



# Central University of Himachal Pradesh

(Established under Central Universities Act 2009)

PO BOX: 21, DHARAMSHALA, DISTRICT KANGRA – 176215, HIMACHAL PRADESH

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## SEMESTER- III

**Course Code: BOT 419**

**Credit: 02**

**Course Name: Anatomy and Development of Plants**

**Course Contents:**

### **Unit I**

**Introduction to Plant Anatomy:** Composition, structure and organization of plant cell walls; Anatomy of root, stem and leaf of monocot and dicot plants; Secondary growth in stem and root.

### **Unit II**

**Shoot development:** Organization of the shoot apical meristem (SAM) and tissue differentiation, Leaf growth and differentiation: differentiation of epidermis and mesophyll. Stomatal types and distribution.

### **Unit III**

**Root development:** Organization of root apical meristem (RAM), cell fates and lineages, tissue differentiation. Lateral roots, root hairs, root microbe interactions. Root shoot transition.

### **Unit IV**

**Cambium and Vascular tissue development:** Development and structure of the primary xylem, primary phloem, secondary xylem, secondary phloem, sieve tube elements; Development of vascular cambium, cork cambium and structure of its derivatives.

### **Unit V**

**Floral development and Embryology:** Floral ontogeny and vascularization; floral development taking the examples of homeotic mutants in Arabidopsis and Antirrhinum. Development of male and female gametophyte; Embryo development.

**Suggested Reading**

1. Evert, R.F., 2006. *Esau's plant anatomy: meristems, cells, and tissues of the plant body: their structure, function, and development*. John Wiley & Sons.
2. Beck, C.B., 2010. *An introduction to plant structure and development: plant anatomy for the twenty-first century*. Cambridge University Press.
3. Raghavan, V., 2012. *Developmental biology of flowering plants*. Springer Science & Business Media.
4. Bhojwani, S. S & Bhatnagar, S. P. 2000. *The Embryology of Angiosperms*, Vikas.
5. Bhojwani, S. S & Radan, M. K. 1983. *Plant Tissue Culture : Theory and Practices* Elsevier, Amsterdam.



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## SEMESTER- III

**Course Code: BOT-565**

**Credit: 02**

**Course Name: Applied and Industrial Biotechnology**

### **Course Contents:**

**Course Objectives:** The course is designed to develop skills associated with screening of industrially important strains and to understand the basic skills applied in fermentation technology.

### **Attendance Requirement:**

Students are expected to attend all the lectures pertaining to the Course. To appear in the examination, a minimum of 75% attendance is compulsory.

### **Evaluation Criteria:**

1. Mid Term Examination: 25%
2. End Term Examination: 50%
3. Continuous Internal Assessment : 25% (Breakup is following)
  - a. Assignment/Quiz/: 40%
  - b. Presentation/Seminar/: 40%
  - c. Class participation: 20%

### **Course Contents:**

#### **Unit I**

Industrially important microbes, its screening, selection and identification. Screening for productive strains and strain improvement.

#### **Unit II**

Introduction of primary and secondary metabolites, production of vitamins, amino acids, organic acid and industrial alcohol, production of beer and wines.

#### **Unit III**

Use of whole cells for food related purposes (Single cell protein production), Production of antibiotics.

## Unit IV

Production of biofuel (bioethanol and biodiesel), Production of microbial insecticides.

## Unit V

Emerging technologies in agro industries: production of vermiculture, composting, production of biofertilizers: rhizobacteria.

### Suggested Readings:

1. Kirakosyan, A. and Kaufman, P.B., 2009. *Recent advances in plant biotechnology* (p. 409). Dordrecht: Springer.
2. Bahadur, B., Rajam, M.V., Sahijram, L. and Krishnamurthy, K.V. eds., 2015. *Plant Biology and Biotechnology: Volume II: Plant Genomics and Biotechnology*. Springer.
3. Plant Biotechnology New Products and Applications. Hammond, J., McGarvey, P., Yusibov, V. (Eds.)
4. [Biotechnology of Natural Products Wilfried Schwab Springer](#) Schwab, Wilfried, Lange, Bernd Markus, Wüst, Matthias (Eds.).



