Central University of Himachal Pradesh
Shahpur Parisar
Department of Plant Science

Program Specific Outcomes

Program Outcomes

Course Outcomes & Course Contents

Of

M.Sc. Plant Science (Botany)

School of Life Sciences

Programme Specific Outcomes of Master of Plant Science

PSO[1] - To ensure participation of all students in classroom discussions

PSO[2] - To enhance students' dissertation and research paper writing skills

PSO[3] - To foster a culture of performance based evaluation

Programme Outcomes of Master of Plant Science

PO[1] - The students will be able to recognize and characterize major groups of plants such as algae, fungi, angiosperms and gymnosperms upto genus level

PO[2] – The students will be able to inter-relate various plant processes and functions, ecology, and environment, bioenergetics of metabolism, genetics, breeding and molecular biology of various plant domains

PO[3] -The students will become competent enough in various analytical and technical methods related to plant sciences

PO[4] - Students will be able to develop skills and expertise viz. plant tissue culture, phytochemistry, omics and protected cultivation, involving the uses of plants in ways that benefit mankind

SEMESTER – I

Course Name: Fundamentals of Phycology and Mycology
Course Code: PLS 415
Credits = 02

Course Outcomes:

On the successful completion of the course, student will be able to:

CO^1 Understand and collect the diversified habitats of algae and fungi.
CO^2 identify different types of algae and fungi
CO^3 Undertake project work about most of the aspects covered concerning algal and cyanobacterial taxonomy, ecology.
CO^4 Understand the industrial application and economic importance of these organisms.

UNIT-1
Principles and systems of classification of Algae (Fritsch F. E. 1935), Contributions of Indian Algologists, Comparative account of algal pigments, food reserves, fllagellation, chloroplasts and eye spots; their taxonomic importance and molecular phylogeny

UNIT-2
Salient Features of Cyanophyta, Chlorophyta, Xanthophyta, Bacillariophyta; Phaeophyta, Dinophyta, Cryptophyta and Rhodophyta

UNIT-3
Characteristics of fungi and fungal systematic, Recent trends in classification of fungi, contribution of Indian Mycologists

UNIT-4
General features of Phylum Chitridiomycota, Zygomycota, Ascomycota and Basidiomycota

UNIT-5
Algae and human affairs : Ecological role of algae, algae as food and feed, uses in industries etc algal biofertilizers, phycocolloids, algal blooms and phycotoxins, Economic importance of fungi, Role of fungi in industry and food, Fungi as biocontrol agent

Reference Books:

1. Lee, R. E. 2018. Phycology 5th Edition. Cambridge University Press, New Delhi.
2. Vashishta, B. R., Sinha, A.K., and Singh, V.P. 2016. Algae. S. Chand & Company, New Delhi.
3. Sharma , O. P. 2017. Fungi and Allied Microbes. McGraw Hill Education
4. Dube, H. C. 2013. An Introduction to Fungi. 4th Edition. Scientific Publishers, India.
5. Kirk, P., Cannon P.F., Minter D.W. & Stalpers J. A. 2008. Ainsworth & Bisby's Dictionary of Fungi. 10th Edition. CAB International, Oxon UK.
6. Alexopoulose, C. J., Mims, C.W. & Blackwell, M. 2007. Introductory Mycology. 4th Edn. John Wiley & Sons, New York.
7. Ainsworth, G.C., Sparrow, K.E. & Sussman, A.S. 1973. The Fungi. Academic Press, New York.
8. Vashishta, B. R., Sinha, A.K., and Kumar,A 2020. Fungi. S. Chand & Company, New Delhi.

Course Articulation Matrix of PLS 415- Fundamentals of Phycology and Mycology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	2	2	2		3	3	3
CO2	3	2	2	2		2	2	2
CO3	3	2	3	2		2	2	2
CO4	3	2	3	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Bryophytes, Pteridophytes and Gymnosperms
Course Code: PLS 416
Credits = 02

Course outcomes:

On the successful completion of the course, student will be able to:

CO^1 - Develop understanding on morphology, anatomy and reproduction of Bryophytes, Pteridophytes and Gymnosperms
CO^2 - Understand the plant evolution and their transition to land habitat
CO^3 - Familiarize the fossil members of these groups
CO^4 - Understand the economic importance of these groups

UNIT-1
General characteristics of Bryophytes, Classification system ((Shofield, 1985), Study of Life cycle of following types: *Lunularia, Pallavicinia, Porella, , Polytrichum*, Origin and evolution of Bryophytes, Brief account on Fossil Bryophytes, Economic importance of Bryophytes, Bryophytes as indicators of water and air pollution

UNIT-2
General characteristics and classification of Pteridophytes (Bierhost, 1971), Structure, reproduction and life cycle of the following types: *Ceratopteris, Lygodium, Trichomannes, Azolla*, Telome theory-basis, elementary proves- origin of sporophylls in Lycopsida, Sphenopsida and Pteropsida- origin of root- merits and demerits of telome theory;

UNIT-3
Evolutionary trends in the gametophytes of Pteridophytes, Conservation of Pteridophytes, Pteridophytes as ecological indicators, Principles of Paleobotany, Fossil pteridophytes: *Rhynia, Lepidocarpo*n, Economic importance of Pteridophytes

UNIT-4
General characteristics, affinities and distribution of Gymnosperms, Classification of Gymnosperms (Sporne, 1965), Phylogeny of Gymnosperms

UNIT-5
Structure, reproduction and life cycle of the following types: *Zamia, Araucaria, Cupressus, Ephedra*, Fossil Gymnosperms (Brief account), Economic importance of Gymnosperms

Reference Books:

1. Botanical Survey of India. 2016. Liverworts and Hornworts of India – An annotated check list.
2. Vanderpoorten A. & Goffinet B. 2009. Introduction to Bryophytes. Cambridge Publishers.
3. Shaw, J. & Goffinet, B. 2000. Bryophyte Biology, Cambridge University Press.
4. Rashid, A. 1998. An introduction to bryophyte. Vikas Publishing House, New Delhi
5. Sharma, O. P. 2017. Text book of Pteridophyta. McGraw Hill Education.
6. Sundara Rajan, S. 1999. Introduction to Pteridophyta. New Age Publications, New Delhi.
7. Rashid, A.1999. Pteridophyta. Vikas Publishing House, New Delhi.
8. Sporne, K. R. 1986. Morphology of Pteridophytes. Hutchinson University Library, London.
9. Stewart, W. N. 1983. Paleobotany and Evolution of Plants. Cambridge University Press, London.
10. Bierhost, D.W. 1971. Morphology of vascular plants. Macmillan, London
11. James W.B. 2015 The Gymnosperms Handbook: A practical guide to extant families and genera of the world. Plant Gateway Ltd.
12. Christenhurz M. J. M. Reveal, J. L. Farjon, A. Gardner, M. F &. Mill, R. R. M. and Chase M. W. (2011) A new classification and linear sequence of extant gymnosperms. Phytotaxa 19: 55-70. Magnolia Press
13. Vashishta, P.C. 2010. Gymnosperms, S. Chand & Company, New Delhi.
14. Chamberlain, C. J. 2000. Gymnosperms. CBS Publishers, New Delhi.
15. Sporne, K. R. 1986. Morphology of Gymnosperms, Hutchinson University Library, London

Course Articulation Matrix of PLS 416- Bryophytes, Pteridophytes and Gymnosperms

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	2	2	2		3	3	3
CO2	3	2	2	2		2	2	2
CO3	3	2	3	2		2	2	2
CO4	3	2	3	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Fundamentals of Phycology and Mycology-LAB
Course Code: PLS 415(L)
Credits = 02

Practicals

1. Field trips to be conducted for students to get familiarized with the algae and fungi present nearby to university
2. Collections and culture (media preparation, sterilization, inoculation and incubation).
3. Culturing techniques of different fungi
4. A record of algal and fungus types mentioned above – A study of their morphology and structures including vegetative and reproductive stage of lifecycle.
5. Range of thallus and sex organs in major algal groups.
6. Study of anatomical structure wherever relevance

7. Heterocysts and their frequency in some cyanophycean genera.

Course Name: Bryophytes, Pteridophytes and Gymnosperms-LAB
Course Code: PLS 416 (L)
Credits = 02

Practicals

1. Structural details of the vegetative and reproductive parts of the types mentioned in the syllabus.
2. Identification of fossil types mentioned in the syllabus

Course Name: Fundamentals of Plant Anatomy and Microtechniques
Course Code: PLS 417
Credits: 02

Course Outcomes:

After the end of the course, the students will be able to:

CO^1 To understand the various tissue systems, anatomical features of plant parts and to identify the anomalous growth

CO^2 To familiarize with various stains and staining techniques

CO^3 To familiarize the techniques for the preparation of different types of glass slides

CO^4 To get practical experience in various methods of Microtechnique and histochemistry

UNIT-1
Introduction to Plant tissue systems (Structure and Function), Meristems and meristematic growth, Anatomy of roots, stems and leaves, Nodal Anatomy, Cambium: Structure and Function, Anomalous secondary structure and growth

UNIT-2
Tissue processing steps: Fixation (Chemical and Freezing), Dehydration, Infiltration and embedding, Sectioning and mounting

UNIT-3
Biological stains: Classification and chemistry of biological stains; general and specific; vital stains and flurochromes

UNIT-4
Tissue processing methods: Squash, Smear and Maceration; Microtomy: Rotary, Freezing, Cryostat and Ultratomes, Micrometry-camera lucida, photomicrography

UNIT-5
Histochemistry: Detection and localization of primary metabolites: Carbohydrates (PARS reaction), Proteins (Coomassie brilliant blue staining), Lipids (Sudan Black method); Detection of secondary metabolites: alkaloids, terpenoids, phenolics

Reference Books:

1. Cutler D.F., Ted Botha T. and Stevenson D.W. 2016. Plant Anatomy: An Applied Approach. John Wiley & amp Sons.
2. Clive K. 2016. Plant Anatomy, Morphology and Physiology. Syrawood Publishing House
3. Yeung E.C.T., Stasolla C., Sumner M. J. & Huang B. Q. 2015. Plant Microtechniques and Protocols. Springer Nature
4. Prasad M. K. & Prasad M. K. 2000. Emkay Publications

5. Arumugam N & Ragland A. Fundamentals of Plant Anatomy and Microtechniques, Saras Publication, India
6. Johanson, W. A.1984. Plant Microtechnique. McGraw Hill, New York.
7. Johanson, W. A. 1982. Botanical Histochemistry-Principles and Practice. Freeman Co.

Course Articulation Matrix of PLS 417- Fundamentals of Plant Anatomy and Microtechniques

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	3		3	3	3
CO2	2	2	3	3		2	2	2
CO3	2	2	3	3		2	2	2
CO4	2	2	3	3		2	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Advances in Cell Biology
Course Code: PLS 418
Credits = 02

Course Outcomes:

After the end of the course, the student will be able to:

CO[1] Understand how these cellular components are used to generate and utilize energy in cells.

CO[2] Understand the structural organization of cell and intracellular organelles.

CO[3] Understand the general principles of cellular communication and roles of different molecules

CO[4] Acquire knowledge of replication, transcription and translation

UNIT-1

General structure and constituents of cell, difference between prokaryotic and eukaryotic cell, cell wall, cell membrane, structure and composition of bio membrane, similarities and distinction between plant and animal cell, Cell division and regulation of cell cycle.

UNIT-2

Structure and function of major cell organelles: nucleus, chloroplast, mitochondria, ribosomes, lysosomes, peroxisomes, endoplasmic reticulum, microbodies, Golgi apparatus, vacuole etc.

UNIT-3

Nucleic acids as a genetic material, structure and properties of DNA and RNA, genome organization of eukaryotes and prokaryotes, chromatin structure and function.

UNIT-4

DNA replication in prokaryotes and eukaryotes, transcription and translation in prokaryotes and eukaryotes.

UNIT-5
Post transcriptional and post translational modifications.

Reference Books:

1. Gupta P.K. 2003. Cell and Molecular Biology. 2nd Ed. Rastogi publication.
2. Lodish H. 2003. Molecular Cell Biology. 5th Ed. W.H. Freeman & co.
3. Primrose S.B. 2001. Moleuclar Biotechnology. Panima
4. Nelson DL &Cox MM. 2007. Lehninger Principles of Biochemistry. 5th Ed. MacMilan.

