Syllabus: PLANT DEVELOPMENT & INTERCELLULAR COMMUNICATION
Course code: 3220
Semester: 8th (Spring)
Type: Obligatory course

Course Overview

1: Introduction to Plant Developmental Biology
Contents
1. Model Organisms in Biology
2. Biodiversity and Plant Taxonomy
3. Model organism species *Arabidopsis thaliana*
4. Ecotypes, natural variation and polymorphisms
5. Mutagenesis
6. Map based cloning

Learning outcomes
Upon completion of this course, the students are expected to:
- Acquire knowledge about model organisms and their unique traits to be selected for Developmental Biology experimental approaches
- Understand the natural variation and molecular polymorphisms among ecotypes and the principles of forward and reverse genetics
- Distinguish the distinct methodologies of plant mutagenesis and the map based cloning approach

2- 3: Molecular interactions that drive plant cell differentiation
Contents
1. The pattern of trichomes developmental
2. The genes that modulate trichomes morphogenesis
3. The theories of Turing
4. The model of trichome development
5. The pattern of root epidermal cell differentiation
6. The types of root epidermal cells
7. Genes that determine the root epidermal cell fate
8. Model of root epidermal cell differentiation
9. Hormonal control of root epidermal cell differentiation
10. The pattern of leaf development
11. Types of phyllotaxy
12. Patterning of phyllotaxy
13. Growth of vein elements
14. Auxin in angiogenesis
15. Canalization hypothesis

Learning outcomes
Upon completion of this course, the students are expected to:

- Acquire knowledge about the mechanisms that drive epidermal cell differentiation and the effects of hormonal interplay
- Distinguish the types of phyllotaxis and understand the molecular networks that determine the position of newly emerged leaves
- Comprehend the mode of plant organ development in time

4: Plant embryogenesis
Contents
1. Stages of embryonic development
2. Maternal Effects from the Female Gametophyte
3. Molecular genetics of embryogenesis
4. Embryo lethal mutants
5. Mutations affecting the embryo body axis
6. Apical–basal axis formation
7. The apical–basal polarity of the embryo
8. The formation of the radial pattern in the embryo
9. The role of auxin in the embryonic apical–basal axis establishment

Learning outcomes
Upon completion of this course, the students are expected to:
- Summarize stages of Arabidopsis embryo development
- Identify genes expressed in temporal and spatial patterns during plant embryo development
- Discuss the establishment of apical-basal embryo polarity
- Summarize the formation of radial pattern

5: Shoot Development
Contents
1. Organization of the Shoot Apical Meristem (SAM)
2. Molecular network of SAM formation and maintenance
3. The *SHOOTMERISTEMLESS* (*STM*) gene
4. The *WUSCHEL* (*WUS*) gene
5. The *ZWILLE* (*ZLL*) gene
6. The *CLAVATA* (*CLV*) genes
7. The CLAVATA network
8. Molecular interactions between regulatory genes in the SAM

Learning outcomes
Upon completion of this course, the students are expected to:
- Describe the basic structure of shoot apical meristem tissue
- Summarize the role of shoot apical meristem in plant development and growth
- Explain the WUS/CLV signaling network for shoot stem cells control

6: Flower Development
Contents

1. The homeotic genes and flower development
2. Flowering pathways in plants
3. Flower meristem identity genes
4. The ABC model
5. The establishment of B-class genes and their function
6. The establishment of A-class and C-class genes
7. The modified ABC model
8. AP2 is regulated by miRNAs

Learning outcomes

Upon completion of this course, the students are expected to:

- Diagram the placement of whorls of floral organs in a wild-type Arabidopsis flower
- Summarize the role of gene regulation in control of floral development
- Identify which floral development genes specify each whorl of floral organs
- Recognize the role of forward and reverse genetics in elucidation of the ABC model
- Observe differences in floral morphology and predict how these changes may relate to altered function or expression of key floral development genes

7: Root system architecture

Contents

1. The functional role of root system
2. Developmental zones of the root system
3. Structure and organization of the root meristem
4. Maintenance of root structure
5. Intercellular communication: morphogenesis of cortex/endodermis

Learning outcomes

Upon completion of this course, the students are expected to:

- Understand the structure and organization of monocotyledonous and dicotyledonous roots and how the cells grow and differentiate
- Analyze and summarize the molecular mechanisms of cell to cell communication and their role in cell fate determination of plant root cells

8: Environmental factors that modulate plant growth

Contents

1. Plant response to gravity
2. Mechanisms of gravitropic response
3. Gravity sensing
4. The Cholodny-Went theory
5. Auxin in tropisms
6. The effect of mechanical stimuli in plant growth

7. Thigmomorphogenesis
8. Response to mechanical stimuli
9. Ethylene in molecular sensing
10. The effect of nutrient depletion in plant growth
11. Trophomorphogenesis
12. Phosphorus and root hair morphogenesis
13. The effect of nitric anions on lateral root development
14. The effect of chilling requirements on flowering
15. Floral bud break and vernalization
16. Epigenetics on flowering

Learning outcomes

Upon completion of this course, the students are expected to:

- Perceive the molecular mechanisms that drive tropisms (phototropism and geotropism) and the effect of mechanical stimuli on plant development (thigmomorphogenesis)
- Analyze the response of plants against nutrient depletion (trophomorphogenesis)
- Comprehend the molecular basis of vernalization and the epigenetic control of flowering

9: miRNAs and plant development

Contents

1. RNA interfering (RNAi)
2. The biological function of RNAi
3. Biogenesis of miRNAs
4. Methods for functional analysis of miRNAs
5. Leaf development and miRNAs
6. Flower development and miRNAs
7. miRNAs and phase transition
8. miRNAs in shoot development
9. miRNAs in root development
10. miRNAs in the crosstalk between phytohormone signaling pathways during plant development
11. A guide to microRNA-mediated gene silencing

Learning outcomes

Upon completion of this course, the students are expected to:

- Explain the structure of microRNAs
- Describe how miRNAs are produced in plants and mammals
- Illustrate the functions of different proteins in miRNA formation and function,
- including DCL, RDR, HEN1, AGO, Pol IV and Pol V
- Describe how miRNAs influence gene expression.
- Compare post-transcriptional gene silencing and transcriptional gene silencing, and diagram how each comes about
- Summarize three examples of miRNA function during plant development

10: Epigenetics

Contents

1. Epigenetics in Plant development
2. Methylation and epigenetic regulation in animals
3. Lamarck vs Darwin
4. Epigentic inheritance
5. Plant epigenomics
6. Epigenetic control of gene expression in maize
7. Developmental timing and tissue influence gene silencing
8. Contribution of epigenetic modifications to evolution and adaptation

Learning outcomes

Upon completion of this course, the students are expected to:

- Compare and contrast epigenetic mechanisms and epigenomes between animals and plants.
- Critically evaluate examples of how the environment can influence the epigenome.
- Discuss how and why epigenetic mechanisms facilitate environmental adaptation and evolution
- Demonstrate understanding of epigenetic mechanisms through interpreting data from primary research papers.