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## SEMESTER- III

**Course Code: BOT 576**

**Credit: 02**

**Course Name: Genetics**

**Course Content:**

### **Unit-1**

**Mendelian and Non- Mendelian:** Chromosome theory of inheritance; Mendelian laws; Gene interactions; Organelle inheritance.

### **Unit-2**

**Allelism and Linkage:** Multiple Allele, Pseudo-alleles, Pleiotropy, Linkage and Crossing over, Sex Linkage, Sex limited and Sex influenced characters.

### **Unit-3**

**Mutations:** Basic concept, Types of Mutations, Mutagens: physical and chemical; Transposons; types and their use in mutagenesis; Gene regulation.

### **Unit-4**

**Population Genetics:** Gene pool, Gene frequency, Hardy- Weinberg Law, Concepts and rate of change in gene frequency through mutation, natural selection and migration ; random genetic drift.

### **Unit-5**

**Microbial Genetics:** Bacterial plasmids, Bacterial conjugation:  $F^+ \times F^-$  Mating, Hfr-conjugation and F- conjugation, transformation, transduction: generalized and specialized transductions, mapping the genome. Fungal genetics – mating types and genetic exchange, heterokaryosis, parasexual cycle.

### **Suggested Readings:**

1. Brooker R.J. Genetics. USA: Addison-Wesley, Longman Publisher, 1999. Print.
2. Brown T.A. Genetics: A Molecular Approach. USA: Chapman & Hall, 1999. Print.

3. Brown T.A. Genomes. USA: Wiley & Sons, 2001. Print.
4. Glick B.R., and Pasternak, J.J. Molecular Biotechnology. USA: American Society for Microbiology, 1998. Print.
5. Griffiths A.J.F., Gelbart, W.M., Miller, J.H., and Lewontin. Modern Genetic Analysis. USA: W.H. Freeman & Company, 2002. Print.
6. Karp G. Cell and Molecular Biology. USA: Wiley & Sons, 1999. Print.
7. Lewin B. Genes VII. UK: Oxford University Press, 2000. Print.
8. Lodish H., Berk, A., Zipursky, L., Matsudaira, P., Baltimore, D., and Darnell, J. Molecular Cell Biology. USA: W.H. Freeman & Co., 2005. Print.
9. Malacinski, J., and Friefelder, D. Essentials of Molecular Biology. USA: Jones and Bartlett Publ., 1999. Print.
10. Primrose S.B., Twyman, R.M., and Old, R.W. Principles of Gene Manipulation. UK: Blackwell Publisher, 2001. Print.
11. Russel, P.J. Genetics. California: Addison Wesley Longman, 2006. Print.
12. Snustad, D.P. and Simmons, M.J. Principles of Genetics. USA: Wiley and Sons, 2003. Print.



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## SEMESTER- III

**Course Code: BOT-578**

**Credit: 02**

**Course Name: Genomics, Proteomics and Metabolomics**

**Course Objectives:** To study the advanced aspects of genomics, proteomics and metabolomics.

### **Attendance Requirement:**

Students are expected to attend all the lectures pertaining to the Course. To appear in the examination, a minimum of 75% attendance is compulsory.

### **Evaluation Criteria:**

4. Mid Term Examination: 25%
5. End Term Examination: 50%
6. Continuous Internal Assessment : 25% (Breakup is following)
  - d. Assignment/Quiz/: 40%
  - e. Presentation/Seminar/: 40%
  - f. Class participation: 20%

### **Course Contents:**

#### **UNIT I: Introduction**

Introduction to Omics, different omics tools; Multi-Omics and Meta-Omics.  
Applications of omics tools in various fields.

#### **UNIT II: Genomics**

Genome. Molecular Markers: RFLP, RAPD, AFLP, SSR, SNPs.  
Sanger's DNA sequencing, brief note on Next generation sequencing (NGS), 16s rDNA sequencing, Whole genome sequencing (WGS).  
Applications of genomics.

#### **UNIT III: Transcriptomics**

Transcriptome.  
Genome wide expression studies: Microarrays, RNA sequencing (RNA-Seq).  
Applications of transcriptomics.