Course Articulation Matrix of PLS 418- Advances in Cell Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	1	2		3	3	3
CO2	3	3	1	2		2	2	2
CO3	3	3	1	2		2	2	2
CO4	3	3	1	2		2	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Principles of Organic and Natural farming
Course Code: PLS 419
Credits: 02

Course Outcomes:

By successfully completing the course, the student will be able to:
- **CO1** Gain the theoretical knowledge in Organic Farming Practices
- **CO2** Learn a means of self-employment and income generation
- **CO3** Learn Effective Microbial Technology in Organic Farming
- **CO4** Learn the role of Organic Farming in Soil Health and Nutrient Management

UNIT-1
Introduction to Organic Farming: Why Organic Farming? Concept and Principles of organic farming; Historical development of Organic Framing / Agriculture, Advantages and Disadvantages,

UNIT-2
Natural Farming, Integrated and Mixed Farming system, Ecological Farming; Organic Farming Models: Fukuoka (Japan), Permaculture (Australian Organic Farming),

UNIT-3
Role of Bio-fertilizers in Organic Farming: Bioformulations and Bio-Pestisides, Effective Microbial Technology in Organic Farming

UNIT-4
Harvest and Post-harvest Management under Organic Farming: Soil Health and Nutrient Management, Integrated Pest and Disease Management; Weed control

UNIT-5

Quality Assurance and Certification in Organic Farming, Marketing of Organic Farming Products:

Reference Books:

1. Sarath Chandran, Unni M.R and Sabu Thomas. 2018. Organic farming. Woodhead Publishing, UK.
2. Reddy, S.R.2017. Principles of organic farming. Kalyani publishers, India
3. Ranjan Kumar Biswas. 2014. Organic farming in India. New Delhi Publishers, India.
4. Peter Fossel. 2014. Organic Farming: How to Raise, Certify, and Market Organic Crops and Livestock. Reprint edition, Voyageur Press, USA.
5. Organic farming-Theory and Practice by S.P. Palaniappan and K. Annadurai
6. Organic crop production (Principles and practices Vol-I: Principles and General Aspects) by J. P. Sharma

Course Articulation Matrix of PLS 419- Principles of Organic and Natural farming

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	2	3	3		2	2	2
CO2	1	2	3	3		2	2	2
CO3	1	2	3	3		2	2	2
CO4	1	2	3	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Fundamentals of Enzymology
Course Code: PLS 420
Credits = 02

Course Outcomes:

After the end of the course, the student will be able to:

CO^1 Describe structure, functions and mechanism of action of enzymes

CO^2 Classify enzymes based on the reactions catalyzed.

CO^3 Understand the kinetics, inhibition and regulation of enzyme catalyzed reactions.

CO^4 Understand the Organization of enzymes in the cell and their degradation

UNIT-1

Basic concept, Classification and Nomenclature of Enzymes, Chemical nature of enzymes. Protein nature of enzymes and Non protein enzymes - Ribozymes and DNAzymes. Coenzymes and Cofactors, Classification of coenzymes: Isozymes, Abzymes, Synzyme

UNIT-2

Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis- Acid-base catalysis, covalent catalysis, Metal ion catalysis

UNIT-3

Enzyme inhibition: Reversible Inhibition- Competitive, Non Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition

UNIT-4

Factors affecting the enzyme activity- Concentration, pH and temperature. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten Equation, Kinetics of Enzyme Inhibition.

UNIT-5

Feedback and Allosteric Regulation, Organization of enzymes in the cell. Mechanisms of enzyme degradation

Reference Books:

1. Fundamentals of Enzymology : Nicholas Price & Lewis Stevens
2. Enzymes : Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer
3. Biochemistry by Donald Voet, Judith G. Voet, Publisher: John Wiley & Sons (2011), Fourth Edition, ISBN-10: 0071737073, ISBN-13: 978-0071737074.
4. Fundamentals of Biochemistry by J. L. Jain, Sunjay Jain, Nithin Jain (2008), Publishers: S. Chand & Co Ltd ISBN: 81-219-2453-7.
5. Lehninger, Principles of Biochemistry by Nelson, D. L., Lehninger, A. L., & Cox, M. M.(2008), 5thEdition, ISBN: 978-0-230-22699-9, Publisher: W. H. Freeman and Company, New York, p: 677-878.

Course Articulation Matrix of PLS 420- Fundamentals of Enzymology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	3	3		3	3	3
CO2	2	3	3	3		3	3	3
CO3	2	3	3	3		3	3	3
CO4	2	3	3	3		3	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Elements of Plant Breeding
Course Code: PLS 421
Credits = 02

Course Outcomes:

After the end of the course, the students will be able to:

CO[1] Develop conceptual understanding of plant genetic resources, plant breeding, gene bank and gene pool.

CO[2] Familiarize with genetic basis of heterosis.

CO[3] Understand the different methods of plant breeding for the improvement of crop

CO[4] Understand the hybrid seed production

UNIT-1

Introduction and objectives of Plant Breeding, History of Plant Breeding (Pre and post-Mendelian era), Important characteristics improved by plant breeding, Self- and cross -pollinated crops including mating systems and response to selection

UNIT-2
Breeding methods in asexually/clonally propagated crops, Line breeding, pedigree, bulk, backcross, single seed descent and multi-line method; Population breeding in self pollinated crops

UNIT-3
Male sterility and self-incompatibility in crop plants and their commercial exploitation, Pure line theory, pure line selection and mass selection methods

UNIT-4
Breeding methods in cross pollinated crops; S1 and S2 progeny testing, progeny selection schemes; Genetical and physiological basis of heterosis and inbreeding, Inbreds production, seed production of hybrid and their parent varieties/inbreds

UNIT-5
Mutation breeding; Breeding for abiotic and biotic stresses. Cultivar development- testing, release and notification, maintenance breeding, Plant breeders‟ rights and regulations for plant variety protection and farmers rights

Reference Books:

1. Roy D. 2003. Plant Breeding, Analysis and Exploitation of Variation. NarosaPubl.House.
2. Sharma JR. 2001. Principles and Practice of Plant Breeding. Tata McGraw-Hill.
3. Singh P. 2006. Essentials of Plant Breeding.Kalyani.
4. Singh S &Pawar IS. 2006. Genetic Bases and Methods of Plant Breeding. CBS.
5. Das, L.D. Vijendra (2006) Plant Breeding. New Age International Publishers, NewDelhi.
6. Singh, B.D. (2012). Plant Breeding: Principles and Methods. Kalyani Publishers. 9thedition.

Course Articulation Matrix of PLS 421- Elements of Plant Breeding

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	3	3		2	3	2
CO2	2	3	3	3		2	3	2
CO3	2	3	3	3		2	3	2
CO4	2	3	3	3		2	3	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Protected cultivation of High Value Crops
Course Code: PLS 422
Credits = 02

Course Outcomes:

After the end of the course, the student will be able to:
- **CO^1** Gain theoretical knowledge on protected cultivation and its implications
- **CO^2** Understand the latest knowledge for growing of high value crops under protected environmental condition.
- **CO^3** Understand the Water Resource Management in protected cultivation

CO^4 Understand the latest knowledge of soil-less culture

UNIT-1

Importance and scope of protected cultivation of vegetable crops; principles used in protected cultivation, energy management, low cost structures; training methods; engineering aspects.

UNIT-2

Protected Cultivation – Greenhouse –Polyhouses- Plastic Tunnel – Shadenet House – Walk in Tunnels – Plant Protection Nets – Surface Cover Cultivation – Plastic Mulching – Soil Solarisation, Manipulation of CO2, light and temperature forvegetable production, fertigation.

UNIT-3

Water Resource Management in protected cultivation – Farm Pond & Reservoir lined with Plastic Films

UNIT-4

Problem of growing vegetables in protected structures and their remedies,insect and disease management in protected structures; soil-less culture, useof protected structures for seed production.

UNIT-5

Crops covered under Greenhouse- Cabbage, Cucumber, Tomato, Capsicm; Crops under shadenet house - Ridge gourd, Bottle gourd, Cucumber, Capsicum, Broccoli, Okra, Chilli Vermi Bed – Organic Farming

BIS Standards - Protected Cultivation; MIDH – Path Forward

Reference Books:

1. Anonymous 2003.Proc. All India Seminar on Potential and Prospects for Protective Cultivation. Organised by Institute of Engineers,Ahmednagar. Dec.12-13, 2003.
2. Chandra S &SomV. 2000. Cultivating Vegetables in Green House. IndianHorticulture 45: 17-18.
3. Prasad S & Kumar U. 2005.Greenhouse Management for HorticulturalCrops.2nd Ed. Agrobios.
4. Tiwari GN. 2003. Green House Technology for Controlled Environment.Narosa Publ. House.

Course Articulation Matrix of PLS 422- Protected cultivation of High Value Crops

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	3	3		2	3	3
CO2	2	3	3	3		2	3	3
CO3	2	3	3	3		2	3	2
CO4	2	3	3	3		2	3	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Biosafety, IPR and Patenting Issues in Plant Sciences
Course Code: PLS 423
Credits = 02

Course Outcomes:

After the end of the course, the student will be able to:

CO^1 Understand the various forms of intellectual property rights and its different forms, like Trade secrets, Trademarks, Copyrights, IPR and plant genetic recourses.

CO^2 **U**nderstand the biohazards, biosafety levels and what are ethics issues in genetic engineering.

CO^3 Understand a specialized knowledge and how to file patent, which material is subjected to patent and its infringements.

CO^4 Understand a specialized knowledge of biopiracy

UNIT-1

Introduction to Biological Safety Cabinets, Primary Containment for Biohazards, Biosafety Levels, Convention on biological diversity, Cartegana Protocol and Nagoya Protocol, Roles of Institutional Biosafety Committee, RCGM, GEAC etc. Definition of GMOs & LMOs, Environmental release of GMOs

UNIT-2

General Introduction to Intellectual Property Rights, Types of IP, Patents, Trademarks, Copyright, Related Rights, Industrial Design, Geographical Indications, Importance of IPR – patentable and non patentables, Patenting of biological materials, patenting life,

UNIT-3

Legal protection of Biotechnological inventions, Indian scenario of patents for higher animal and higher plants, Patenting of transgenic organisms and isolated genes, GURT, GATT, TRIPS, WTO agreement, Special issues in Biotechnology Patents, Patent Litigation.

UNIT-4

Recent Development in Patent System and Patentability of Biotechnology invention, Budapest treaty Development of patent system in India, Basic requirements of patentability, patentable subject matter, novelty and the Public Domain, Non obviousness compulsory licensing

UNIT-5

Patent infringements and revocation, Implications of intellectual property rights on the commercialization of biotechnology products, Indian Patent Act 1970 & recent amendments.

Reference Books:

1. Elements of Biotechnology, Gupta PK, Rastogi Publications, Meerut.
2. Intellectual Property rights in the WTO and Developing countries, Watal J, Oxford Univ Press.
3. Intellectual Property Bulletin, New Delhi
4. Biosafety and Bioethics: Joshi

Course Articulation Matrix of PLS 423- Biosafety, IPR and Patenting Issues in Plant Sciences

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	2	3		2	2	2
CO2	2	3	2	3		2	2	2
CO3	2	3	2	3		2	2	2
CO4	2	3	2	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Gardening and Landscaping
Course Code: PLS 424
Credits = 02

Course Outcomes:

After the completion of this course the learner will be able to:

CO^1 Apply the basic principles and components of gardening

CO^2 Design various types of gardens according to the culture and art of bonsai

CO^3 Establish and maintain special types of gardens for outdoor and indoor landscaping

CO^4 Start Gardening and landscaping activity as an agri- business enterprise by liaising with different stake holders

UNIT-1

Scope and introduction to gardening, Gardening components and features, Special types of Gardens: Home garden, roof garden, sunken garden, vertical garden, terrace garden, water garden, rock garden, bottle garden, window garden, Suitable plants for different types of garden, Advantages and limitations in establishing different types of gardens,

UNIT-2

Detailed description of potted plants such as outdoor, foliage, flowers, creepers, climbers etc, Culture of Bonsai and its maintenance (pruning and wiring), Establishment and maintenance of lawn, Types of lawn, Machineries required for mowing a lawn, Establishment of topiaries and its maintenance

UNIT-3

Importance, features and maintenance of commercial gardening , Components such as statues, garden benches, paths, floral clock etc, Annuals, perennials and flowering trees for commercial / ornamental gardening, Designing of hedges

UNIT-4

Landscape designs (Components and Features), Urban landscaping, Landscaping in various places and its value addition. Landscaping for specific situations, institutions, industries, residents, hospitals, roadsides, traffic islands, dam sites, river banks, IT parks, corporate.

