

**M. Sc. IN PHYTOMEDICAL SCIENCE AND TECHNOLOGY  
(FACULTY OF SCIENCE)**

**01. SYLLABUS**

Detailed syllabus please refer appendix 1

**02. SCHEME OF INSTRUCTION**

<b>CODE</b>	<b>SEMESTER</b>	<b>TITLE</b>	<b>MARKS</b>
PHYTOM 01	1	Systematic Botany, Biodiversity and Economic botany	100
PHYTOM 02	1	Medicinal and Aromatic plants: Conservation, Cultivation and Management	100
PHYTOM 03	1	Introduction to Traditional and Modern Systems of Medicine	100
PHYTOM P 01	1	PRACTICALS	100
PHYTOM 04	2	Principles of Management	100
PHYTOM 05	2	Plant Physiology, Biochemistry and Ecology	100
PHYTOM 06	2	Microbiology and Plant Molecular Biology	100
PHYTOM P 02	2	PRACTICALS	100
PHYTOM 07	3	Cell Biology and Biotechnology	100
PHYTOM 08	3	Phytochemistry	100
PHYTOM 09	3	Pharmacognosy	100
PHYTOM P 03	3	PRACTICALS	100
PHYTOM 10	4	Pharmacology, Clinical trial and Biostatistics	100

PHYTOM 11	4	Product development, Quality control and IPR	100
PHYTOM 12	4	Business plan and Entrepreneurship development	100
PHYTOM D	4	PROJECT/DISSERTATION	100
PHYTOM V	4	VIVA VOCE	100
<b>TOTAL MARKS</b>		<b>1700</b>	

**Practical:** Schedules for practical work shall be based on the syllabus of the theory papers.

**Fieldwork:** Fieldwork including visit to important areas [institutions and floristic areas] related to the subject.

### 03. SCHEME OF EXAMINATION

Code	Title	External exam	Internal assessment	Marks
<b>SEMESTER 01</b>				
PHYTOM 01	Systematic Botany, Biodiversity and Economic botany	75	25	100
PHYTOM 02	Medicinal and Aromatic plants: Conservation, Cultivation and Management	75	25	100
PHYTOM 03	Introduction to Traditional and Modern Systems of Medicine	75	25	100
PHYTOM-P 01	PRACTICALS	75	25	100
<b>TOTAL MARKS IN SEMESTER - 1</b>		<b>300</b>	<b>100</b>	<b>400</b>
<b>SEMESTER 02</b>				
PHYTOM 04	Principles of Management	75	25	100
PHYTOM 05	Plant Physiology, Biochemistry and Ecology	75	25	100
PHYTOM 06	Microbiology and Plant Molecular Biology	75	25	100

PHYTOM-P 02	PRACTICALS	75	25	100
<b>TOTAL MARKS IN SEMESTER- 2</b>		<b>300</b>	<b>100</b>	<b>400</b>
<b>SEMESTER 03</b>				
PHYTOM 07	Cell Biology and Biotechnology	75	25	100
PHYTOM 08	Phytochemistry	75	25	100
PHYTOM 09	Pharmacognosy	75	25	100
PHYTOM P-03	PRACTICALS	75	25	100
<b>TOTAL MARKS IN SEMESTER- 3</b>		<b>300</b>	<b>100</b>	<b>400</b>
<b>SEMESTER 04</b>				
PHYTOM 10	Pharmacology, Clinical trial and Biostatistics	75	25	100
PHYTOM 11	Product development, Quality control and IPR	75	25	100
PHYTOM 12	Business plan and Entrepreneurship development	75	25	100
PHYTOM-D	PROJECT/DISSERTATION	100		100
PHYTOM-V	VIVA VOCE	100		100
<b>TOTAL MARKS IN SEMESTER- 4</b>		<b>425</b>	<b>75</b>	<b>500</b>
<b>TOTAL MARKS</b>				<b>1700</b>

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**DETAILED SYLLABUS**

**SEMESTER 01**

**PHYTOM 01**

**SYSTEMATIC BOTANY, BIODIVERSITY AND ECONOMIC BOTANY (100 hrs)**

- 1. Taxonomy and systematics:** Concepts and taxonomic characters: taxa and taxonomic hierarchy; Systems of classification: artificial, natural and phylogenetic systems; Classification systems of Bentham and Hooker, Engler and Prantle, Hutchinson, and Bessey; Taxonomic evidence: morphology, anatomy, embryology, palynology, cytology and micromorphology; Chemotaxonomy; Variation and speciation; Phylogeny of angiosperms, phylogenetic reconstruction **(45 hrs)**
- 2. Organizations for systematic studies and taxonomic literature:** Botanical specimen collection, herbarium preparation; Important herbaria and botanical gardens; Botanical Survey of India; Floras, monographs, revisions, keys, indices, and glossaries **(10 hrs)**
- 3. Plant nomenclature:** Binomial system; Need for scientific names; Principles of ICBN; Type method; Publication of names: conservation, retention and rejection of names, Principle of Priority **(10 hrs)**
- 4. Biodiversity:** Biodiversity concepts and definitions; Genetic diversity, species diversity and ecosystem diversity; Agro biodiversity and cultivated taxa; Loss of biodiversity, factors causing biodiversity loss; Red Data book and Red Lists; Conservation of biodiversity: *in situ* conservation, protected areas-biosphere reserves and national parks, homestead gardens and sacred groves; *ex situ* conservation, botanic gardens seed banks, field gene banks; *in vitro* conservation methods; Biodiversity legislation and conventions, international biodiversity laws, Convention on Biological Diversity, Agenda

21, national legislation, Biodiversity Act; Economic value of biodiversity; Trade restrictions; Economic, legal and ethical issues of biodiversity **(20 hrs)**