#### **UNIT IV: Proteomics**

Proteome. Introduction to Gel based and Gel free proteomics, SDS PAGE, 2D PAGE, Mass Spectrometry, Protein identification by peptide mass fingerprinting.

Applications of proteomics.

**UNIT V: Metabolomics**

Metabolome.

Tools: Gas and liquid chromatography.

Applications of metabolomics.

**Reference Material:**

1. Discovering Genomics, Proteomics and Bioinformatics, 2nd edition-A. Malcolm Campbell and Laurie J. Heyer (ISBN 0-8053-4722-4)-Cold Spring Harbor Laboratory press and Benjamin Cummings, 28 Feb 2006.





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## **SEMESTER: III**

**Course Code: BOT-577**

**Credit: 02**

**Course Name: Economic Botany and Medicinal Plants**

**Course Content:**

### **Unit-1: Importance and History of plants:**

Economic importance of plants and their products; History of food plants; Centers of origin; New world and Old world

### **Unit-II: Food Plants: Cereals and Legumes:**

Cereals; origin, history, distribution, cultivation, botanical description, breeding, high yield varieties, uses and diseases of wheat, Rice, Barley, Jowar, Bajra and Maize, Legumes and oil yielding plants; Origin, cultivation, botanical description and uses of Chickpea, Pigeon Pea, Pea, Mustard and Groundnut.

### **Unit-III: Food Plants: vegetables, nuts and spices:**

Botanical description, cultivation and uses of vegetables; Carrot, Beetroot, Potato, onion and eggplant, Nuts; Cashewnut, walnut and almond, Spices; ginger, turmeric, cinnamon, cloves and cardamom.

### **Unit-IV: Sources of beverages, fibre and wood:**

Origin, cultivation, botanical description and uses of coffee, tea, coca and chocolate, Uses of wood and wood product; from Deodar, Teak, Sal and Pine; Classification of fibre, sources of fibre; cotton, jute and kapok.

## **Unit-V: Plants of medicinal value:**

Origin, distribution, botanical description, active constituents, parts used and uses of Neem, Ashwagandha, Babool, Aleo, Tulsi, Amala, Belladonna, Quinine tree, Rauwolfia and Ephedra

### **Suggested Readings**

1. Bawa, R and Khosla, P. K. 1998. Biodiversity of Forest Species (A Community Forestry Approach) Bishen Singh Mahendra Pal, Dehradun, 218pp.
2. Cotton, C. M. 1996. Ethnobotany- Principles and applications John Heywood, Wiley, V.(ed.) 1995. Global Biodiversity Assessment . Cambridge Univ. ,Camb. Pub, Dehradun
3. Swaminathan, M. S &Kocchar, S. L.(eds.) 1989. Plants and Society
3. Macmillan, Wagner, H., Hikino, H &Farnsworth, N. 1989. Economic and Medicinal Plant Research. Vols.1-3. Academic Press, London.
4. Bedi, Y.S., Dutt, H.C. and Kaur, H. (2011). Plants of Indian System of Medicine (Vol. I &II). Lambert Academic Publishing, Germany.
5. Bose, T.K. and Som, M.G.V. (1986). Vegetable crops in India. NayaProkash, Calcutta
6. Bose, T.K. (1985). Fruits of India tropical and subtropical. NayaProkash, Calcutta.
7. Chrispeels, M.J. and Sadava, D.E. (1994). Plants, Genes and Agriculture. Jones and Bartlett Publishers, London
8. Furry S.M. and Viemont V.M. (1935). Home Dyeing with Natural Dyes. Thresh Publications. California.
9. Hanson, H. Borlaug N.E. and Anderson, R.G. (1982). Wheat in the Third World. Westbiew Press, Colorado.
10. Maiti, R.K. and Singh R.K. (2006). An Introduction to Modern Economic Botany. Agrobios (India).
11. Metcalfse, D.S. and Elkins, D.M. (1980). Crop Production: Principles and Practices (IV ed.). Macmillan Publishing Co. Inc. New York.
12. Pradhan S. (1995). Economic Botany. HarAnand Publication, New Delhi



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## SEMESTER- III

**Course Code: BOT 121**

**Credit: 02**

**Course Name: Plant Physiology**

**Course Contents:**

### **Unit 1**

**Photosynthesis:** General concepts and historical background, photosynthetic pigments and light harvesting complexes, mechanism of electron transport chain, carbon assimilation: the calvin cycle, photorespiration and its significance, the C4 cycle, the CAM pathways.