UNIT-5

Bioaesthetic planning, ecotourism, theme parks, indoor gardening, therapeutic gardening, Non-plant components (water scaping, xeriscaping, hardscaping); Computer Aided Designing (CAD) for outdoor and indoor scaping

Reference Books:

1. Berry, F. and Kress, J. (1991). Heliconia: An Identification Guide . Smithsonian Books.
2. Russell, T. (2012). Nature Guide: Trees: The world in your hands (Nature Guides).
3. Sabina, GT and Peter KV. 2008. Ornamental Plants for Gardens. New India Publ. Agency
4. Bose, T. K and Mukherjee, D. 1977. Gardening in India. Oxford & IBH Publishing Co. Pvt. Ltd., Calcutta
5. Bose, T. K. Malti, R. G. Dhua, R. S and Das, P. 2004. Floriculture and Landscaping. Nayaprakash, Calcutta
6. Nambisan, K. M. P. 1992. Design Elements of Land Scape Gardening Oxford & IBH Publishing Co. Pvt. Ltd., New Delh

Course Articulation Matrix of PLS 424- Gardening and Landscaping

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	2	3		2	2	2
CO2	2	3	2	3		2	2	2
CO3	2	3	2	3		2	2	2
CO4	2	3	2	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Commercial Horticulture Crops
Course Code: PLS 425
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO[1] Understand the different classifications of horticultural crops, nursery management and use of technology in horticulture.

CO[2] Develop their competency on pre and post-harvest technology in horticultural crops

CO[3] Evaluate the importance of floriculture and contribution spices and condiments on economy

CO[4] Evaluate the importance of various crop specific practices

UNIT-1

National and International scenario in fruit production and floriculture, Recent advances in propagation – root stock influence, planting systems, High density planting, crop modeling, Precision farming, decision support systems - aspects of crop regulation- physical and chemical regulation effects on physiology and development, influence of stress factors, strategies to overcome stress effects, integrated and modern approaches in water and nutrient

management. Total quality management (TQM) - Current topics.

UNIT-2
Fruit Crops: Mango, Papaya, Citrus, Guava, Apple, Plums, Peach

UNIT-3
Specific objectives of breeding in flower crops, Methods of breeding suited to seed and vegetatively propagated flower crops, Introduction, selection, polyploidy and mutation breeding in the evolution of new varieties, Exploitation of heterosis, utilization of male sterility incompatibility problems, *In Vitro* breeding.

UNIT-4
Floral oil industry, floral concrete production, extraction methods, recent advances. Flower forcing and year-round flowering through physiological interventions; Chemical regulation; Environmental manipulation; Harvest indices; Harvesting techniques; Post-harvest handling; Precooling, pulsing, packing, marketing; Export potential; Agri Export Zones.

UNIT-5
Crop specific practices – rose, anthurium, orchids, carnation, Jasminum sp., marigold, tuberose, crossandra

Reference Books:

1. Bose TK, Maiti RG, Dhua RS & Das P. 1999. Floriculture and Landscaping. Naya Prokash.
2. Chadha KL & Choudhury B. 1992. Ornamental Horticulture in India. ICAR.
3. George S & Peter KV. 2008. Plants in a Garden. New India Publ. Agency.
4. Lauria A & Victor HR. 2001. Floriculture – Fundamentals and Practices. Agrobios.
5. Randhawa GS & Mukhopadhyay A. 1986. Floriculture in India. Allied Publ.
6. Reddy S, Janakiram B, Balaji T, Kulkarni. S & Misra RL. 2007. Hightech Floriculture. Indian Society of Ornamental Horticulture, New Delhi.

Course Articulation Matrix of PLS 425- Commercial Horticulture Crops

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	2	3		1	2	2
CO2	3	3	2	3		1	2	2
CO3	3	3	2	3		1	2	2
CO4	3	3	2	3		1	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Indian Knowledge system #
Course Code:
Credits = 02

 # Course will be developed by University Level Committee and uniform for all programmes

SEMESTER - II

Course Name: Plant Physiology and Advanced Biochemistry
Course Code: PLS 465
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO^1 Learn about the ways plants use light to assimilate atmospheric carbon dioxide to support life on this planet

CO^2 Understand the advance function micromolecules and marcomolecules.

CO^3 Understand the core principles and topics of biochemistry and their experimental basis, and enable students to acquire specialized knowledge in plant signalling, the effect of elicitor, and their response in defense.

CO^4 Understand the defense mechanisms of plants and their communication.

UNIT-1

Structure of chloroplast and mitochondria, photorespiration, photo morphogenesis, phytochrome, cryptochrome, photoperiodism and verbalization, Gibberellin and Auxin signal transduction in plants

UNIT-2

Scope and importance of biochemistry, structure of water, pH, buffer, Classification, structure and function of Carbohydrates, lipids, amino acids, proteins, and nucleic acid.

UNIT-3

Second messengers and G-proteins, Physiological roles of cyclic nucleotide gated channels in plants, Role of cyclic nucleotides, Cacium-Calmodulin cascade, Protein kinases and phosphtases, Two component sensor-regulator system in bacteria and plants

UNIT-4

Signaling in bacteria and leguminous plants during nitrogen fixation, Signaling to the actin Cytoskeleton during cell morphogenesis and patterning, Signaling via plant peroxidases, Signaling and cell walls, Signaling in plant gravitropism

UNIT-5

Role of elicitors, Pathogen associated molecular patterns, Nitric oxide and salicylic acid in plant defense, and plant defence activator, Pathogen or Pattern-Triggered Immunity, Role of PR proteins in plants

Reference Books:

1. Nelson DL &Cox MM. 2007. Lehninger Principles of Biochemistry. 5thEd. MacMilan.
2. Voet D, Voet J G & Pratt CW.2007. Fundamentals of Biochemistry. Jhon wiley.
3. Hopkins WG & Huner NPA. 2004. Introduction to plant physiology.Jhon Wiley & sons
4. Pandey SN & Sinha Bk. 1972 plants physiology H.S. Srivastava N. Shankar Plant physiology and Biochemistry.
5. Alberts, B., Bray, D., Lewis, J. Raff, M., Roberts, K. and Watson, J.D. 1989. Molecular Biology of the cell, Garland Publishing Inc., New York.
6. Brown TA. (2008) Gene cloning and DNA analysis (5th Edition),Blackwell Publishing, Oxford, UK.
7. Lodish H, Berk A, Kaiser CA and Krieger M. (2008) Molecular Cell Biology, 6th Edition, W.H. Freeman and Company, New York, USA.

Course Articulation Matrix of PLS 465- Plant Physiology and Advanced Biochemistry

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	2	2		1	2	2
CO2	3	3	2	2		1	2	2
CO3	3	3	2	2		1	2	2
CO4	2	2	2	2		1	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Microbiology and PhytoPathology
Course Code: PLS 466
Credits = 02

Course Outcomes:

On the completion of the course, the student will be able to:

CO^1 Gain knowledge in the area of Microbiology like classification, structure, metabolism.
CO^2 Understand the various plant diseases caused by different types of pathogens
CO^3 Understand the different Bacterial culture and microbial diseases.
CO^4 Understand the various control measures related to diseases

UNIT-1
Introduction to Microbiology: Different System of Classifications, Methods of Microbial identification, Major groups of microorganisms and their characteristics – prions, viroids, viruses, bacteria, archaebacteria, actinomycetes, cyanobacteria, viable but nonculturable (VBNC) bacteria, Simple and Differential staining, Gram staining

UNIT-2
Nutritional classes of microorganisms, Types of nutrient media for culturing microbes, Methods of isolation and enumeration of microbial populations, Preservation of microbial cultures, Microbial growth Kinetics: Batch and continuous growth, Factors affecting growth of bacteria, Bacterial Reproduction: Transformation, Transduction and Conjugation, Physical and chemical agents for control of microbial growth, antibiotic susceptibility test

UNIT-3
Basic Concept of pathogenecity and plant disease: Koch's postulates, Plant pathogens and types of plant pathogens, Growth, reproduction, survival and dispersal of plant pathogens, biotic and abiotic causes of plant diseases, Methods for control of plant diseases

UNIT-4
Host-Pathogen Interaction: recognition and infection, Pre-penetration activities of pathogens on host surface, Penetration through intact plant surfaces (Direct and Indirect), post-penetration development, Defence mechanisms in plants, Phytoalexins; Pathogenesis-related (PR) proteins Disease control by physical, chemical and biological methods

UNIT-5
Study of the following plant diseases with reference to symptoms, causal organism, disease cycle and control measures:

i. Wheat - Rust disease, Smut disease
ii. Sugarcane - Red rot
iii. Ladies finger - Yellow vein mosaic
iv. Potato - Early blight

Reference Books:

1. Pelczar Jr., M.J., Chan, E.C.S. and Krieg, Noel R., Microbiology, McGraw Hill (2003) 5th ed.
2. Stanier, R.Y., Ingraham, J.L. and Wheelis, M.L., General Microbiology, MacMillan (2007) 5th ed.
3. Tortora, G.J., Funke, B.R., and Case, C.L., Microbiology- An Introduction, Pearson Education (2007)8th ed.
4. Burns, R. (2010). Plant Pathology: Techniques and Protocols. Humana Press Inc., USA.
5. Singh, R. S. (2014). Introduction to principles of plant pathology. Oxford & Ibh Publishing Co Pvt Ltd
6. 1 Singh R.S. 2017. Introduction to Principles of Plant Pathology. 5th Edition. Medtech Publisher.
7. Singh RS. 2002. Introduction to Principles of Plant Pathology. Oxford & IBH, New Delhi.
8. Singh DP & Singh A. 2007. Disease and Insect Resistance in Plants. Oxford & IBH, New Delhi

Course Articulation Matrix of PLS 466- Microbiology and PhytoPathology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	2	3		2	2	2
CO2	2	3	2	3		2	2	2
CO3	2	3	2	3		2	2	2
CO4	2	3	2	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Advances in Molecular biology
Course Code: PLS 467
Credits = 02

Course Outcomes:

On the completion of the course, the student will be able to:

CO[1] Learn advance level knowledge on molecular biology
CO[2] Familiarize molecular level details of central dogma
CO[3] Undersatand the various molecular techniques
CO[4] Familiarize molecular level details of Post transcriptional modifications

UNIT-1

Genome Organization: Central Dogma of molecular Biology and reversal of central dogma. Organization of genes as operons in prokaryotes and as multigene family in eukaryotes. Monogenic vs polygenic traits and Quantitative trait loci (QTLs).

UNIT-2

Prokaryotic Transcription: Transcription unit-start site, upstream promoter regions, terminator, RNA polymerases, sigma factors, mechanism of transcription –initiation, elongation and termination Rho- dependant and independent termination; inducible (lactose) and repressible (tryptophan) operons; RNA polymerase interactions; anti-termination by bacteriophage proteins, inhibitors of prokaryotic transcription.

UNIT-3

Eukaryotic Transcription: Transcription, Trancription factors – general features, motifs –zin fingers, leucine zippers, helix-turn helix, homeodomains, regulatory elements –enhancers, silencers, response elements. RNA Polymerase I,II, III. Inhibitors of eukaryotic transcripton.

