co. California, USA.

**BOTANY**  
**(Semester-V)**

**(For examinations to be held in the years Dec 2018, 2019, 2020)**

**Course No: UBOPE502**

**Title: Cell Biology and Genetics**  
**(Practical)**

**Duration of Exam: 3 hrs**

**Maximum Marks: 50**

**Credits: 02**

**External Examination: 25 Marks**

**Internal Assessment: 25 Marks**

1. To study cell structure from onion leaf peels and demonstrate staining and mounting methods.
2. Comparative study of cell structure in onion cells, *Hydrilla* and *Spirogyra*. Study of cyclosis in *Tradescantia* petal cells.
3. Study of plastids to examine pigment distribution in plants (e.g. *Cassia*, Tomato and *Capsicum*).
4. Examination of electron micrographs of eukaryotic cells with special reference to organelles.
5. Study of electron micrographs of viruses, bacteria, cyanobacteria and eukaryotic cells for comparative cellular organization.
6. Examination of various stages of mitosis and meiosis using appropriate plant material (e.g. onion root tips, onion flower buds).
7. Preparation of karyotypes from dividing root tip cells and pollen grains.
8. Cytological examination of special types of chromosomes; barr body, lampbrush and polytene chromosomes.
9. Working out the laws of inheritance (monohybrid, dihybrid, gene interactions) using seed mixtures.
10. Working out the mode of inheritance of linked genes from test cross and / or F<sub>2</sub> data.

**Note for distribution of 50 Marks in Practical Examination ( 50% internal and 50% external)**

**I. Internal Assessment**

- |    |   |   |          |
|----|---|---|----------|
| 1. | Attendance                                      | : | 5 Marks  |
| 2. | Practical Test:                                 |   | 5 Marks  |
| 3. | Daily performance based on practical work done: |   | 10 Marks |
| 4. | Viva-voce                                       |   | 5 Marks  |

**II. External Assessment**

- |    |                                |  |          |
|----|--------------------------------|--|----------|
| 5. | External practical examination |  | 20 Marks |
| 6. | Viva-voce                      |  | 5 Marks  |

**BOTANY**  
**(Semester-V)**  
**(For examinations to be held in the years Dec 2018, 2019, 2020)**  
**SKILL ENHANCEMENT COURSE**

**Course No: UBOTS 503**                      **Title: MUSHROOM CULTIVATION TECHNOLOGY (Theory)**  
**Duration of Exam: 2.5hrs**              **Maximum Marks: 100**  
**Credits: 04**                                      **End Semester Examination: 80 Marks**  
**Assessment Test : 20 Marks**

**UNIT-1. INTRODUCTION AND TYPES OF MUSHROOMS.**

- 1.1 Introduction to the world mushrooms, history. Characteristics of mushrooms. Types of edible mushrooms available in India- *Volvariella volvacea*, *Pleurotus citrinopileatus*, *Calocybe indica*. *Agaricus bisporus*.
- 1.2 Structure and life cycle of mushrooms with special reference to *Agaricus* and *Morchella*.
- 1.3 Nutritional and Pharmaceutical value of mushrooms
- 1.4 Poisonous mushrooms with famous poisoning mushroom.

**UNIT-2. CULTIVATION TECHNOLOGY.**

- 2.1 Infrastructure: Substrates (locally available) Polythene bag, vessels, inoculation hook, inoculation loop, low cost stove, sieves, culture rack.
- 2.2 Spawn Production Technology: Mushroom Unit (Thatched house) water sprayer, tray, small polythene bags, Pure culture: Medium, sterilization, preparation of spawn, multiplication.
- 2.3 Mushroom bed preparation- paddy straw, sugarcane trash, maize straw, banana leaves. Factors affecting the mushroom bed preparation.
- 2.4 Composting technology in mushroom production (A low cost technology).

**UNIT-3. CULTIVATION, STORAGE AND DISEASES.**

- 3.1 Cultivation of *Volvariella volvacea*, *Pleurotus citrinopileatus*.
- 3.2 Cultivation of *Calocybe indica*. *Agaricus bisporus*.
- 3.3 Shelf life of mushrooms, Short-term storage (Refrigeration – upto 24 hours), Long term storage (canning, pickles, papads), drying, storage in salt solutions.
- 3.4 Diseases, infections and pests of mushrooms (Pre and Post harvest).

**UNIT-4. NUTRITIONAL VALUE, FOOD PREPARATION AND PROSPECTS.**

- 4.1 Composition and Nutritional value- elemental nutrition and Proximate value- Proteins, amino acids, carbohydrates, Fats, crude fibre content, vitamins.