### **Unit 2**

**Respiration:** Overview of plant respiration, Glycolysis, the TCA cycle, electron transport and ATP synthesis, pentose phosphate pathways.

### **Unit 3**

**Nitrogen Metabolism:** Nitrate assimilation: nitrate, light, and carbohydrates regulate nitrate reductase, nitrite reductase converts nitrite to ammonium, plants can assimilate nitrate in both roots and shoots. Ammonium assimilation: conversion of ammonium to amino acids requires two enzymes, biological nitrogen fixation, Nod factors, nodule formation in plants.

### **Unit 4**

**Water Balance in Plants:** Water in the soil, water moves through the soil by bulk flow, water absorption by roots—Apoplast and Symplast pathways, root pressure, water transport through the xylem---cohesion tension theory, physical challenges of xylem transport of water in tall trees.

### **Unit 5**

**Stress Physiology:** Drought stress/Water stress- effects on the plants, mechanism to avoid water stress, drought signalling. Heat stress- effects of heat stress, mechanism to avoid heat stress, defence mechanism of plants against heat stress. Cold stress-types, symptoms in plants, injuries and defence mechanism, mechanism to tolerate chilling stress, mechanism to avoid freezing stress, cold stress signalling. Salt stress-causes, effects on plants, response of plants, defence strategies/mechanisms of plants.

**Suggested Readings:**

Taiz I and Zeiger E (1998) Plant Physiology (2 nd edition) Sinaur Associates Inc. Publishers, Massachusetts, USA.

Nelson DL and Cox MM (2008) Lehinger Principles of Biochemistry: 5<sup>th</sup> Edition Publisher- Sara Tenney.



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## **SEMESTER- III**

**Course Code: BOT-516**

**Credit: 02**

**Course Name: Genetics and Molecular Biology**

**Course Contents:**

**Credit: 4**

**Course Objectives:** To obtain insights on the genetic and molecular mechanisms of basic life processes of cell. Approaches to discover genes and regulatory elements.

**Attendance Requirement:**

Students are expected to attend all the lectures pertaining to the Course. To appear in the examination, a minimum of 75% attendance is compulsory.

**Evaluation Criteria:**

7. Mid Term Examination: 25%
8. End Term Examination: 50%
9. Continuous Internal Assessment : 25% (Breakup is following)
  - g. Assignment/Quiz/: 40%
  - h. Presentation/Seminar/: 40%
  - i. Class participation: 20%

**Course Contents:**

### **UNIT I: 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 II: 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; DNA foot printing to study Promoter-RNA polymerase interactions; anti-termination by bacteriophage proteins, inhibitors of prokaryotic transcription.

## **UNIT II: Eukaryotic Transcription**

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

## **UNIT III: Post transcriptional modifications**

Introns, exons, mechanism of gene splicing, 5' cap formation, 3' polyadenylation; RNA editing, RNA interference (RNAi), catalytic role of RNA (Ribozyme).

## **UNIT IV: Translation.**

Translation, Post-translational modifications of proteins, transport of proteins and molecular chaperones; Protein stability; Protein turnover and degradation; inhibitors of translation.

## **UNIT V: Gene discovery**

Screening of genomic and cDNA libraries, Enhancer trap, promoter trap, insertional mutagenesis, gene tagging, activation tagging.

## **Reference Material:**

1. Alberts B, Bray D, Lewis J, Raff M, Roberts K, and Watson J.D. Molecular Biology of the Cell. Garland Science.
2. Pollard T.D., Earnshaw W.C, Schwartz J.L. Cell Biology. Elsevier Publishing Co.
3. H.Lodish and A.Berk, Molecular Cell Biology, W.H.Freeman Publishers
4. D.E.Sadava Cell Biology, CBS Publishers.
5. Latest review articles from Peer reviewed journals.
6. Genomes by T. A. Brown.