UNIT-4

Post transcriptional modifications: Intorns, exons, mechanism of gene splicing, 5' cap formation, 3' polyadenylation, RNA editing, RNA interference (RNAi), catalytic role of RNA (Ribozyme); Translation: Translation, Post –translational modification of proteins, transport of proteins and molecular chaperons; Protein stability, Protein turnover and degradation inhibitors of translation

UNIT-5

Techniques in Molecular Biology: Polymerase chain reaction (PCR) Procedure and Components. Types of PCR i) inverse PCR ii) Rapid amplification of cDNA ends (RACE) iii) Real-Time quantitative PCR. PCR applications; Blotting techniques Southern, Western, Northern and Dot Blot. Labelling of Nucleic acids; New Trends in Gene modification – CRISPER/CAS System

Suggested Readings:

1. Krebs, J. E., Goldstein, E. S. & Kilpatrick, S. T. 2018. LEWIN'S GENES XII. Jones & Bartlett Learning.
2. Iwasa, J. & Marshall, W. 2017. KARP'S Cell And Molecular Biology John Wiley & Sons, Inc.
3. Lodish, H., Berk, A., Kaiser, C. A. & Krieger, M. 2012 Molecular Cell Biology. 7 th Edition, W. H. Freeman, NY, USA.
4. Benjamin A. Pierce. 2012. Genetics. A Conceptual Approach 4th Edition. W. H. Freeman and Company. 6. Klug, W. S., Cummings, M. R., Spencer, C. A. & Palladino. M. A. 2012. Concepts of genetics. Pearson Education, Inc.
5. Lodish, H., Berk, A., Kaiser, C. A. & Krieger, M. 2012 Molecular Cell Biology. 7th Edition, W. H. Freeman, NY, USA.
6. Hartwell, L. H., Hood, L., Goldberg, M. L., Reynolds, A. E. & Silver, L. M. 2011. The McGraw Hill Companies, Inc.
7. Russell, P. J. 2010. Genetics: A molecular approach. 3rd Edition. Pearson Education, Inc.
8. Alberts, B., Bray, D., Hopkin, K. & Johnson, A. D. 2009. Essential Cell Biology. 3rd Edition, Garland Science, NY, USA. 39
9. Strickberger, M. W. 2008. Genetics 3rd Edition. Pearson Education India.
10. Weaver, R. F. 2008. Molecular Biology. 5th Edition. McGraw-Hill, New York.
11. Brown, T.A. 2006. Genomes. 3 Garland Science.
12. Tamarin, R. 2001. Principles of Genetics 7th Edition. McGraw Hill Education.
13. Goodenough, U. Genetics. 1984. Holt Saunders, New York. 16. Sinnot, E. W. Dunn, L. C. & Dobzhansky, T. 1958. Principles of Genetics. McGraw Hill, New Delhi.

Course Articulation Matrix of PLS 467- Advances in Molecular biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	3	3	3		2	2	3
CO2	1	3	3	3		2	2	3
CO3	1	3	3	3		2	2	3
CO4	1	3	3	3		2	2	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Plant Physiology and Advanced Biochemistry-LAB
Course Code: PLS 465 (L)
Credits-02

Practicals:

1. Preparation of standard and buffer solutions.
2. Qualitative test for carbohydrates, proteins, amino acids
3. Separation of biomolecules by TLC and paper chromatography.
4. Estimation of DNA (DPA Method)
5. Estimation of total proteins [Bradford's / Lowry's]
6. Effect of pH on enzyme activity.
7. Estimation of Ascorbic acid [Calorimetric / volumetric]
8. Separation of proteins by SDS-PAGE
9. Estimation of moisture content, separation of plant pigments.
10. Measurement of water potential by different methods.
11. Osmosis, plasmolysis, root pressure, transpiration rate.
12. Opening and closing of stomata, separation of xanthophylls and chlorophylls.

Reference Books:

1. Keith Wilson and John Walker,2000. Principle and Technoques of practical Biochemistry.
2. S.R Thimmaiah, 2009. Standard Methods of Biochemical Analysis.
3. H.S. Srivastava N. Shankar Plant physiology and Biochemistry

Course Name: Microbiology and PhytoPathology-LAB
Course Code: PLS 466 (L)
Credits-02

Practicals:

1. Preparation of media and sterilization methods
2. Methods of Isolation of bacteria from different sources (soil/water/air)
3. Differential staining – Gram staining of pure culture of Lactobacillus/Rhizobium
4. To perform standard growth curve of purified bacterial strain
5. Isolation of Rhizobium from root nodule of legumes.
6. A record of all diseases mentioned in the syllabus

Course Name: Advances in Molecular biology-LAB
Course Code: PLS 467 (L)
Credits-02

Course Outcomes:

On the completion of the course, the student will be able to:
CO^1 Bestow practical skill in isolation of DNA
CO^2 Get familiarize the isolation and separation of DNA, RNA and Protein
CO^3 Bestow practical skill in PCR amplification
CO^4 Get familiarize with the spectroscopic techniques

1. Isolation and purification of genomic DNA
2. Estimation of DNA using diphenylamine reagent/UV Spectrophotometry
3. PCR amplification study using thermal cycler (Demonstration only)
4. Electrophoresis – Horizontal and Vertical (Demonstration only)
5. Isolation of total RNA (Demonstration only)
6. Isolation and Partial purification of Proteins

References:

1. Lodish, H., Berk, A., Kaiser, C. A. & Krieger, M. 2012 Molecular Cell Biology. 7th Edition, W. H. Freeman, NY, USA.
2. Alberts, B., Bray, D., Hopkin, K. & Johnson, A. D. 2009. Essential Cell Biology. 3rd Edition, Garland Science, NY, USA.
3. Watson, J.D., Baker T.A., Bell S.P., Gann A., Levine M. & Losick R. 2014. Molecular biology of the gene. 7th Edition. Cold Spring Harbor Laboratory, Tania, MIT
4. Cooper, G. M. & Hausman R. E. 2013. The Cell – A Molecular Approach. Sinauer Associates
5. Jones, R. L. 2012. The Molecular Life of Plants. Wiley-Blackwell.
6. Clark, D. P. 2010. Molecular Biology Elsevier Inc. 7. Cold Spring Harbor Laboratory Course manuals

Course Articulation Matrix of PLS 467 (L)- Advances in Molecular biology-LAB

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	3	3		2	2	2
CO2	2	3	3	3		2	2	2
CO3	2	3	3	3		2	2	2
CO4	2	3	3	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Bio-analytical Techniques in Plant Science
Course Code: PLS 468
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO^1 Apply the concepts of bioanalytical techniques in plant research
CO^2 Operate and optimize the experimental conditions of different analytic Techniques
CO^3 Implement knowledge for the separation of bioentities
CO^4 Implement knowledge for the microscopic techniques

UNIT-1
Centrifugation: Principles of centrifugation, concepts of RCF, different types of instruments and rotors, preparative, differential and density gradient centrifugation, analytical ultra-centrifugation, determination of molecular weights and other applications

UNIT-2
Microscopy: Light microscopy, phase contrast microscopy, fluorescent microscopy, Flow-cytometer, scanning electron microscopy (SEM/FESEM), transmission electron microscopy (TEM)

UNIT-3
Chromatography: Principle, procedure and applications of Paper, Column, Thin layer chromatography and Gas chromatography, Ion exchange chromatography, High Performance Liquid Chromatography (HPLC) and Fast Protein Liquid Chromatography (FPLC)

UNIT-4
Electrophoresis: Principle of gel electrophoresis, polyacrylamide gel electrophoresis (PAGE and SDS-PAGE), agarose gel electrophoresis, pulse field gel electrophoresis (PFGE) and 2-Dimensional gel electrophoresis.

UNIT-5
Spectroscopy: Concepts of spectroscopy, Laws of photometry, Beer-Lamberts law, Visible and UV spectroscopy, Nuclear Magnetic Resonance, atomic absorption and MS spectrophotometry,

Reference Books:

1. Spectrometric identification of Organic Compounds, Robert. M. Silverstein, Basseler, Morril (John Wiley and Sons. N.Y).
2. Principles of Instrumental Analysis by Donglas A. Skoog, James, J. Leary, 4th Edition.
3. Chromatographic Analysis of Pharmaceuticals, John A. Adamovics, 2nd Edition.
4. Instrumental Methods of Chemical Analysis – B. K. Sharma - 9th Edition.
5. Techniques and Practice of Chromatography – Raymond P. W. Scott, Vol. 70.
6. Instrumental Methods of Chemical Analysis – B. K. Sharma - 9th Edition.

Course Articulation Matrix of PLS 468- Bio-analytical Techniques in Plant Science

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	3	3	3		3	3	3
CO2	2	3	3	3		3	3	3
CO3	2	3	3	3		3	3	3
CO4	2	3	3	3		3	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Plant Systematics
Course Code: PLS 469
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO^1 Understand the concepts and principles related to plant systematics
CO^2 Acquire the skill in plant identification and herbaria preparation
CO^3 Create an attitude in conserving plants for sustainable development
CO^4 Get the skill in phylogenetic tree construction

UNIT-1

Classification – brief study of Artificial (Linnaeus), Natural (Bentham and Hooker) and Phylogenetic (Bessey and Takhtajan) systems, Detailed study on modern system of classification, Angiosperm Phylogeny Group (APG) SYSTEM – Principles of the APG System - APG I, APG II, APG III and APG IV

UNIT- 2

Classification of taxonomical literature, general indices, floras, icons, monographs, reviews and journals; Molecular Plant identification, Herbarium – definition, steps involved in the development of herbarium, utility of herbarium and their maintenance, general account of National and regional herbaria with special reference to Central National Herbaria

UNIT -3

Phylogenetic systematics; Taxa and characters; Features of cladogram, Cladogram construction, Cladogram analysis, brief description about major angiosperm clades; Evolution of flowering plants; Angiosperm apomorphies, origin of angiosperms; molecular phylogeny, Gene and Species tree. Molecular evolution and Kimuras theory, Phylogenetic Trees, Terminology in Phylogenetic tree. Phylogram, Significance of Molecular Phylogeny.

UNIT-4

Plant Systematics an over view; Modern concepts and trends in plant systematics. Elementary treatment of i. Cytotaxonomy, ii. Chemotaxonomy,iii. Numerical taxonomy (taximetrics), iv. Molecular taxonomy vs. Biosystematics.

UNIT-5

Study of the following angiosperm families giving importance to morphological peculiarities if any (Special emphasis should be given on morphological and phylogenetic interrelationships, recent revisions and rearrangements between and within the families, and

its critical analysis if any): i.Ranunculacaceae ii. Brassicaceae iii. Malavaceae iv. Asteraceae: v. Fabaceae vi. Rosaceae vii. Apiaceae viii. Apocynaceae: ix. Solanaceae x. Lamiaceae xi. Lilliaceae xii. Poaceae

REFERENCES:

1. Arora PK and Nayar EK. Wild relatives of Crops plants in India, NBPGR Sci. Monograph No. 7.
2. Simpson MG. Plant Systematics, Elsevier publications.
3. Judd WS, Campbell CS, Kellog EA & Stevens PF (1999), PlantSystematics. Sinauer Associates, Inc., Massachusetts, USA.
4. Kochar LS (1981) Economic Botany in the Tropics, Macmillan.
5. Lawrence GHM (1964), Taxonomy of Vascular Plants, Mac Millon Co., New York.
6. Rendle AB (1967), Classification of flowering plants, Cambridge University Press.
7. Sharma OP (1990) Plant Taxonomy, Oxford Publishers, New Delhi.
8. Singh G (1999), Plant systematics: Theory and Practice, Oxford IBH.
9. Sivarajan, V. V. 1999. Principles of Plant Taxonomy, Oxford and IBH Publishing Co
10. Sivarajan, V. V. 1991. An introduction to Principles of Taxonomy, London
11. Stace, C. 1985. Plant Taxonomy and Biosystematics, London.
12. Hutchinson, J. 1959. Families of Flowering Plants, Cambridge University Press.

Course Articulation Matrix of PLS 469- Plant Systematics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	3	2		3	3	3
CO2	3	3	3	2		3	3	3
CO3	3	3	3	2		3	3	3
CO4	3	3	3	2		3	3	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Principles of Ecology and Environment
Course Code: PLS 470
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO[1] Understand characteristics of plants at community, population and ecosystem levels.
CO[2] Have sound background of ecosystem structure and function.
CO[3] Use various tools and techniques for ecological studies
CO[4] Understand the source of the environmental pollution and how to control the pollution in a sustainable way

UNIT-1

Basic concept of Ecology, Environment interaction with ecological factors, Approaches to Ecology, Biological Clocks, Ecological niche, and type of niche, Ecological Equivalents and Character Displacement, Basic Concepts of Population, Population Characteristics and Population Dynamics.

UNIT-2

Methods of study of communities, Individualistic concept and vegetational continuum concept of communities, Interspecific associations and ordination, Community Dynamics, Types of Succession, General process of succession, Hydrosere, Lithosere and Heterotrophic Succession.

UNIT-3

Ecosystem Development, Climax concept and Biome, Structure of Ecosystem, Function of an ecosystem, Ecological Energetic, Nutrients cycles in ecosystem, Basic concept of system ecology, Freshwater Ecology, Marine Ecology, Estuarine ecology, terrestrial ecology and desert ecology

UNIT-4

Forest resources, forest cover, Forest survey of India, Deforestation, Desertification, Afforestation, Energy plantations for ethanol and biodiesel, Conventional and non conventional sources of energy

UNIT-5

Environmental pollution, Kinds, sources, Climate change, Basic concepts of sustainable development, Industrial ecology and recycling industry, role of natural products and biodiversity in international trade.