- 4.2 Types of foods prepared from mushroom.
- 4.3 Cost benefit ratio – marketing in India and abroad, Export value.
- 4.4 Prospects of round the year cultivation of mushrooms.

## **UNIT-5. RESEARCH, FUTURE PROSPECTIVE SAND CHALLENGES.**

- 5.1 Research Centres- National level and Regional level.
- 5.2 Scope of mushroom cultivation for rural upliftment.
- 5.3 Educational objective for designing mushroom training programmes.
- 5.4 Challenges to mushroom cultivation Technology.

### **Pattern of examination (Internal)**

#### **I. End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

**The question paper will have 3 sections.**

**Section I: Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)**

**Section II: Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)**

**Section III: Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.**

#### **II. Assessment Test (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

#### **Suggested readings:**

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

**BOTANY**  
**(Semester-VI)**  
**(For examinations to be held in the years May 2019, 2020, 2021)**  
**DISCIPLINE SPECIFIC ELECTIVE**

**Course No: UBOTE601**  
**Duration of Exam: 2.5hrs**

**Title: Economic Botany and Biotechnology (Theory)**  
**Maximum Marks: 100**

**Credits: 04**

**External Examination: 80 Marks**  
**Internal Assessment: 20 Marks**

***Objectives:***

*The course is designed to make students aware of the conventional use of biological diversity in terms of the proper utilization of plant parts. An attempt is being made to impart students the training of using tissue culture tools and biotechnological techniques in the utilization as well as improvement of crops.*

**Unit-I Utilization of Plants**

- 1.1 Food plants: Origin of wheat, maize and rice and their cultivation in India.
- 1.2 Fibres: Cultivation and processing of cotton and jute.
- 1.3 Non-alcoholic beverages: Botany and processing of tea and coffee.
- 1.4 Spices and condiments: Botany and utility of asafoetida, cumin, fennel, coriander, cloves, cinnamon, ginger, turmeric and cardamom.

**Unit- II Utilization of Plants- Oil crops, timber yielding and medicinal plants**

- 2.1 Vegetable oils: Botany, cultivation and utilization of groundnut, mustard and coconut.
- 2.2 Major firewood and timber yielding plants of J&K state and their utilization.
- 2.3 Medicinal plants of J&K state: a general account.
- 2.4 Sources, extraction and processing of commercial rubber.

**Unit-III. Utilization of plants-Pulses, fruits and vegetables**

- 3.1 Pulses (rajmash, pea and urd) - their cultivation and utilization.
- 3.2 Vegetables (cauliflower, bottle gourd, fenugreek, ladyfinger and spinach) – their cultivation and utilization.
- 3.3 Fruits (apple, mango, peach, walnut, apricot and almond) - their cultivation and utilization.

3.4 Indoor and outdoor ornamentals; their cultivation and maintenance.

#### **Unit-IV Plant Tissue Culture**

- 4.1 Basic concepts of plant tissue culture, cellular totipotency, differentiation and morphogenesis, protoplast fusion.
- 4.2 Micropropagation- concept and techniques; haploid production through androgenesis and gynogenesis.
- 4.3 Somatic embryogenesis; Methods of formation of somatic embryos and factors affecting their production; synthetic seeds.
- 4.4 Somaclonal variations and factors underlying their generation; advantages of somaclonal variants.

#### **Unit-V Plant Biotechnology**

- 5.1 Concept of biotechnology, recombinant DNA technology and gene cloning; restriction endonucleases, Agarose gel electrophoresis, Southern blotting; genomic and cDNA libraries.
- 5.2 Salient features of cloning vectors – plasmids, bacteriophages and cosmids; Biology of *Agrobacterium* vectors for gene delivery.
- 5.3 Polymerase chain reaction; Mechanism and applications.
- 5.4 Salient achievements in crop biotechnology; transgenic plants – a general account.