- 5. Economic Botany:** Plant products and their importance to mankind; Origin and distribution of food plants; Cereals, legumes and nuts, vegetables, fruit plants; Spices and condiments; Fatty oils and waxes; Essential oils; Forest products: timber, Non-wood forest products- gums, resins; honey, dyes and pigments, etc. **(15 hrs)**

**References:**

- Briggs, D. and Walters, S.M. 1997. *Plant Variation and Evolution*, 3<sup>rd</sup> ed., Cambridge University Press, Cambridge.
- Davis, P.H. and Heywood, V.H. 1963. *Principles of Angiosperm Taxonomy*. Oliver and Boyd, Edinburgh.
- Jones, P.G and Sutton, J.M. 1997. *Plant Molecular Biology: Essential techniques*. John Wiley & Sons, New York.
- Krishnamurthy, K.V. 2003. *An Advanced Text Book of Biodiversity: Principles and Practice*. Oxford IBH Pub. Pvt. Ltd., New Delhi
- Melchias, G. 2001. *Biodiversity and Conservation*. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi
- Nayar, M.P. 1992. *Hot spots of Endemic Plants of India, Nepal and Bhutan*. Tropical Botanic Garden and Research Institute, Thiruvananthapuram
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- Radford, A.E., Dickison, W.C. Massey J.R and Bell, C.R. 1974. *Vascular Plant Systematics*. Harper and Row Publishers, New York.
- Rao, C.K., Geetha, B.L. and Geetha Suresh. 2003. *Red List of Threatened Vascular Plant Species in India*. ENVIS, Botanical Survey of India, Ministry of Environment and Forests, New Delhi

- Swaminathan, M.S. and Jana, S. (Eds.). 1992. *Biodiversity: Implications for Global Food Security*. Macmillan India Ltd., Chennai
- Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*. Oxford & IBH Pub. Co. Pvt. Ltd., New Delhi
- Sivarajan, V.V. 1991. *Introduction to Principles of Plant Taxonomy* (2<sup>nd</sup> ed). Edward Arnold, London.
- Wills, J.C. 1973. *A Dictionary of the Flowering Plants and Ferns* (8<sup>th</sup> ed), revised by Airy-Sahw, H.K. Cambridge University Press, Cambridge.

## **PHYTOM 02:**

### **MEDICINAL AND AROMATIC PLANTS: CONSERVATION, CULTIVATION AND MANAGEMENT (100 Hrs)**

- 1. Medicinal and Aromatic plants:** Important medicinal and aromatic plants of India; Non-angiosperm medicinal and aromatic plants (bacteria, fungi, algae, lichens, bryophytes and gymnosperms); Problems of overexploitation and deforestation; Rare and endangered species of medicinal and aromatic plants; Policies for their conservation, regeneration and sustainable use; Medicinal Plant Specialist Group of Species Survival Commission (IUCN) **(10 hrs)**
- 2. History and status of medicinal plant cultivation in India (3hrs)**
- 3. Fundamentals of cultivation:** Agro climatic zones of India; Soil: components, types, physical and chemical properties, fertility and productivity, management and maintenance; Cultivation of medicinal plants: season and time, selection and preparation of land for cultivation, tillage (different types), planting density, planting patterns; Methods of propagation: sexual and asexual (vegetative, budding, grafting, layering) **(27 hrs)**
- 4. Plant hybridization:** Conventional methods of hybridization: inbreeding and out breeding crops, hybrid vigour, role of human in the selection and production of new varieties of crops; Mutation breeding: spontaneous and induced mutations; physical and chemical mutagens; role of mutation breeding in the production of new varieties of crops **(8 hrs)**

5. **General management:** Irrigation: requirement, methods and time, irrigation efficiency, drainage; Mineral nutrition of plants: organic manures and fertilizers, mode and time of fertilizer application, fertilizer dosage calculation; Growth regulators; Weeds: methods of weed control **(10 hrs)**
  
6. **Principles of crop protection:** Diseases: cause of plant diseases (brief account of fungi, bacteria and viruses), classification of plant diseases and their symptoms; Plant disease management: principles and control measures such as physical, cultural, biological and chemical methods; Pests: different types and important groups of insects and pests, their mode of attack and control measures (physical, mechanical, chemical, biological and cultural); Integrated disease and pest management **(30 hrs)**
  
7. **Harvesting:** Pre and post harvest treatments; Yield analysis; Cost-benefit analysis; authentic suppliers of seeds and planting materials **(10 hrs)**
  
8. **References of Vrukshayurveda (2 hrs)**

## References

- Ambasta, S.P. (ed) 1988. *The useful plants of India*. CSIR, New Delhi
  
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- CSIR. 1971. *The Wealth of India*. Vol. A-Z. Council for Industrial and Scientific Research, New Delhi
  
- Dillon, B.S., Tyagi, R.K., Lal, A. and Saxena, S. (Eds.). 2004. *Plant Genetic Resources Management*. Narosa Pub. House, New Delhi
  
- Farooqui, A.A., Khan, M.M. and Sreeramu, B.S. 1997. *Cultivation of Medicinal and Aromatic Crops in India*. Naya Prakash, Kolkatta
  
- Kameswara Rao, C.2000. *Database of medicinal plants*. KSCST, Bangalore
  
- Honda, S.S. and Kaul, M.K. 1996. *Cultivation and Utilization of Medicinal Plants*. RRL, Jamu.