Reference Books:

1. Ambasht, R. S. and Ambasht, A. K. 2002. A textbook of Plant Ecology. C.B.S. Publishers and Distributors.
2. Kumar, H. D. 2000. Modern Concepts of Ecology. Prentice Hall India, New Delhi.
3. E. P. Odum, 2005,Fundamentals of Ecology, Cengage Publisher, 5 edition
4. P. D. Sharma, 2011, Ecology and Environment, RastogiPublication
5. Chapman, J.L. and Reiss, M.J. 1988. Ecology – Principles and Applications, Cambridge University Press, U.K.
6. Tiwari, S.C. 1993. Concept of Modern Ecology, Bishan Singh Mahendra Pal Singh, Dehra Dun.
7. Kormondy, E.J. 1996. Concepts of Ecology, Prentice-Hall of Indian Ltd., New Delhi

Course Articulation Matrix of PLS 470- Principles of Ecology and Environment

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	3	3	2		2	2	2
CO2	1	3	3	2		2	2	2
CO3	1	3	3	2		2	2	2
CO4	1	3	3	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Community Development
Course Code: PLS 471
Credits = 02

Course Outcomes:

On the completion of the course, the students will be able to:

CO^1 Understand characteristics of plants at community, population and ecosystem levels.
CO^2 Have sound background of ecosystem structure and function.
CO^3 Use various tools and techniques for ecological studies
CO^4 Understand the source of the environmental pollution and how to control the pollution in a sustainable way

Under this course, projects will be given to students to study the concepts in plant sciences with practical approach such as

1. Study of agricultural crop pattern around the villages near to University campus
2. Survey of biodiversity of villages
3. Agricultural weeds
4. Survey and documentation of medicinal Ayurveda practitioners in the surrounding areas to discuss the traditional medicines being used since ages
5. Community Based Natural Resource Management
6. Field trips: Field visit to gardens, standing crop sites, nurseries, vegetable gardens and horticultural fields at agricultural institutes / universities or other suitable locations to aware the students about the natural vegetation, Preparation of Field Notes
7. Plant sample collection, Preparation of Herbarium sheets and preservation. Purpose and importance of herbaria.
8. Attempt be made to grow the ethnobotanical plants
9. Workshops : Creative Writing and Entrepreneurship in plant science (Botany) (Soft skill)

Course Articulation Matrix of PLS 471- Community Development

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	3	3		2	2	2
CO2	3	3	3	3		2	2	2
CO3	3	3	3	3		2	2	2
CO4	3	3	3	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Methods for Vegetation Mapping
Course Code: PLS 472
Credits = 02

Course Outcomes:

After completing this course, the student will be able to:

CO^1 Evaluate vegetation dynamics and variations
CO^2 Evaluate the mapping and distribution of vegetation
CO^3 Analyse data reviews, sampling approach and management using modern tools
CO^4 Analyse the Characteristics of a Successful Sampling Approach

UNIT-1
Nature of Vegetation, Community vs. Continuum, Vegetation Structure and Parameters (occurrence of species, Frequency, Cover), Different methods for field sampling - Quadrat, linetransect and random spot method

UNIT-2
Vegetation Dynamics (Seasonal Variations and Succession) and its spatial distribution, various approaches for sampling (Stratified Random Sampling, Ecological gradients, Sampling scale issue and Gradient Oriented Transect (Gradsect) Sampling)

UNIT-3
Relationships between Classification and Mapping, Characteristics of a Successful Sampling Approach (Flexibility, Replicability, Cost Effectiveness)

UNIT-4
Overview of Planning Process and Field Methods: Preliminary Collection and Review of Existing Information, Initial Site Visit and Information Gathering, Review of data

UNIT-5
Sampling Approach, Collection of Field Data, GIS and GPS, Remote Sensing, Management and Analysis and Photo interpretation

Reference Books:

1. Causton, D.R.(1988). An Introduction to Vegatational Analysis: Principles, Practice and Interpretation. Unwin Hyman, Boston.
2. Pearcy, R.W., Mooney, H.A., Rundel, P.W. (2011).Plant Physiological Ecology: Field methods and instrumentation. Springer.
3. Ferretti, M., Fischer, R. (2013).Forest Monitoring: Methods for Territorial investigations in Europe with an overview of North America and Asia. Elsevier.
4. Brocklehurst, P., Lewis, D., Napier, D., Lynch, D. (2007) Northern Territory Guidelines and Field Methodology for Vegetation Survey and Mapping. Technical Report No. 02/2007D. Department of Natural Resources, Environment and the Arts, Palmerston, Northern Territory.
5. William G. Cochran (2012) Sampling Techniques, 3ed, Wiley

Course Articulation Matrix of PLS 472- Methods for Vegetation Mapping

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	2	3	2		2	2	1
CO2	3	2	3	2		2	2	1
CO3	3	2	3	2		2	2	1
CO4	3	2	3	2		2	2	1

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Fundamentals of Seed Technology
Course Code: PLS 473
Credits = 02

Course Outcomes:

After completion of the course, the students will be able to:

CO[1] Understand the seed development process and different ways of its processing
CO[2] Examine the various methods of Seed testing
CO[3] Explain the concept of hybrid seed production
CO[4] Understand the evaluation of seed related traits

UNIT-1
Overview of seed Technology: types of seeds and their characteristics, Development of seed and morphology, Difference between monocot and dicot seed, Seed Dormancy, methods of breaking dormancy

UNIT-2
Seed germination: pattern and basic requirement for germination, normal and abnormal seedlings, germination inhibitors, Evaluation of seed related traits

UNIT-3
Seed processing: Methods of seed conditioning, Methods used for seed treatment, Principles of seed storage: various methods for seed storage, factors affecting seed storage, Seed viability, Methods of testing of seed viability

UNIT-4
Overview of seed certification, Function of seed certification agency, Seed Legislation and Act in India, Basic concept of seed pathology and seed entomology.

UNIT-5
Principles and methods of seed production, Importance of seed marketing, Concept of hybrid seed and its production

Reference Books:

1. Agrawal, P. K., (2010). Principles of Seed Technology. Indian Council of Agricultural Research, New Delhi.
2. Agrawal, R.L. (2015). Seed Technology. Oxford & Ibh Publishing Co Pvt Ltd.

3. Basra, A. (2006). Handbook of Seed Science and Technology. CRC Press.
4. Khare, D. and Bhale, M. S. (2014). Seed Technology 2nd Revision, Jain Book

Course Articulation Matrix of PLS 473- Fundamentals of Seed Technology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	2	2	2		2	2	2
CO2	3	2	2	2		2	2	2
CO3	3	2	2	2		2	2	2
CO4	3	2	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Historical Perspectives of Economic Plants of India
Course Code: PLS 474
Credits = 02

Course Outcomes:

At the end of the course, Student will be able to:

CO[1] Identify the concept of Traditional knowledge and its importance.
CO[2] Explain the need and importance of protecting traditional knowledge.
CO[3] Explain the importance of Traditional knowledge in Agriculture and Medicine
CO[4] Explain the importance of Yoga and Holistic Health care

UNIT-1
Traditional knowledge (TK) vs western knowledge, Legal concepts for the protection of traditional knowledge, Traditional medicine system, Traditional knowledge in agriculture.

UNIT-2
The Pre-Vedic Period (10000 B.C. – 1500 B.C.), Vedic Period (1500 B.C. – 500 B.C.) and Post-Vedic Period (500 B.C. – A.D. 600): The Brief description of use of Medicinal plants, Functional foods in Vedas viz. Rigveda, Yajurveda, Atharveda and ancient Ayurvedic treatises like Charaka Samhita, Sushruta Samhita.

UNIT-3
The Early Mediaeval Period (A.D. 600 - A.D. 1400): Brief description of plants, foods in various ancient Ayurvedic treatises like, Ashtanga Hridya, Chakradatta, Sharangdhara Samhita, Bhel Samhita, Harita Samhita, Vangasena.

UNIT-4
The Late Mediaeval Period (A.D. 1400 – A.D. 1800): Brief description of use of Medicinal plants, Functional foods in various ancient Ayurvedic treatises like Bhava Prakasha, Bhaishajya Ratnavali, and Arka Prakasha.

UNIT-5
Yoga and Holistic Health care

Reference Books:

1. Traditional Knowledge System and Technology in India (English, Hardcover, Basanta Kumar Mohanta, Vipin Kumar Singh) Edition : 2012 Language English

2. Panpaatu Maanudaviyal: Author: Bakthavachala Barathi, Meyappan Pathippagam,Chidambaram- Edition2009; Language: Tamil
3. Traditional Knowledge System in India, by Amit Jha, 2009.
4. Traditional Knowledge System in India by Amit Jha Atlantic publishers, 2002.
5. Knowledge Traditions and Practices of India" Kapil Kapoor1, Michel Danino.
6. V. Sivaramakrishnan (Ed.), Cultural Heritage of India-course material, Bharatiya Vidya Bhavan, Mumbai. 5th Edition, 2014

Course Articulation Matrix of PLS 474- Historical Perspectives of Economic Plants of India

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	1	1	1		2	2	2
CO2	3	1	1	1		2	2	2
CO3	3	1	1	1		2	2	2
CO4	3	1	1	1		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

SEMESTER - III

Course Name: Fundamentals of "Omics" Technologies
Course Code: PLS 515
Credits = 04

Course Outcomes:

On the completion of the course, the students will be able to:

CO^1 provide the basic knowledge on Bioinformatics and its applications
CO^2 familiarize the students on protein and nucleic acid data bases
CO^3 introduce the advance aspects of genomics, proteomics and metabolomics and its applications
CO^4 familiarize the students with Gas and liquid chromatography

UNIT-1
Introduction to Bioinformatics: Definition and History of Bioinformatics; Biological databasesTypes of data and databases, Nucleotide sequence database (EMBL, GENBANK, DDBJ) - Protein sequence database (PIR, SWISS-PROT, TrEMBEL), Secondary Databases (PROSITE, PRINTS, BLOCKS), Protein Structure Database (PDB).

UNIT-2
Tools (Softwares) used in Bioinformatics - BLAST (including ALGORITHM of BLAST), Sequin, ClustalX, Clustal W, RasMol, Treeview, Phylip, GRAIL, GENSCAN, BIOPERL.

UNIT-3
Genomics: Genome, Molecular markers: RFLP,RAPD, SSR, SNPs, Sangers DNA Sequence, Brief note on Next Generation Sequencing (NGS), 16s r DNA sequencing, Whole genome sequencing (WGS); Applications of genomics Transcirpomics: Microarrays, RNA Sequencing (RNA-Seq), Applications of transcriptomics

UNIT-4
Proteomics: Gel based and gel free proteomics; SDS PAGE, 2D PAGE, Mass spectrometry, protein identification by peptide mass finger printing; Applications of proteomics

UNIT-5
Metabolomics; Metabolome tools: Gas and Liquid chromatography, Applications of metabolomics

References Books:

1. Rocha, M. & Ferreira, P.G. 2018. Bioinformatics Algorithms: 1st Edition. Academic Press.
2. Momand, J. & McCurdy, M. 2017. Concepts in Bioinformatics and Genomics. Oxford University Press.
3. Jeremy, R. 2015. Bioinformatics: An Introduction. Springer Publishing Co.
4. Choudhuri, S. 2014. Bioinformatics for Beginners. 1st Edition. Academic Press.
5. Kumar, S. A, Mohan T. C. K., Murugan, K. & Subramaniyan, S. 2011. General Informatics and Bioinformatics. Ane Books India Pvt Ltd.
6. Xiong, J. 2007. Essential Bioinformatics, Cambridge University Press India, Pvt Ltd.
7. Higgs, P. G. 2005. Bioinformatics and Molecular Evolution, Ane Books India Pvt Ltd.
8. Vyas, S.P. & Kohli, D.V. 2007. Methods in Biotechnology and Bioengineering. CBS Publishers and Distributors.