#### **Note for paper setters**

**External End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

**The question paper will have 3 sections.**

**Section I:** Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)

**Section II:** Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)

**Section III:** Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.

**Internal Assessment (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

## Suggested Readings

17. Bhojwani, S.S. 1990. Plant Tissue Culture: Applications and Limitations. Elsevier Science Publishers, New York, USA.
18. Bhojwani, S.S. and Razdan, M.K. 2005. Plant Tissue Culture: Theory and Practice. Revised Edn. Elsevier Science Publication, The Netherlands.
19. Hartmann, H.T. and Kestler, D.E. 1976. Plant Propagation: Principles and Practices. 3<sup>rd</sup> Edn., Prentice Hall of India Pvt. Ltd. New Delhi.
20. Brown, T.A. 2010. Genomes. John Wiley and Sons (Asia) Pvt. Ltd.
21. Primrose, S. B. 1995. Principles of Genome Analysis. Blackwell Scientific Publishers, Oxford UK.
22. Glick, B.R., Pasternak J.J. and Patten, C.L. 2010. Molecular Biotechnology: Principles and Applications of Recombinant DNA. 4<sup>th</sup> Edn. ASM Press Washington, DC.
23. Old, R.W. and Primrose, S.B. 1989. Principles of Gene Manipulation. Blackwell Scientific Publications, Oxford, UK.
24. Vasil, I.K. and Thorpe, T.A. 1994. Plant Cell and Tissue Culture. Kluwer Academic Publishers. The Netherlands.
25. Raghvan, V. 1986. Embryogenesis in Angiosperms: A Developmental and Experimental Study. Cambridge University Press, New York, USA
26. Raghvan, V. 1997. Molecular Biology of Flowering Plants. Cambridge University Press, New York, USA.
27. Collin H.A. and Edwards, S. 1998. Plant Cell Culture: Introduction to Biotechniques. BIOS Scientific Publishers Ltd. UK.
28. Das, H.K. 2007. Textbook of Biotechnology. 3<sup>rd</sup> Edn. Wiley India Pvt. Ltd. U.P., India.
29. Razdan, M.K. 2000. An Introduction to Plant Tissue Culture. Oxford and IBH
- Salisbury, F.B. and Ross, C.W. 1992. Plant Physiology. Wadsworth Publication Co. California, USA.
30. Sambamurthy, A.V. S.S. and Subramanyam, N.S. 1989. A textbook of Economic Botany. Wiley Eastern Ltd. New Delhi.
31. Sharma, O.P. 1996. Hills Economic Botany. (Late Dr. A.F. Hill, Adapted by Dr. O.P.Sharma), Tata McGraw Hill Co. Ltd. New Delhi.
32. Simpson, B.B. and Conner Ogorzaly, M. 1986. Economic Botany- Plants in Our World, McGraw Hill, New York.
33. Kochar, S. L. 1998. Economic Botany in Tropics. 2<sup>nd</sup> edition. Macmillan India Ltd. New Delhi.

**BOTANY**  
**(Semester-VI)**

**(For examinations to be held in the years May 2019, 2020, 2021)**

**Course No: UBOTE602**  
**Duration of Exam: 3 hrs**

**Title: Economic Botany and Biotechnology (Practical)**  
**Maximum Marks: 50**

**Credits: 02**

**External Examination: 25 Marks**  
**Internal Assessment: 25 Marks**

1. Study of the morphology, structure and simple microchemical tests of the food storing tissues in rice, wheat, maize, potato and sugarcane. Microscopic examination of starch in these plants (except sugarcane).
2. Study of cotton flowers, sectioning of the cotton ovules/developing seeds to trace the origin and development of cotton fibres. Microscopic study of cotton and test for cellulose. Sectioning and staining of Jute stem to show the location and development of fibres, Microscopic structure. Tests for ligno-cellulose.
3. Study of hand sections of groundnut, mustard and coconut and staining of oil droplets by Sudan III and Sudan Black.
4. To study sources of firewood yielding trees (10) and bamboos. A list to be prepared mentioning special features.
5. Examine black pepper, cloves, cinnamon (hand sections) and opened fruits of cardamom and describe them briefly.
6. Preparation of an illustrated Inventory of 10 wild and locally available medicinal plants used in indigenous systems of medicine or allopathy. Write their botanical and common names, parts used and diseases/disorders for which they are prescribed.
7. Section various pulses and from temporary mounts work out the various cellular inclusions.
8. Study the structure and types of various fruits and vegetables.
9. Demonstrate media preparation for culturing plant tissues.
10. Demonstration of the technique of micropropagation by using different explants e.g. axillary buds, shoot meristems.
11. Demonstration of the technique of anther culture.