- Hurtmann, H.T., Kester, D.E., Davies, F.T. and Geneva, R.L. 2004. *Plant Propagation: Principle and Practice*. Prentice-Hall of India, New Delhi
- ICAR. 2003. *Handbook of Agriculture*. Indian Council Agricultural Research, New Delhi
- Nair, C.K.N. and Mohanan, N. *Medicinal Plants of India*. Nag Publishers, Delhi
- Nehra, S. 2005. *Plant Diseases: Biocontrol and Management*. Aavishkar Publishers and Distributors, Jaipur
- Pearce, D. and Moran, D. 1994. *The economic value of biodiversity*. Earthscan Pub., London
- Prajapati, N.S., Purohit, S.S., Sharma, A.K. and Kumar, T. 2003. *A Handbook of Medicinal Plants*. Agrobios-India.
- Pushpangadan, P. and Nair, K.N. 1997. Medicinal Plants. In: *The Natural Resources of Kerala*. K. Balachandran Thampi *et al.* (Eds.), World Wide Fund for Nature-India, Kerala Chapter, Thiruvananthapuram.
- Reddy, T.Y. and Reddy, G.H.S. 2005. *Principles of Agronomy*. Kalyani Publishers, New Delhi.
- Sharma J.R. 1994. *Principles and Practice of Plant Breeding*. Tata McGraw-Hill Publishing Co.Ltd, New Delhi
- Sharma, R. 2004. *Agrotechniques of Medicinal Plants*. Daya Publishing House, Delhi
- Singh, R.S. 1984. *Introduction to Principles of Plant Pathology*. Oxford & IBH Publishing Co. Pvt. Ltd., New Delhi
- Sivarajan, V.V. and Indira Balachandran. 1988. *Ayurvedic Drugs and Their Plant Sources*. Oxford and IBH Pub. Co. Pvt. Ltd., New Delhi.
- Trivedi, P.C. 2004. *Medicinal Plants: Utilization and Conservation*. Aavishkar Publishers and Distributors, Jaipur



## **PHYTOM 03**

### **INTRODUCTION TO TRADITIONAL AND MODERN SYSTEMS OF MEDICINE (100 hrs)**

1. **Herbs and healing:** Historical perspectives: local, national and global level; Herbal cultures: origin and development of human civilizations; Ethnobotany and Ethnomedicine; Development of European, South and Central American, African, Indian, Chinese, and South East Asian Herbal Cultures **(15 hrs)**
2. **Classical health traditions:** Systems of medicine: origin and development of biomedicine; Indian Systems of Medicine (*Ayurveda, Siddha, Unani, Tibetan*) *Ayurveda:* Historical perspective, *Swasthavritta* (measures to be adopted for maintaining the health of healthy person in a positive way through prevention, promotion and correction), *Athurvritta* (disease management and treatment which involves eight specialties including Internal medicine and Surgery); Fundamental principles of *Ayurveda: Panchabhootha* theory, *Thridosha* theory, *Saptadhatu* theory and *Mala* theory; Ayurvedic Pharmacology, Ayurvedic Pharmacopoeia; *Mrigayurveda* and *Vrikshayurveda* **(25 hrs)**
3. **Local health traditions:** Symbiotic relationship between Classical health tradition and Local health tradition; Contemporary relevance of Local health traditions/Oral health traditions, primary health care and local health traditions, homestead level of medicinal plant garden for conservation and utilization of medicinal plants; Scientific documentation of traditional/indigenous knowledge related to plants used for healthcare **(25 hrs)**
4. **Concept of health and disease:** A comparative account of (a) concept of health and disease (b) principles of prevention and treatment of disease and (c) health care in Ayurveda, Sidha, Unani and Homoeopathy **(5 hrs)**
5. **Cross cultural influences:** Mutual influences of Ayurveda, Tibetan Medicine; Chinese Medicine, South American herbal medicine, Homoeopathy and Biomedicine; benefits of integration of ideas and material **(10 hrs)**
6. **Dietetics and supportive therapies:** Role of diet in health and disease; *pathya, apathya, anupana*; therapeutic and nutritive value of Indian foods; Fermentation techniques and development of self generated alcoholic drinks; role of Raw Juice Therapy, Aromatherapy, Bach's flower remedies, Naturopathy, Hydrotherapy and Yoga in health care **(10 hrs)**
7. **Cultural, Social and economic issues in health and disease:** Causes for the decline and the current revival of interest in indigenous systems of medicine; a comparative

evaluation of accessibility, benefits and costs of different systems of medicine; the relevance of herbal medicine as health care package for the masses in the 21<sup>st</sup> Century  
(10 hrs)

#### References:

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- Chancellor, P.M. 1971. *Handbook of the Bach flower remedies*. Saffron Waldon, Essex.
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- Keys, J.D. 1976. *Chinese herbs*. CE Tuttle Co., Tokyo.
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- Available Classical Ayurvedic Text books: *Charaka Samhita, Susrutha Samhita, Ashtanga Hridaya*.
- Other available Ayurvedic Text books: *Sarngadhara Samhita, Bhava Prakasha*, etc.

## PHYTOM-P 01

### **PRACTICALS (based on *Phytom 01 to Phytom 03*) (150 hrs)**

1. **Medicinal plant resources:** Field exploration; Collection and preservation of plant specimens; Preparation of herbarium (50 sheets)