9. Evens, W.J. & Grant, G.R. 2005. Statistical Methods in Bioinformatics: An Introduction. Springer.
10. Claverie, J.M. & Notredame C. 2003 Bioinformatics for Dummies.Wiley Editor.
11. Mount, D.W. 2001. Bioinformatics – Sequence and GenomeAnalysis, 1st Edn, Cold Spring Harbor Laboratory Press, New York, USA.
12. Pierre Baldi & Soren Brunak. 2001. Bioinformatics: The Machine Learning Approach. 2nd Edition. The MIT Press
13. Lesk, A.M. 2002. Introduction to Bioinformatics, 1st Edn. Oxford University Press, Oxford, UK.
14. Patterson, B.K. 2000. Techniques in Quantification and Localization of Gene Expression.
15. Liu, B.H. 1998. Statistical Genomics: Linkage Mapping and QTL Analysis. CRC Press.
16. Discovering Genomics, Proteomics, and Bioinformatics, 2nd edition –A Malcom Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4) Cold Spring HarbourLabortory press and Benjmin Cumnings.28Feb 2006.

Course Articulation Matrix of PLS 515 - Fundamentals of "Omics" Technologies

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	2		2	2	2
CO2	2	2	3	2		2	2	2
CO3	2	2	3	2		2	2	2
CO4	2	2	3	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Ethnobotany and Ethnopharmacology
Course Code: PLS 516
Credits = 04

Course Outcomes:

At the end of the course, Student will be able to:

CO^1 know about the morphology and cultivation of plants used in daily life as food, fibers, spices etc.
CO^2 gain the knowledge about aesthetic and medicinal and industrial values of plants
CO^3 use different medicinal plants for a particular disease
CO^4 understand the active mechanism of medicinal and aromatic plants.

UNIT-1

Ethnobotany in brief: History and objectives, Indigenous Systems of Medicines: Basic concept and development of Ayurveda, Siddha, Unani, Yoga, Homeopathy and Naturopathy

UNIT-2

Different ethnic groups and their role in conservation of medicinally important plant genetic resources, role of indigenous people for plant based drug identification, Regulatory/Legal perspective related with Ethnobotany and traditional Knowledge

UNIT-3

Definition, scope and applications in herbal medicine. Classification and identification of drugs: Need for classification of drugs; classical (taxonomic, morphological, organoleptic, therapeutic); microscopy and modern (biogenetic)

UNIT-4

Types, methods of evaluation, biological, anatomical, physical, phytochemical investigation. status of Indian medicinal plant trade, WHO regulation of herbal medicine, CHMP/ CVMP guidelines of the European Medicines Agency Inspections

UNIT-5

Principles of extraction methods, types of extraction. Extraction of Plant drugs by Microwave assisted techniques and their merits and demerits. Selection of Solvents for extraction.

References Books:

1. Dey. P.M. and J.B.Horborne: Plant Bio Chemistry Acadamic Press, London.
2. Sadasivam. S. and A. Manickam: Bio Chemical methods 2nd edition. New Age International Pvt. Ltd. New delhi.
3. Dennis D.T., Turpin, D.H. Lefebvre, Layzell D.D and D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.
4. Verma S.K. and Verma Mohit 2007. A.T. B of Plant Physiology, Biochemistry and Biotechnology, S.Chand Publications
5. Leninger A.C 1987. Principles of Biochmistry, CBS Publishers and Distributers (Indian Reprint).

Course Articulation Matrix of PLS 516 - Ethnobotany and Ethnopharmacology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	2	1		2	2	2
CO2	3	3	2	1		2	2	2
CO3	3	3	2	1		2	2	2
CO4	3	3	2	1		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Plant Biotechnology and Genetic Engineering
Course Code: PLS 517
Credits = 04

Course Outcomes:

On the successful completion of the course, student will be able to:

CO^1 understand the different types of plant tissue culture
CO^2 perform genetic manipulations using types of enzymes and vectors
CO^3 examine gene cloning and evaluate different methods of gene transfer
CO^4 analyze the major concerns and applications of transgenic technology

UNIT-1

Micropropagation: Principles and techniques of tissue culture, Principles and practices of clonal selection, Preparation of stock solution and tissue media for micropropagation, Stages of Micropropagation, Types of Micropropagation Techniques (Meristem culture, Pollen culture, Ovary culture, Callus culture), Artificial Seed production, Application of Micropropagation approach and its exploitation for commercial purpose

UNIT-2

Introduction to genetic engineering, Enzymes used in genetic engineering: Restriction enzymes, Ligases, Polymerases, Kinases and Phosphatases, DNA methylases and Topoisomerases, Homopolymer tailing, Linkers, Adaptors

UNIT-3

Isolation and purification of nucleic acids, DNA sequencing; Maxam Gilbert's and Sanger dideoxy chain termination and automated methods of DNA sequencing, Construction of genomic and c-DNA libraries, chromosome walking; Screening of libraries

UNIT-4

Vectors, General characteristics of cloning and expression vectors: Plasmids, bacteriophages, phagemids, cosmids; Artificial chromosomes as vectors: YAC, BAC and their applications

UNIT-5

Transformation methods: Chemical methods: calcium phosphate precipitation method, liposome mediated method; Physical methods: Particle bombardment, Electroporation and Microinjection, Agrobacterium mediated gene transfer in plants, Screening and selection of transformants, Generation and maintenance of transgenic plants, molecular farming, Genetically modified (GM) plants (Bt cotton, Bt Brinjal)

References Books:

1. Maheshwari, P. and Rangaswamy, N.S. (Eds.) 1963. Plant, Tissue and organ culture – A symposium, Intern. Soc. Plant Morphologists, New Delhi.
2. Plant Biotechnology and Genetics: Principles, Techniques and Applications by C.Neal Stewart (Wiley Publisher, 2008)
3. Plant Biotechnology and Genetic Engineering by N. Arumugam and V. Kumaresan, 1st Edition, Saras Publication
4. Plant Genetic Engineering by A.D. Arencibia, 1st Edition Volume 5, Elsevier Science, 2000
5. Brown, T. (2010). Gene cloning and DNA analysis: an introduction. John Wiley & Sons.
6. Primrose, S. B., & Twyman, R. (2009). Principles of gene manipulation and genomics. Wiley. com.
7. Howe, C. J. (2007). Gene cloning and manipulation. Cambridge University Press.

Course Articulation Matrix of PLS 517 - Plant Biotechnology and Genetic Engineering

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	3		2	2	2
CO2	2	2	3	3		2	2	2
CO3	2	2	3	3		2	2	2
CO4	2	2	3	3		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Underutilized Economic plants
Course Code: PLS 518
Credits = 04

Course Outcomes:

At the end of the course, Student will be able to:

CO^1 understand the role and value of underutilized plants that has potential for diversification of food basket to ensure better food and nutritional security.
CO^2 explore the plants and plant products encountered in everyday life
CO^3 appreciate the diversity of plants
CO^4 explore the utilization of plant products in human use

Course Content:
Introduction, origin and taxonomy, climatic and soil requirements, commercial varieties/hybrids, sowing/planting times and methods, seed rate & seed treatment, nutritional and irrigation requirements, intercultural operations, weed control, mulching, physiological disorders, harvesting, post-harvest management, plant protection measures and seed production.

UNIT-1
Amaranth, Asparagus and Artichoke and Bamboo

UNIT-2
Leek Brussels' sprouts Chinese cabbage, broccoli, kale and Kachnar

UNIT-3
Celery, parsley, parsnip, lettuce, rhubarb, spinach, basella, bathu (chenopods), chekurmanis and Lasoda, Discoria sp.

UNIT-4
Elephant foot yam, lima bean, winged bean, vegetable pigeon pea, jack bean and sword bean

UNIT-5
Sweet gourd, Spine gourd, pointed gourd, oriental pickling melon and little gourd (kundru), colocasia

Reference Books:

1. Bhat KL 2001, Minor vegetables-untapped potential
2. Indira P & Peter KV.1984.Unexploited tropical vegetables
3. Peter KV (Ed) 2007-08.Underexploited and underutilized horticultural crops Vol.I-IV
4. Rubatzky VE Yamaguchi M (Eds).1997.World vegetables: Principles, Production and nutritive values.
5. Srivastava U,Mahajan RK,Gangopadhyay KK,Singh M & dhillon BS (2001).Minimal descriptors of agri-horticultural crops.Part-II: Vegetable Crops. NBPGR

Course Articulation Matrix of PLS 518 - Underutilized Economic plants

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	3	2		2	2	2
CO2	3	3	3	2		2	2	2
CO3	3	3	3	2		2	2	2
CO4	3	3	3	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Fundamentals of Research Methodology
Course Code: PLS 519
Credits = 04

Course Outcomes:

At the end of the course, Student will be able to:
CO[1] understand the concept of research and different types of research in the context of biology
CO[2] develop laboratory experiment related skills.
CO[3] develop competence on data collection and process of scientific documentation
CO[4] analyze the ethical aspects of research

UNIT-1: Science and Research
Scientific Research: Definition and Characteristics, Different types, Identification of the problem, assessing the status of the problem, formulating the objectives, preparing design (experimental or otherwise), Actual investigation.

UNIT-2: Introduction to Research Methodology:
Meaning and importance of Research: Types of Research, Selection and formulation of Research Problem; Research Design: Developing a Research Plan, Experimental and Sample Designs; Analysis of Literature Review; Hypothesis: Different Types, Significance, Development of Working Hypothesis, Null hypothesis; Research Methods: Scientific method vs Arbitrary Method, Logical Scientific Methods

UNIT-3: Data Collection and Analysis
Sources of Data: Primary, Secondary and Tertiary, Types of Data: Categorical, nominal & Ordinal; Methods of Collecting Data: Observation, field investigations, Direct studies: Reports, Records or Experimental observations; Sampling methods: Data Processing and Analysis strategies, Graphical representation, Descriptive Analysis, Inferential Analysis, Correlation analysis, Least square method; Data Analysis using statistical package, Generalization and Interpretation.

UNIT-4: **Scientific Writing**

Significance of Report Writing, Different Steps in Writing Report, Layout of the Research Report, Types of Reports, Oral Presentation, Mechanics of Writing a Research Report, Precautions for Writing Research Reports, Conclusions,

UNIT-5: **Ethics**

Ethical Issues: Ethical Committees, Commercialization, copy right, royalty, Intellectual Property rights and patent law; Reproduction of published material: Plagiarism, Citation and Acknowledgement, Reproducibility and accountability

Reference Books:

1. Dawson, C. (2002). Practical research methods. UBS Publishers, New Delhi.
2. Stapleton, P., Yondeowei, A., Mukanyange, J., Houten, H. (1995). Scientific writing for agricultural research scientists – a training reference manual. West Africa Rice Development Association, Hong Kong.
3. Sinha, S.C. and Dhiman, A.K., 2002. Research Methodology, Ess Ess Publications. 2 volumes. Trochim, W.M.K., 2005. Research Methods: the concise knowledge base, Atomic Dog Publishing. 270p.
4. Wadehra, B.L. 2000. Law relating to patents, trade marks, copyright designs and geographical indications. Universal Law Publishing.
5. Fink, A., 2009. Conducting Research Literature Reviews: From the Internet to Paper. Sage Publications
6. Leedy, P.D. and Ormrod, J.E., 2004 Practical Research: Planning and Design, Prentice Hall.

Course Articulation Matrix of PLS 519 - Fundamentals of Research Methodology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	2	2		2	2	2
CO2	1	1	2	2		2	2	2
CO3	1	1	2	2		2	2	2
CO4	1	1	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Biostatistics
Course Code: PLS 520
Credits = 02

Course Outcomes:

At the end of the course, Student will be able to:

CO^1 understand role of statistics in biological science
CO^2 understand Correlation, regression, Chi-SquareTest, F-Test and Analysis of Variance
CO^3 use different methods by different software such as Microsoft Office
CO^4 understand role of SPSS, MATLAB in biological science

UNIT-1

Measures of Dispersion: Range, Quartile Deviation, Mean deviation, Standard deviation, Variance and their Coefficients.

UNIT-2

Correlation: Introduction and Significance. Types of Correlation, Methods of studying Correlation, Correlation coefficient, Illustrations. **Regression Analysis:** Regression analysis, Application and limitations, Regression coefficient, Regression coefficient and Regression Lines and its Illustrations.

UNIT-3

Chi-SquareTest: Introduction, Properties and Applications of Chi Square Test.Chi-square test for independence of attributes, Goodness of fit and homogeneity of samples.