**Note for distribution of 50 Marks in Practical Examination ( 50% internal and 50% external)**

**I. Internal Assessment**

- |  |   |          |
|--|---|----------|
| 1. Attendance                                      | : | 5 Marks  |
| 2. Practical Test:                                 |   | 5 Marks  |
| 3. Daily performance based on practical work done: |   | 10 Marks |
| 4. Viva-voce                                       |   | 5 Marks  |

**II. External Assessment**

- |                                   |  |          |
|-----------------------------------|--|----------|
| 7. External practical examination |  | 20 Marks |
| 8. Viva-voce                      |  | 5 Marks  |



**BOTANY**  
**(Semester-VI)**  
**(For examinations to be held in the years May 2019, 2020, 2021)**  
SKILL ENHANCEMENT COURSE

**Course No: UBOTS 603**                      **Title: BIOFERTILIZERS (Theory)**  
**Duration of Exam: 2.5 hours**           **Maximum Marks: 100**

**Credits: 04**                                      **End Semester Examination: 80 Marks**  
**Assessment Test: 20 Marks**

**Unit-I**

- 1.1 Biofertilizers: definition, different sources and importance.
- 1.2 Biological nitrogen fixation, symbiotic and asymbiotic.
- 1.3 General account of the microbes commonly used as biofertilizers.
- 1.3 *Rhizobium*- infection and nodulation, isolation and mass multiplication.

**Unit-II**

- 2.1 *Azospirillum*: isolation, important characteristics and mass multiplication.
- 2.2 *Azotobacter*: Isolation, important characteristics and mass multiplication.
- 2.3 Manures: definition, types and their importance.
- 2.4 Preparations of green manure, its features and importance.

**Unit-III**

- 3.1 Cyanobacteria: cell structure and characteristic features.
- 3.2 Forms of cyanobacteria: unicellular, filamentous; heterocystous and non-heterocystous forms.
- 3.3 Site of nitrogen fixation: heterocyst and importance of Nitrogenase.
- 3.4 Importance of Cyanobacteria and *Azolla* in rice cultivation.

**Unit-IV**

- 4.1 Mycorrhizae and its types.
- 4.2 Ectomycorrhizae-host diversity and importance.
- 4.3 Endomycorrhizae-host diversity and importance.
- 4.4 General application of VAM in agriculture.

**Unit-V**

- 5.1 Concept, types and importance of vermin-composting.
- 5.2 Methods of vermi-compositing; General layout of vermi-compost unit.
- 5.3 Recycling of bio-degradable municipal, agricultural and Industrial wastes.
- 5.4 Bio-compost preparation: methods, compositions, sources and applications.

**Pattern of examination (Internal)**

**I. End Semester Examination (Total marks: 80) Time duration: 2 hrs 30 min**

**The question paper will have 3 sections.**

**Section I: Five (5) short answer questions representing all units i.e at least one from each unit (without detailed explanation having 70-80 words) of 3 marks each = 15 marks (All compulsory)**

**Section II: Five (5) medium answer questions (with explanation having 250-300 words) of 7 marks each = 35 marks (All compulsory)**

**Section III: Five (5) long answer questions (with detailed explanation/ of 500-600 words) covering all the units. The candidate will be required to answer only two questions of 15 marks each = 30 marks.**

**II. Assessment Test (Total Marks: 20) Time duration: 1 hr.**

**The internal assessment under CBCS shall comprise of two parts**

**Part A: Total weightage to this part shall be 10 marks.** It will have eight short answer questions, selecting at least three from each of the two/three units/50% of the syllabus covered. A candidate has to attempt any five questions of two marks each.

**Part B: Total weightage to this part shall be 10 marks.** It will have two long answer questions, selecting at one each from first two/three units/50% of the syllabus covered. A candidate has to attempt any one question of 10 marks.

**Suggested Readings**

- Robert L Tate (2012). Soil Microbiology. Wiley India Pvt Ltd; Second edition PP 532
- Atlast Bartha (1998) Microbial Ecology: Fundamentals and applications. Benjamin/Cummings, (4<sup>th</sup> edition)
- D.K.Das (2002). Introduction to Soil Science. Kalyani Publisher 3<sup>rd</sup> edition.
- E. Russel (2010) Soil Conditions and Plant Growth Nabu Press Publisher
- S.K.Mukerjee. (2006) An Introduction to Soil Science. Tata Mcgraw Hills
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- L.F. Diaz, M. de Bertoldi, W. Bidlingmaier (Eds.) (2007). Compost Science and Technology, Elsevier, new York
- W.S. Subbha Rao (1982). Biofertilizers in Agriculture and Forestry. Oxford and IBH Publishing Co., New Delhi.
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- H.L.S. Tandon. Fertilizers, Organic Manures, Recyclable Wastes and Biofertilizers.
- A.C. Gaur (1990) Phosphate Solubilities, Micro-organisms and Biofertilizers.. Oxford and IBH Publishing Co. New Delhi.
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- Sathe, T.V. (2004). Vermiculture and organic Farming. Daya Publishers,
- Nadiad Vayas, S.C. Vayas, S. and Modi, H.A. Biofertilizers and organic Farming Akta Prakashan