**Plant morphology:** Morphological description of plants; **Habit:** ephemeral/annual/biennial herbs, herbaceous perennials, creepers, trailers, climbers, twiners, woody perennials, shrubs, lianas, trees; **Root:** Taproot, adventitious roots, aerial roots, assimilatory roots, fibrous roots; tuberous roots; prop roots, stilt roots; **Stem:** nodes, internodes and buds; phylloclades and cladodes; stem thorns and tendrils; rhizome, corm, tuber and bulb, bulbils and pseudobulbils; **Leaf:** leaves, stipules; phyllodes; Phyllotaxy: alternate, opposite, whorled; Leaf forms: shape, margin, apex, surface, texture, venation; Types of leaves: simple leaves, pinnately compound leaves and palmately compound leaves; Leaf modifications: scale leaves, phyllode, leaf tendrils; **Inflorescence:** Inflorescence types: racemose, cymose and specialized types; **Flower:** unisexual and bisexual flowers; complete and incomplete flowers; actinomorphic and zygomorphic; bractiate and ebractiate; pedicellate and sessile; hypogynous, perigynous and epigynous; pentamerous, tetramerous, cyclic and spirocyclic; **Calyx:** polysepalous and gamosepalous; caduceus, deciduous and persistent; **Corolla:** polypetalous and gamopetalous; **Aestivation:** valvate, twisted, imbricate, quincuncial and vexillary; **Androecium:** polyandrous, monadelphous, diadelphous, syngenesious, epipetalous, synandrous; didynamous, tetradidynamous, diplostemonous, obdiplostemonous; basifixed, adnate, dorsifixed and versatile; **Gynoecium:** monocarpellary, bicarpellary, tricarpellary, tetracarpellary, pentacarpellary and multicarpellary; unilocular, bilocular, trilocular, tetralocular, pentalocular and multilocular; apocarpous and syncarpous; **Placentation:** marginal, parietal, axile, free central, basal, superficial; **Ovule:** orthotropous, anatropous, campylotropous and amphitropous; **Fruits:** follicle, legume or pod, siliqua, capsule; dry indehiscent fruit: drupe, berry, pepo and pome; aggregate fruit; multiple (composite) fruit: sorosis and synconium; **Floral formula and floral diagram**

2. **Selected families of flowering plants:** Acanthaceae, Amaranthaceae, Anacardiaceae, Apiaceae, Apocynaceae, Araceae, Aristolochiaceae, Asclepiadaceae, Asteraceae, Capparaceae, Clusiaceae, Combretaceae, Convolvulaceae, Cucurbitaceae, Cyperaceae, Dipterocarpaceae, Euphorbiaceae, Fabaceae, Lamiaceae, Lauraceae, Liliaceae, Malvaceae, Meliaceae, Moraceae, Myrtaceae, Nyctaginaceae, Orchidaceae, Poaceae, Ranunculaceae, Rubiaceae, Rutaceae, Scrophulariaceae, Solanaceae, Verbenaceae, Zingiberaceae.

3. **Soil analysis:** Soil sampling; Determination of soil moisture, pH, water holding capacity, field capacity; Estimation of organic carbon, carbonate, bicarbonate, calcium, magnesium, chloride, nitrogen, phosphorus and potassium.
4. **Field trial (agrotechnology) for important medicinal plants.**

## **SEMESTER 02**

### **PHYTOM 04**

#### **PRINCIPLES OF MANAGEMENT (100 hrs)**

1. **General Management:** Introduction, significance and definition of management, Administration vs management, Functions of management: planning, organizing, staffing, directing and controlling, Levels of management, Managerial skills, motivation, communication, decision making **(15 hrs)**
2. **Forms of business organization:** Sole ownership, joint stock company, advantages and limitations and salient features of each, cooperatives, private and public companies, government companies **(10 hrs)**
3. **Organization:** Basic principles of organization: responsibility and authority, delegation and control, coordination, span of control, **(10 hrs)**
4. **Management structure:** line and staff and functional relationships, use of committees **(5 hrs)**
1. **Management Theories:** Henri Fayol's principles of management, Taylor's scientific management, Max Weber's theory of bureaucracy; human relations approach; Hawthorne studies, behavioral sciences and quantitative approaches **(15 hrs)**
5. **Personnel Management:** Recruitment, sources, selection procedure, various stages, different types of employment tests, interviewing techniques, placement, transfers and promotions, exit interviews **(15 hrs)**
2. **Marketing management:** Sales vs marketing, functions of marketing, market research, sales promotion, and advertising **(10 hrs)**
3. **Training and development:** Types of training, methods of training, management development, on & off the job training, performance appraisal **(10 hrs)**

- 4. Financial management:** Objectives, financial planning, functions of finance managers, sources of industrial finance **(10 hrs)**

## References

- Chhabra, T.N. 2002. *Principles and Practice of Management*. Dhanpat Rai and Co. Pvt. Ltd., Delhi
- Koontz, H. and Weihrich, H. 1998. *Essentials of management*. Tata McGraw Hill Pub. Co. Pvt. Ltd., New Delhi
- Massie Joseph, L. 2000. *Essentials of Management* (4<sup>th</sup> ed.). Prentice Hall of India Pvt. Ltd., New Delhi
- Singh, B.P., Chhabra, T.N. and Taneja, P.L. 2001. *Personnel management and Industrial Relations*. Dhanpat Rai and Co. Pvt. Ltd., Delhi
- Terry, G.R. and Franklin, S.G. 2000. *Principles of Management*. (8<sup>th</sup> ed.). AITBS Publishers and Distributors, Delhi
- Weihrich, H. and Koontz, H. 2001. *Management: A Global Perspective*. Tata McGraw Hill Pub. Co. Pvt. Ltd., New Delhi

## PHYTOM 05

### **PLANT PHYSIOLOGY, BIOCHEMISTRY AND ECOLOGY (100 hrs)**

- 1. Nutrition and transport and storage:** Inorganic and organic nutrient requirement, mineral deficiency; Transport of water and solutes in plant body, role of membranes in transport, water balance, transpiration, accumulation and storage of organic compounds in plant tissues; Growth and development: chemical regulation, centers of growth, cell differentiation and morphogenesis; physiology of reproduction; Seed germination, seed viability, seed dormancy, seed vigour and longevity, factors affecting seed quality, seed testing and certification **(15 hrs)**
- 2. Physiological improvement of plants:** Physiological efficiency of target characteristics for improvement (salt tolerance, draught and flood resistance, low and high

temperature tolerance, pest and pathogens resistance, herbicide resistance, photoperiodism, nitrogen fixation, enhanced nutritional value, shelf life.) **(10 hrs)**