UNIT-4

F-Test and Analysis of Variance: Null and alternative hypothesis, Type I and type II errors, F-Test, Analysis of Variance or ANOVA-One and two way ANOVA

UNIT-5

Software Analysis: Use of different software like Microscoft Office, SPSS, MATLAB for above mentioned units

Reference Books:

1. Milton. Susan, Statistical Methods in the Biological and Health sciences, MGH, 2nd ed. or later editions.
2. Jerrold H. Zar, Biostatistical Analysis, Pearson publication.
3. S. C. Gupta & V.K. Gupta, Mathematical Statistics, Sultan Chand & Sons.
4. K. C. Aggarwal, Biostatistics, Bioinformatics & Computer Application, Nidhi Publisher.
5. Essential Bioinformatics By Jin Xiong, Cambridge University Press
6. Rao, P.S. and Richard, J., An introductions to Biostatistics, 3rded, 1996.
7. Principle of Biostatistics, Marcello Pagono, Thomson Learning, 2004 Brooks & Cole.
8. Introduction to Biostatistics: Glover, T. & Mitchell, K. (2002) Mc Graw- Hill, New York.

Course Articulation Matrix of PLS 520 - Biostatistics

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	2	2		2	2	2
CO2	1	1	2	2		2	2	2
CO3	1	1	2	2		2	2	2
CO4	1	1	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Fundamentals of Computer Applications in Data analysis
Course Code: PLS 521
Credits = 02

Course Outcomes:

At the end of the course, Student will be able to:

CO^1 understand the IT applications in the area of biology

CO^2 open Office tools using document preparation and spreadsheet handling packages

CO^3 plot graphs, use of Internet and its application

CO^4 understand the technical skills in the area of biology

Software for paper formatting like MS Office

UNIT-1

Word Processing Word processing concepts: saving, closing, Opening an existing document, Selecting text, Editing text, Finding and replacing text, printing documents, Creating and Printing Merged Documents, Character and Paragraph Formatting, Page Design and Layout. Editing and Profiling Tools: Checking and correcting spellings. Handling Graphics, Creating Tables and Charts, Document Templates and Wizards.

UNIT-2

Spreadsheet Package Spreadsheet Concepts, Creating, Saving and Editing a Workbook, Inserting, Deleting Work Sheets, entering data in a cell / formula Copying and Moving from selected cells, handling operators in Formulae, Functions: Mathematical, Logical, statistical, Formatting a Worksheet: Formatting Cells – changing data alignment, changing date, number, character or currency format, changing font, adding borders and colors, Printing worksheets, Charts and Graphs – Creating, Previewing, Modifying Charts

UNIT-3

Presentation Package Creating, Opening and Saving Presentations, Creating the Look of Your Presentation, Working in Different Views, Working with Slides, Adding and Formatting Text, Formatting Paragraphs, Checking Spelling and Correcting Typing Mistakes, Making Notes Pages and Handouts, Drawing and Working with Objects, Adding Clip Art and other pictures, Designing Slide Shows, Running and Controlling a Slide Show, Printing Presentations.

UNIT-4

WWW and Web Browsers: Web Browsing software, Surfing the Internet, Basic of electronic mail, Using Emails, Document handling, Network definition, Common terminologies: LAN, WAN, Node, Host, Workstation, bandwidth, Network Components: Severs, Clients, Communication Media.

UNIT-5

Methods to search required information effectively, Multimedia software like Adobe Photoshop

Reference Books:

1. A.Goel, Computer Fundamentals, Pearson Education, 2010.
2. P. Aksoy, L. DeNardis, Introduction to Information Technology, Cengage Learning, 2006
3. P. K.Sinha, P. Sinha, Fundamentals of Computers, BPB Publishers, 2007

Course Articulation Matrix of PLS 521 - Fundamentals of Computer Applications in Data analysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	2	2		2	2	2
CO2	1	1	2	2		2	2	2
CO3	1	1	2	2		2	2	2
CO4	1	1	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Data mining for Review of Literature
Course Code: PLS 522
Credits = 02

Course Outcomes:

At the end of the course, Student will be able to:

CO[1] present a structured philosophical framework for critically analyzing the theoretical arguments of others, as well as developing and defending one's own arguments.

CO[2] write effective research paper, review article.

CO[3] understand the Guidelines for maintaining Academic integrity while writing Literature review

CO[4] write effective research proposal and thesis.

UNIT-1
What is Literature review? Definition and characteristics of literature review. Significance of literature reviews in scientific study

UNIT-2
Difference between Literature review and Academic paper, Types of Literature reviews: Evaluative, Explorative, Instrumental and Systematics

UNIT-3
Sources of Literature Review: Primary and Secondary. Use of Search Engines in Literature Review: PubMed, Google Scholar

UNIT-4
Structure of Literature Review (Introduction, Body and Conclusion), Characteristics of a good literature review

UNIT-5
Strategies for writing discipline specific literature review, Guidelines for maintaining Academic integrity while writing Literature review

Course Articulation Matrix of PLS 522 - Data mining for Review of Literature

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	1	2		1	1	3
CO2	1	1	1	2		1	1	3
CO3	1	1	1	2		1	1	3
CO4	1	1	1	2		1	1	3

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Research Proposal/Project writing
Course Code: PLS 523
Credits = 02

Course Outcomes:

At the end of the course, Student will be able to:

CO[1] demonstrate the ability to conduct literature reviews and gather the critical scientific information related to the research proposal

CO[2] demonstrate writing skills by writing, a clear, concise research proposal with scientifically defensible aims, methods and conclusions

CO[3] understand howproposed research would lead to a significant improvement over the original studies

CO[4] understand how to publish the research work

UNIT-1

Guidelines for preparation of research proposals, Academic Integrity while writing for a Research Proposal, Identification of the particular research problem. **Introduction:** Explain the issue you are examining and why it is significant

UNIT-2

Background/Review of the Literature

- A description of what has already known about this area and short discussion of why the background studies are not sufficient.
- Discuss several critical studies that have already been done in this area (cite according to APA style).
- Point out why these background studies are insufficient. In other words, what question(s) do they leave unresolved that you would like to study?

Rationale

A description of the questions you are examining and an exploration of the claims.

- Explain how these research questions are related to the larger issues raised in the introduction.
- Describe what specific claim, hypothesis, and/or model you will evaluate with these questions.

UNIT-3

Methodology and Research Design

A description of how you would go about collecting data and test the questions you are examining.

Method: How would you collect the data and why?

- Describe the general methodology you choose for your study, in order to test your hypothesis.
- Explain why this method is the best for your purposes.

Design: What would the stimuli look like and why?

- Describe what kinds of manipulations/variations you would make or test for in order to test your hypothesis.
- Controls: What kinds of factors would you need to control for in your study?
- Describe what types of effects would be likely to occur which would make your results appear to confirm, or to disconfirm your hypothesis.

Analysis

- How will you analyze the results?
- What kind of results would *confirm* your hypothesis?
- What kind of results would *disconfirm* your hypothesis

UNIT-4

Significance and Conclusion

- Discuss, in general, how your proposed research would lead to a significant improvement over the original studies, and how it would benefit the field. (In other words, why should someone care?
- If you were applying for money to do this, why would someone fund you? If you wanted to publish your results, why would they be interesting?)

References

Include all references in APA style.

UNIT-5

Inclusion of budgetary requirement with its justification, Include permission / endorsement letter from parent organization for onward submission of Project proposal to discipline specific funding agency for the financial support

Course Articulation Matrix of PLS 523 - Research Proposal/Project writing

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	3	2		2	2	3
CO2	3	3	3	2		2	2	3
CO3	3	3	3	2		2	2	3
CO4	3	3	3	2		2	2	3

1. Partially Related
2. Moderately Related
3. Highly Related

SEMESTER - IV

Course Name: Herbal medicines in Human Health Care
Course Code: PLS 565
Credits = 04

Course Outcomes:

At the end of the course, Student will be able to:

CO^1 analyse various plant drugs in single and combination dosage forms
CO^2 understand identification, processing and finishing of herbal drugs
CO^3 understand role of bioactive molecule in herabal drug
CO^4 know how herbal based is used for particular disease

UNIT-1
Role of natural products in herbal medicines, General status and importance of herbal medicines, Safety of herbals/herbal pharmacovigilance

UNIT-2
Herbs as raw materials, definition of herb, herbal medicines, herbal medicinal product and herbal drug preparations, source, selection, identification and authentification of herbal materials, Drying and processing of herbal raw materials, packing and labelling of finished products

UNIT-3
Preparation of liquid orals, tablets, capsules, ointments, creams and cosmetics, monoherbal and polyherbal formulation with their merits and demerits, Excipeints used in herbal formulation, pharmacokinetic aspects for herbal drugs, and clinically used herbal drugs

UNIT-4
Isolation of bioactive steroids such as, diosgenin, estrone, estrodiol, isolation and characterization of terpenes, bioactive alkaloids-isolation such as atropine, quinine, papaverine, thebaine, vincristine

UNIT-5
Screening of natural products for the various biological activities like Antidiabetic, Antihypertensive, Antipyretics, Antioxidants, Antibacterial and Immunomodulators

References Books:

1. Pharmacognosy by G.E. Trease, W.C.Evans, ELBS.
2. Pharmacognosy by Verno E. Taylor, Linn. R.Braddy, James E.Robberts, K.M.Varghese Co. Mumbai.
3. Text Book of Pharmacognosy by T.E.Wallis, CBS Publication, Delhi.
4. Indian Herbal Pharmacopoeia Vol. I and II
5. British Herbal Pharmacopoeia
6. Standardisation of botanicals testing and extraction methods of Medicinal Herbs by Dr. Rajpal.Vol. I and II
7. General Pharmacy by J.W. Cooper and Coline Gunn
8. Research guideline for evaluating for the safety and efficacy of herbal medicines, WHO publications (ISBN)
9. Quality control methods for medicinal plant materials- WHO
10. Dey. P.M. and J.B.Horborne: Plant Bio Chemistry Acadamic Press, London.

11. Sadasivam. S. and A. Manickam: Bio Chemical methods 2nd edition. New Age International Pvt. Ltd. New delhi.
12. Dennis D.T., Turpin, D.H. Lefebvre, Layzell D.D and D.B. (eds) 1997. Plant Metabolism (Second Edition) Longman, Essex, England.

Course Articulation Matrix of PLS 565 - Herbal medicines in Human Health Care

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	2	2		2	2	2
CO2	2	2	2	2		2	2	2
CO3	2	2	2	3		2	2	2
CO4	2	2	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: *In Vitro* Plant Biology
Course Code: PLS 566
Credits = 04

Course Outcomes:

On the completion of the course the students will be able to:

CO^1 familiarize with the tools and techniques of plant tissue culture
CO^2 understand the possibility for the production of elite plants
CO^3 apply the technique in micropropagation of plants
CO^4 establish a commercial micropropagation unit

UNIT-1
Historical developments and landmarks in plant tissue culture, Totipotency, Basic techniques in plant tissue culture. Media formulation for plant tissue culture. Role of Plant growth regulators in plant differentiation and morphogenesis,

UNIT-2
Induction of morphogenesis *in vitro*, Somatic embryogenesis and Organogenesis. Factors affecting somatic embryogenesis and organogenesis, Synthetic seeds and their applications

UNIT-3
Somaclonal and gametoclonal variations, Meristem culture, Endosperm culture, Production of haploids using anther and pollen – Importance and applications, Initiation and maintenance of callus cultures, cell suspensions cultures, Mass cultivation of plant cells using bioreactors

UNIT-4
Production of secondary metabolites from cell cultures and hairy root cultures, Isolation, purification and culture of protoplasts, Methods used for protoplast fusion, Somatic hybridization/cybridization

UNIT-5
Germplasm storage *in vitro*, cryopreservation, Strategies used for enhanced production of secondary metabolites, Commercial exploitation of micropropagation approach

Reference Books:

1. Plant Cell and Tissue Culture Edited by Indra K. Vasil and Trevor A. Thorpe, Kluwer Academic Publishers
2. Plant Tissue Culture: Theory and Practice By S. S. Bhojwani and M. K. Razdan Elsevier Publishers
3. *In Vitro* Cultivation of Plant Cells BIOTOL Biotechnology by Open Learning Butterworth/Hernemann Ltd.
4. Plant Cell Biotechnology By R. Endress, Springer-Verlag
5. Plant Tissue Culture: Applications and Limitations By S. S. Bhojwani
6. Plant Tissue Culture By Kalyan Kumar De

Course Articulation Matrix of PLS 566 - *In Vitro* Plant Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	2	2		2	2	2
CO2	2	2	2	2		2	2	2
CO3	2	2	2	3		2	2	2
CO4	2	2	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Plant Stress Biology
Course Code: PLS 567
Credits = 04

Course Outcomes:

On the completion of the course the students will be able to:

CO^1 develop the understanding of concept of stress, stress factors
CO^2 develop the ability for critical appraisal of various physiological mechanisms that protect the plant from environmental stress i.e. adaptation, avoidance and tolerance.
CO^3 analyze the role of production and scavenging mechanisms
CO^4 develop the understanding of resistance mechanisms.