3. **Phyto-hormones:** Chemical structure, synthesis, translocation; Mode of action and physiological effects of growth regulators and inhibitors: Auxins, cytokinins, giberellines, ethylene and abscissic acid **(8 hrs)**
4. **Bioinorganic and organic compounds:** Distribution and role of elements and inorganic compounds in plants; General classification and basic molecular structure of phenolic compounds, terpenes and terpenoids; their biosynthesis, and degradation, function and distribution in plants **(15 hrs)**
5. **Chemistry of biological molecules:** Structure and classification of Carbohydrates (monosaccharides, oligosaccharides and polysaccharides), Lipids (fatty acids, triglycerides, fats and oils), Nucleic acids, Amino acids and Proteins (classification of proteins, primary, secondary, tertiary and quaternary structure of proteins); nature of peptides; Enzymes: catalytic activity protein enzymes and ribozymes, structure of enzymes, nomenclature and classification isozymes and allozymes, cofactors, enzymes kinetics, regulatory role of enzymes in metabolism; purification and characterization **(15 hrs)**.
6. **Photosynthesis:** Pigments: chlorophyll, carotenoids, xanthophylls; Photo-phosphorylation; CO<sub>2</sub> fixation, Calvin cycle, Hatch-slack pathway; Photo-respiration and C<sub>3</sub> and C<sub>4</sub> pathways; Spectra of electromagnetic radiation and biologically significant wavelengths, electron transport, energy relation in photosynthesis, aerobic oxidation of sugars and secondary oxidative mechanisms **(15 hrs)**
7. **Introduction to Ecology:** Definition and scope of Ecology; Ecosystem: concept of ecosystem, significance of habitat, trophic levels, primary and secondary productivity; Population: population characteristics, population growth, biotic potential, factors affecting population growth, carrying capacity; Community ecology: classification of communities, qualitative, quantitative and synthetic characteristics **(12 hrs)**
8. **Phytogeography:** Principles governing plant distribution; Phyto-geographic regions of the world and India; Adaptation; Speciation and extinction; Native, naturalized and exotic taxa; Endemism: Concept of endemism, endemic flora; Rarity: Rare, endangered and threatened category (IUCN) species **(10 hrs)**

#### References:

- Anderson, J.W. and Beardall, J. 1991. *Molecular Activities of Plant Cells*, Blackwell Scientific Publication, Oxford

- Clarke, G.L. 1954. *Elements of Ecology*. John Wiley Publ., London
- Copeland, L.O. and McDonald. M.B. 1995. *Principles of Seed Science and Technology* 3<sup>rd</sup> ed Chapman & Hall New York
- Dennis, D.T and Turpin D.H. (ed). 1990. *Plant physiology, Biochemistry and Molecular biology*, Longman Scientific and Technical Essex
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- Odum, E.P. 1991. *Fundamentals of Ecology* (3<sup>rd</sup> ed). Saunders & Co., Philadelphia.
- Postage, J. 1998. *Nitrogen fixation* (3<sup>rd</sup> ed) Cambridge University Press Cambridge.
- Price, N.C. and Stevens, L. 1989. *Fundamentals of enzymology*. Oxford University Press Oxford
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- Taiz, I. and Zeiger, E. 1999. *Plant Physiology*. The Benjamin/comings publishing Co., Redwood City, USA
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- Walker J.M. and Gingold, E.B. 1993. *Molecular biology and Biotechnology* 3<sup>rd</sup> ed Royal Society of Chemistry, Cambridge
- Wilson, K. and Walker, J. 2004. *Practical Biochemistry: Principles and Techniques*. Cambridge University Press, Cambridge



## **PHYTOM 06**

### **MICROBIOLOGY AND PLANT MOLECULAR BIOLOGY (100 hrs)**

1. **Introduction to microbiology:** History and scope of microbiology; Principles of microscopy: Bright field and electronic microscope; Micrometry: ocular and filar micrometers; camera lucida; Microscopic examination of microorganisms **(10 hrs)**
2. **Microbial taxonomy and physiology:** Five kingdom classification; Microbial types: Fungi, Bacteria, Protozoa and Viruses; their morphology and structural characteristics; microbial metabolism; factors determining microbial growth and multiplication **(15 hrs)**
3. **Control of microorganisms:** Sterilization principles and techniques, methods of testing efficacy of antimicrobial substances, drug resistance in bacteria **(10 hrs)**
4. **Host-parasite interactions:** Infection, immunity, immune response, vaccines; Plant microbial interactions; symbiosis, antagonism and parasitism **(10 hrs)**
5. **Fermentation technology:** Microbial growth; fermentation process; fermentation products; industrial production of antibiotics, vitamins, amino acids; organic acids, enzymes; genetic improvement of fermentation products; Immunotechnology: Components of the immune system and immune response; cytokines, monoclonal antibodies and vaccines **(20hrs)**
6. **Structural organization of DNA and RNA:** Organization of pro and eukaryotic genomes, nucleotides (diversity in genome size), coding regions, non coding regions, introns and repetitive sequences; DNA and RNA polymerases, restriction enzymes, gene cloning and *in situ* hybridization of DNA **(15 hrs)**
7. **DNA replication:** Mutation, DNA repair; Site directed mutagenesis; Polymerase chain reaction and its applications **(10 hrs)**
8. **Gene expression:** Gene expression in prokaryotes and Eukaryotes, Transcription and Translation; Reverse transcription; Regulation of gene expression; Transposable elements; Expression of foreign DNA in pro and Eukaryotes **(10 hrs)**

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## **PHYTOM-P 02**

**PRACTICALS (based on Phytom 05 and Phytom 06) (150 hrs)**

1. **Plant physiology:** Determination of leaf extract (cell sap) pH; Estimation of relative water content in leaves; Extraction of pigments; Separation and identification of pigments (chlorophylls, carotenoids and xanthophylls) by chromatography; Growth analysis: Net primary productivity (NPP), Relative growth rate (RGR), Net assimilation rate (NAR) and Leaf weight ratio (LWR).
2. Estimation of chlorophyll: Spectrophotometric assay of total chlorophyll, chlorophyll-a and chlorophyll-b.
3. **Biochemistry:** Estimation of total sugar, reducing sugars, lipids, phenolic compounds, terpenes, terpenoids, amino acids and proteins; Assay of enzymes: protease, amylase, invertase and succinic dehydrogenase; Electrophoresis: Protein
4. **Microbiology:** Staining of bacteria: simple, Gram's staining, spore staining, etc.; Media preparation: Nutrient agar, blood agar, etc.; Cultivation of microbes, bacterial motility and colony characteristics; Biochemical tests for bacterial identification; Study of anti-bacterial effects of plant extracts; Sterility tests for *Ayurvedic* concepts.
5. **Ecology:** Community analysis for quantitative characteristics through quadrat method: quadrat sampling, minimum size and number of quadrat, measurement of density, abundance, frequency, dominance and importance value index (IVI).

## SEMESTER 03

### PHYTOM 07

#### CELL BIOLOGY AND BIOTECHNOLOGY (100 hrs)

1. **Ultra structure of plant cell:** Organization and functions of cell; Cell membrane and cell organelles: cytosol, membranes, cytoskeleton, endoplasmic reticulum, nucleus, nucleolus, chromosomes, golgi complex, lysosomes, peroxisomes, mitochondria and chloroplast; Nucleo-cytoplasmic transport **(10 hrs)**
2. **Cell cycles:** Phases of cell cycle, check point of cell cycle, extra cellular cell signals (hormones, cytokinines and growth factors), signal receptors, photoreception; Chromosomes and cell division: chromatin structure (histones, nucleosomes and fibers) and chromosome replication, mitosis (nuclear envelope, centromere, telomeres) meiosis (chromosome pairing, synapsis and movement, meiotic spindle), cytokinesis **(20 hrs)**
3. **Chromosomal (numerical and structural) variation:** Euploids, aneuploids and polyploids;  $\beta$ -chromosomes; structural aberrations; Experimental induction of numerical and

structural changes in chromosomes, role of chromosomal variation in evolution and plant breeding **(15 h)**

4. **Recombinant DNA technology:** DNA sequence analysis: gene libraries, gene cloning, cutting and joining of DNA; Transformation, vectors, laboratory synthesis of genes, nucleic acid hybridization; Plant improvement: improvement of plants through manipulation of phenotypic traits; protoplast isolation and fusion; genetic engineering and transgenic plants **(15 hrs)**
5. **Plant tissue culture:** Totipotency of cells; concept and general composition of culture media; cell, tissue and organ culture; Somatic embryos, somaclonal variation; control of differentiation, growth and flowering; Haploid production, embryo rescue; Micropropagation **(15 hrs)**
6. **Applications of biotechnology:** Applications in: Pharmaceuticals (production of therapeutic proteins, drugs and nutritional supplements), Medicine (molecular diagnosis of disease, monoclonal antibodies, gene therapy, biotransformation, vaccine production), Forensic science (blood typing and DNA finger printing), Industry (enzyme engineering, biocatalysts, biopolymers, biosensors), Environment management (bioremediation), Genetic conservation (storage of DNA, cells, pollen, tissues and organs by *in vitro* methods), and Food (enhanced keeping quality, nutritional superiority, fermentation products **(20 hrs)**
7. **Economic, Social and ethical implications:** Intellectual and material property rights; Technology transfer; International trade; Ethical and social concerns regarding the use of genetically engineered organisms or their products in agriculture and medicine **(5 hrs)**

#### References:

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- Walker, J.M. and Gingold, E.B. 1993. *Molecular Biology and Biotechnology* (3<sup>rd</sup> ed.). Royal Society of Chemistry, Cambridge

## **PHYTOM 08**

### **PHYTOCHEMISTRY (100 hrs)**

- 1. Metabolic processes and products:** Photosynthesis mechanism; Concepts of primary and secondary metabolism; Biosynthesis of secondary metabolites such as steroids, terpenoids, flavonoids, coumarins, anthocyanins and alkaloids **(10hrs)**
- 2. Phytochemical techniques:** Cold and hot extraction methods, liquid-liquid extraction techniques, liquid-carbon dioxide extraction, concentration and evaporation techniques, lyophilisation; TLC, preparative TLC, PC, column chromatography, gel-chromatography, affinity chromatography, ion-exchange chromatography, gas-liquid chromatography, high performance liquid chromatography, high performance thin layer chromatography and colorimetric analysis of extracts; finger printing of extracts and estimation of bioactive molecules **(15hrs)**
- 3. Bioactive secondary metabolites:** **Steroids:** Occurrence and distribution in plants, saponins, sapogenins and steroids; Isolation, structure elucidation and synthesis of bioactive steroids such as cholesterol, diosgenin, estrone, estradiol, etc.; **Terpenoids:** Occurrence and distribution in plants, essential oils, aroma chemicals, mono and sesquiterpenoids, their use in flavour and perfumery industry, diterpenes, triterpenes, isolation and characterization of terpenes, their synthesis; **Alkaloids:** occurrence and distribution in plants, bioactive alkaloids-isolation and structure elucidation of alkaloids such as atropine, quinine, papaverine, thebaine, vincristine, etc.; **Anthocyanidin:** occurrence and distribution in plants, isolation and characterization of anthocyanins, chalcones, flavones, isoflavones, chromones, coumarins; structure elucidation of quercetin, kaempferol, etc. **(20 hrs)**
- 4. Spectroscopy:** UV/Visible, IR, <sup>1</sup>H and <sup>13</sup>C NMR, 2D NMR and MS; application of spectroscopic techniques in structural elucidation of secondary metabolites **(20 hrs)**
- 5. Instrumentation:** Analytical Methods: Light and electron microscopy, tissue printing cytochemical localization, immunological methods (production of monoclonal and