UNIT-1

Plant and environment, environmental strain, Concept of plant stress and stress factors, biotic and abiotic stresses, stress phases, alarm reaction, hardening, resistance, Tolerance, acclimation and avoidance

UNIT-2

Stress response (specific and aspecific responses), Various mechanisms of acquiring resistance to Temperature stress, drought stress, Salinity stress, Sensing and uptake of toxic heavy metals, Photoinhibition, stress caused by excess light and Stress caused by xenobiotics, Pyrethroids, isoprenoids and alleopathy

UNIT-3
Biotic stress caused by viruses, bacteria and fungi. Constitutive and induced resistance, recognition and specificity, Wounding, Stress caused by herbivores.

UNIT-4
Signalling: Hormonal, Calcium modulation, Phospholipid signaling.

UNIT-5
Oxidative stress. Production of active oxygen forms in plants, their physiological effects, Oxidative damage of macromolecules. Protective mechanisms. Sensing of anoxya and hypoxya caused by flooding.

Reference Books:

1. Jenks M. A. and Hasegawa P. M. (eds..) Plant Abiotic Stress p.270. Blackwell Publishing, Oxford (2005)
2. Smirnoff N. (ed.) Antioxidants and Reactive Oxygen Species in Plants p. 302. Blackwell Publishing, Oxford (2005)
3. Huang B. (ed.) Plant-Environment Interactions p.388 Taylor & Francis Boca Raton, etc (2006)
4. Hopkins, W.G. and Huner, A. (2008). Introduction to Plant Physiology. 4th edition.John Wiley and Sons. U.S.A.
5. Taiz, L., Zeiger, E., MØller, I.M. and Murphy, A (2015). Plant Physiology and Development. 6th edition. Sinauer Associates Inc. USA.
6. Singh D.P. (2003).Stress Physiology. New Age International pvt. Ltd.

Course Articulation Matrix of PLS 567 - Plant Stress Biology

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	3	3	2	2		2	2	2
CO2	3	3	2	2		2	2	2
CO3	3	3	2	2		2	2	2
CO4	3	3	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Grafting techniques in Plants
Course Code: PLS 568
Credits = 04

Course Outcomes:

On the completion of the course the students will be able to:

CO^1 understand the concept of plant propagation and grafting techniques for skill enhancement
CO^2 learn the basic steps for grafting followed for all type of plants
CO^3 understand the establishment of commercial nurseries for plant propagation
CO^4 understand the Post Grafting Handling Management in fruits/Vegetable Crops

UNIT-1
Historical Background of Grafting, Importance and Scope in India, Grafting: Concept, Production Process, Present Status and Benefits

UNIT-2
Disease Management in Plants through Resistant Rootstocks, Infrastructure and Grafting Aids, Importance and Selection of Rootstocks, Suitable Potential Crops for Grafting, Grafting Techniques in Vegetables

UNIT-3
Grafting techniques in major fruit/ vegetable plants (Mango, Citrous, Guava, Post Grafting Handling Management in fruits/Vegetable Crops, Transplanting of Grafted Seedlings and After Care

UNIT-4
The Future Recombinant Horticultural Wonder Plants, Robotic Grafting, Impact of Grafting on Quality of Vegetables and Fruit plants, Physiological and Molecular Mechanism of grafting

UNIT-5
Establishment of commercial nurseries for plant propagation, Visit to commercial plant propagation units, Post Grafting Handling Management in fruits/Vegetable Crops.

Reference Books:

1. Manual of Plant Grafting: Practical Techniques for Ornamentals, Vegetables, and Fruit by Peter McDonald
2. Grafting and Budding: A Practical Guide for Fruit and Nut Plants and Ornamentals by Donald McEwan Alexander
3. Practical Manual on "Grafting Techniques in Vegetable Crops" by Pardeep Kumar, Parveen Sharma and Binny Vats
4. The Plant Propagator's Bible: A Step-by-Step Guide to Propagating Every Plant in Your Garden by Miranda Smith

Course Articulation Matrix of PLS 568 - Grafting techniques in Plants

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	3		2	2	2
CO2	2	2	3	3		2	2	2
CO3	3	3	2	2		2	2	2
CO4	3	3	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Academic Writings
Course Code: PLS 569
Credits = 02

Course Outcomes:

On the completion of the course the students will be able to:

CO[1] acquaint the students to different types of scientific writing.

CO^2 identify ethics of research in writing research proposal, thesis and research paper.
CO^3 represent the research proposal, thesis and research paper effectively
CO^4 understand the various Challenges in Indian research and writing

UNIT-1
Introduction of academic and research writing, Structure and components of Scientific Reports: types of Report, Technical Reports and Thesis, Significance

UNIT-2
Different steps in the writing: Layout, structure and Language of typical reports, citation styles, Illustrations and tables, Bibliography, Referencing and foot notes, Importance of Effective Communication.

UNIT-3
Preparing Research papers for journals, Seminars and Conferences: Design of paper using TEMPLATE, Calculations of Impact factor of a journal, citation Index, ISBN & ISSN.

UNIT-4
UGC guidelines on Academic integrity, Avoid Plagiarism, Journal metrices, author metrices

UNIT-4
Challenges in Indian research and writing, Team and Time management, time management, Open Education resources,

Reference Books:

1. Stephen B. Heard. The Scientist's Guide to Writing: How to Write More Easily and Effectively throughout Your Scientific Career, Princeton University Press (2016)
2. John M. Swales, Christine B. Feak. Academic Writing for Graduate Students: Essential Tasks and Skills, University of Michigan Press (2012)

Course Articulation Matrix of PLS 568 - Grafting techniques in Plants

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	3	3		2	2	2
CO2	2	2	3	3		2	2	2
CO3	2	2	3	3		2	2	2
CO4	3	3	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Paper Publications/Seminar, Conferences Presentation at National Level
Course Code: PLS 570
Credits = 02

Objective:
The basic objective of the course is to bring together students, academicians and experts from different parts of the country and abroad to exchange knowledge and ideas.
This will provide an indepth analysis of subjects and update the knowledge of the participants from academic as well as research institutions.

Course Outcomes:

On the completion of the course the students will be able to:

CO^1 write effective research paper, research proposal and thesis.
CO^2 identify ethics of research in writing research proposal, thesis and research paper.
CO^3 represent the research proposal, thesis and research paper effectively.
CO^4 represent the poster presentation effectively.

1. Preparation of manuscript for Publication of Research paper, Presenting a paper in scientific seminar

2. Student must publish atleast one research article and one review in UGC approved research Journal/Journal of Himalayan Life Sciences.

3. Student must participate in an oral presentation / talk in refereed conference/ Seminar after which student must submit a write up at Department to the concerned before the end of this course.

4. Student must participate in poster presentation in a referred conference / Seminar after which student must submit a write up at Department to the concerned before the end of this course.

5. Detailed report must be prepared after attending the discipline specific seminars and conferences

Course Articulation Matrix of PLS 570 - Paper Publications/Seminar, Conferences Presentation at National Level

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	2	2		2	2	2
CO2	1	1	2	2		2	2	2
CO3	1	1	2	2		2	2	2
CO4	3	3	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Application of Artificial intelligence in Plant Science
Course Code: PLS 571
Credits = 02

Course Outcomes:

On the completion of the course the students will be able to:

CO^1 expand basic informatics skills and attitudes
CO^2 understand how this couse is relevant to the emerging knowledge society
CO^3 effectively utilize the digital knowledge resources for their chosen area of study
CO^4 understand the importance of Drone, Precision Farming, Challenges in Artificial Intelligence Adoption in Agriculture

UNIT-1

Artificial Intelligence (AI): History and Concept of AI, Different Research areas of AI, Applications of AI, Task classification of AI, Agents and Environment

UNIT-2

Machine learning: Decision tree induction, Artificial Neural Networks, Hidden Markov Models, Genetic Algorithms

UNIT-3

Evaluation of prediction methods: Parametric and Non-parametric tests, cross validation and empirical significance testing, Clustering (Hierarchical and K-mean), Principal Component Analysis

UNIT-4

Artificial Intelligence in the Agricultural Industry: Image-based insight generation (Disease detection, Crop readiness identification, Field management), Importance of Drone, Precision Farming, Challenges in Artificial Intelligence Adoption in Agriculture

UNIT-5

AI based systems for Traditional Medicine, Automated plant species identification

Reference Books:

1. Artifcial Intelligence: A Modern Approach Third Edition Stuart Russell and Peter Norvig, 2010. Pearson Education, Inc. ISBN: 978-0-13-604259-4
2. Hutter, Marcus (2005). Universal Artificial Intelligence. Berlin: Springer. ISBN 978-3-540-22139-5.
3. Neapolitan, Richard; Jiang, Xia (2018). Artificial Intelligence: With an Introduction to Machine Learning. Chapman & Hall/CRC. ISBN 978-1-138-50238-3. Archived from the original on 22 August 2020. Retrieved 3 January 2018.
4. Nilsson, Nils (1998). Artificial Intelligence: A New Synthesis. Morgan Kaufmann. ISBN 978-1-55860-467-4. Archived from the original on 26 July 2020. Retrieved 18 November 2019.
5. Russell, Stuart J.; Norvig, Peter (2003), Artificial Intelligence: A Modern Approach (2nd ed.), Upper Saddle River, New Jersey: Prentice Hall, ISBN 0-13-790395-2.

Course Articulation Matrix of PLS 571 - Application of Artificial intelligence in Plant Science

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	1	1	2	2		2	2	2
CO2	1	1	2	2		2	2	2
CO3	2	2	2	2		2	2	2
CO4	1	1	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: Advanced softwares used in Plant Sciences for Data Analysis
Course Code: PLS 572
Credits = 02

Course Outcomes:

On the completion of the course the students will be able to:

CO[1] analyze example data sets using different tools and learn to interpret the outputs.
CO[2] understand overview of plant-image-analysis.org during research process
CO[3] understand the Overview of Biorender, Phylogenetic softwares and other Statistical softwares
CO[4] To apply the mentioned softwares during research process

1. **GPS, GIS:** Global Positioning Systems or Geographic Information Systems for real-time analysis and forecasts of weather, floods, and monitoring crop area sown, lost, or damaged due to floods and rainfall.

2. **IMAGE ANALYSIS:** Extraction of meaningful information from images; mainly from digital images by means of digital image processing techniques, Overview of plant-image-analysis.org (*plant image analysis* software)

3. **BIORENDER:** Overview of Biorender, Drawing of original Illustrations or Figures

4. **MENDLEY:** Reference Manager tool, Insertion of citation and bibliography into Microsoft word

5. **TURNITIN:** For Plagiarism Check to maintain academic integrity.

6. Phylogenetic softwares and other Statistical softwares used for analysis of scientific data obtained during Plant Research

Course Articulation Matrix of PLS 572 - Advanced softwares used in Plant Sciences for Data Analysis

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	2	2		2	2	2
CO2	2	2	2	2		2	2	2
CO3	2	2	2	2		2	2	2
CO4	2	2	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related

Course Name: M.Sc Dissertation (50% Dissertation, 50% Presentation & Viva-Voce)

Course Code: PLS 595
Credits = 08

CO[1]The course of dissertation is based on their specialization field to get more learning in particular field with Practical knowledge

Course Articulation Matrix of PLS 595 - M.Sc Dissertation (50% Dissertation, 50% Presentation & Viva-Voce)

Course Outcomes	Programme Outcomes 1	Programme Outcomes 2	Programme Outcomes 3	Programme Outcomes 4		Programme Specific Outcomes 1	Programme Specific Outcomes 2	Programme Specific Outcomes 3
CO1	2	2	2	2		2	2	2

1. Partially Related
2. Moderately Related
3. Highly Related