polyclonal antibodies, agglutination and precipitation tests, immuno diffusion assays, immuno electrophoresis, radio immunological assay), radioactive isotopes and autoradiography, photometry and radiometry, atomic spectroscopy, GC-MS, LC-MS, centrifugation, electrophoresis, IEF and 2D electrophoresis, joint selective electrodes, enzymes, medicinal analysis **(25 hrs)**

- 6. Applications:** Applications of biomolecular chemistry in plant systematics, plant physiology, medicine and pharmaceuticals, forensic science, environmental science, biotechnology, herbal and modern drug industries, food flavour and cosmetic industries **(10 hrs)**

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## **PHYTOM 09**

### **PHARMACOGNOSY (100 hrs)**

1. **Pharmacognosy**: Definition, scope and applications in herbal medicine **(5hrs)**
2. **Processing of plant drugs**: Methods of collection, process and storage of medicinal and aromatic plants; purification of raw drugs; factors causing drug contamination, methods of storage of drugs **(20 hrs)**
3. **Classification and identification of drugs**: Need for classification of drugs; classical (taxonomic, morphological, organoleptic, therapeutic); microscopy and modern (biogenetic) criteria for classification of powdered drug, methods for documentation of raw drugs **(30 hrs)**
4. **Drug administration in Indian systems of medicine**: The holistic concept of drug administration; description of Sapta padarthas in Dravya guna; **(20 hrs)**
5. **Single plant drugs** and formulations in Ayurveda, Siddha and Unani; classical and modern means of drug administration **(20 hrs)**
6. **Pharmacognosy of crude drugs**: based on market survey including adulterants and substitutes **(5 hrs)**

#### **References:**

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### **PHYTOM-P 03**

#### **PRACTICALS (based on *Phytom-07 to Phytom-9*) (150 hrs)**

**Phytochemistry:** Estimation of fixed oil from fruit kernel (e.g. Percentage yield of coconut oil in copra); Determination of saponification value, Iodine value and acid value of fixed oil; Estimation of nitrogen in plant parts using Kjeldahl's method; Estimation of the alkaloid piperine from Pepper, vasicine from *Adhatoda* leaves and carbohydrates in plant samples using Duboi's method; Thin Layer Chromatography of the Petroleum ether extract of Cinnamon bark/Clove/Nutmeg kernel/Turmeric/Cardomom seeds; Paper Chromatography of 70% aqueous alcoholic extract of Hibiscus leaves/ Curry leaves/ Muringa leaves for amino acids (spray reagent: Ninhydrin); Isolation of Starch from Potato; Isolation and estimation of caffeine from tea leaves; Paper Chromatography of monosaccharides from fruits such as Mango/ Jack fruit /Orange; Estimation of ascorbic acid from gooseberry.

**Pharmacognosy:** Study of physical evaluation of crude drugs: determination of optical rotation and refractive index of drug samples (Castor oil); determination of R<sub>f</sub>-value by Thin Layer Chromatography; determination of total ash value, acid soluble ash value and water soluble ash value of crude drug samples; morphological/taxonomic description (including morphological description of useful plant parts) and identification of important medicinal and aromatic plants of Kerala; histochemical/chemical tests for identifying various plant components such as suberin, cutin, mucilage, pectin, starch, protein, oils, alkaloids, tannin, calcium oxalate and calcium carbonate, in various crude drug samples; organoleptic evaluation of 25 crude drug samples:

colour, odour, taste and other features; tests for detection of organic acids in: fruits of tamarind and lemon, leaves of *Oxalis corniculata*, etc.; **Anatomical studies:** killing and fixing of tissues, tissue dehydration, paraffin infiltration, mounting, microtomy, staining and mounting; anatomical study of selected plants: *Cinnamomum verum*, *Mimusops elengi*, *Azadirachta indica* and *Saraca asoca*; Micrometry: determination of cell size and area using micrometers and cameralucida; determination of stomatal index and frequency.

**Raw drug resources:** Collection and submission of raw drug samples (25 samples)

## **SEMESTER 04**

### **PHYTOM 10**

#### **PHARMACOLOGY, CLINICAL TRIAL AND BIOSTATISTICS (100 hrs)**

1. **Pharmacology and Ethnopharmacology:** Definition, scope and applications in herbal medicines; Ethnopharmacology: Pharmacological evaluation of drugs from ethnomedicine (*Strychnos nux-vomica*, *Rauwolfia serpentina* and *Digitalis species*); Importance of ethnopharmacological studies **(10 hrs)**
2. **Criteria for pharmacological evaluation of drugs:** Absorption, distribution, elimination, pharmacokinetics and drug reception; Drug abuse and iatrogenic diseases **(5 hrs)**
3. **Pharmacological activity of plant drugs:** Examples of plant drugs with effects on the autonomous and central nervous systems, cardiovascular system and the gastrointestinal system; Plant drugs with antimicrobial activity; Plant chemicals in modern pharmacology: Biochemistry and pharmacology of atropine, caffeine, ephedrine, opioids, taxol, Vinca alkaloids; synthetic substitutes for therapeutically active plant constituents; drug improvement by structure modification and biotransformation **(15 hrs)**
4. **Clinical pharmacology,** Drug therapy and clinical pharmacology; therapeutic situation; benefits and risks of use of drugs; qualitative and quantitative aspects of drug action; mechanisms of drug action; therapeutic efficacy; therapeutic index; tolerance; dosage forms and routes of drug action; factors affecting drug action; drug dosage and dosing schedules; biological variations in drug action; Adverse drug reactions and Drug Poisoning: Definition, detection, classification, and causes of ADR; principal clinical manifestations and treatment of ADR, general principles of management of drug poisoning; antidotes; Classification of drugs **(15 hrs)**
5. **Recent developments in ethnopharmacological validation of traditional medicine:** Bioassays related to active principles from plants: anti-bacterial, anti-fungal and anti-viral agents; anti-malarials; immuno-modulators; mediators of

inflammation; anti-hepatotoxic agents; platelet aggregating factors; cardiovascular agents; anti-inflammatory agents; diuretic agents; anti-allergic principles; fertility regulating agents; aphrodisiacs; hypo lipidaemic and hypo glycaemic agents; acute toxicity testing **(10 hrs)**

6. **Culture of animal cells for ethnopharmacological research:** Use of isolated tissues for determination of pharmacological activity **(2 hrs)**
7. **Care, breeding and management of laboratory animals (2 hrs)**
8. **Computerized database creation of ethnopharmacologically proven Indian medicinal plants (3 hrs)**
9. **Discovery and Development of Drugs:** Pharmacology in drug development; principal approach to drug discovery; process of new drug development, pre-clinical trials **(5 hrs)**
10. **Evaluation of drug in man:** Therapeutic evaluation; therapeutic trial design; size of therapeutic trial; clinical trials **(10 hrs)**
11. **Pharmacoepidemiology:** Observation cohort study; case control study; record linkage by computer **(5 hrs)**
12. **Principles:** Experimental design and research concepts: sampling, probability, levels of significance, degrees of freedom and normal distribution; measure of central tendency; arithmetic mean, median and mode **(8 hrs)**
13. **Measure of dispersion:** Standard deviation, standard error, coefficient of variation, correlation and regression; Tests of significance: t-test, normal curve test, F-test and modified F-test and chi-square test **(10 hrs)**

## References

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## **PHYTOM 11**

### **QUALITY CONTROL, PRODUCT DEVELOPMENT AND IPR (100 hrs)**

1. **Quality control from traditional medicine perspective:** Ayurvedic Formulary of India and pharmacopoeial standards for Ayurvedic formulations; Ayurvedic Pharmacopoeia of India; Indian herbal pharmacopoeia; British pharmacopoeia; Japanese standards for herbal medicine; Pharmacopoeia of the Peoples Republic of China **(20 hrs)**

2. **Quality control of raw drugs and Product development:** WHO guidelines for assessment of herbal drugs; authentication and standardization of herbal raw materials; quality control of processed herbal drugs: general protocols, chemical assay, bioassay, stability and safety assessments; Good manufacturing practices; regulatory bottlenecks with herbal drugs **(20 Hrs)**
3. **Production technology:** Methods of preparation and quality assessment of *Arishtas, Asavas, Gulikas, Ghrithas, Satva, Tailas, Churnas, Lepas* and *Lehyas*; preparation of Siddha and Unani formulations; industrial practices of manufacture of herbal drugs **(20 Hrs)**
4. **Drug testing, marketing network and feasibility studies (10 hrs)**
5. **Intellectual Property Rights:** Patent Amendment Act 2002; Patent Rules 2003; Biodiversity Act 2002; Biodiversity Rules 2004 of the Government of India; Protection of Plant Varieties and Farmer's Act 2001; *sui generis* system; benefit sharing model **(15 hrs)**
6. **Rights relating to medicinal and aromatic plants:** Natural resource rights of countries and geographical areas; rights of governments, organizations, communities and individuals; geographical indication; intellectual property rights and traditional knowledge; new varieties and species and new uses and processes **(15 hrs)**

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## **PHYTOM 12**

### **BUSINESS PLAN AND ENTREPRENEURSHIP DEVELOPMENT (100 hrs)**

1. **Entrepreneur and intrapreneur:** generation of project ideas; portfolio models of planning; screening of project ideas **(10 hrs)**
2. **Technical Feasibility:** Technology development; acquisition-decisions on appropriate technology; environmental appraisal for projects **(15hrs)**
3. **Financial feasibility:** estimation of cost of project; requirement of long term funds; estimation of working capital requirements; projected cash flow statement and budgeting; project appraisal techniques; social cost benefit analysis; concept and approaches **(25 hrs)**
4. **Marketing feasibility:** Market opportunity analysis; systematic market appraisal; demand forecasting methods; quantitative and qualitative; Economic evaluation and marketing: Market demand and supply potential; import and export policies, criteria to determine economic value, value of land for cultivation, cultivation costs, value of raw and processed drugs, royalties and costs of marketing **(30 hrs)**
5. **Preparing Business Plan, Pre-feasibility report and its clearance:** Estimates and Techno Economic Feasibility Report (TEFR); role of inter-related projects (multi-projects); Preparation of Detail Project Reports (DPR) **(20 hrs)**

## References

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- Patel, B.M. 2005. *Project Planning, Analysis and Management*. Vikas Publishing House, New Delhi

## PHYTOM-D

### DISSERTATION

## PHYTOM-V

### VIVA VOCE