

**DISCIPLINE SPECIFIC ELECTIVE COURSE (DSE-14): Immunological Concepts and Applications in Plant Science**

**CREDIT DISTRIBUTION, ELIGIBILITY AND PRE-REQUISITES OF THE COURSE**

Course title & Code	Credits	Credit distribution of the course			Eligibility criteria	Pre-requisite of the course (if any)
		Lecture	Tutorial	Practical/Practice		
<b>Immunological Concepts and Applications in Plant Science DSE-14</b>	<b>4</b>	<b>2</b>	<b>0</b>	<b>2</b>	Semester VII	Nil

**Learning Objectives:**

- Comprehend innate and induced plant immune responses. Recognize major plant pathogens—fungi, bacteria, viruses, and nematodes—and study their interactions with host defense systems.
- Examine the molecular and physiological basis of plant-microbe interactions and the dynamic strategies used by both.
- Utilize immunological tools and diagnostics for plant disease management, including detection and characterization of plant pathogens.
- Apply knowledge of plant immunology to develop eco-friendly, sustainable control strategies using beneficial microbes and natural compounds.
- Understand and apply plant immune principles for breeding disease-resistant crops and enhancing plant health.
- Design and conduct laboratory experiments to investigate plant immune responses and assess disease control strategies.

**Learning Outcomes:**

At the end of this course students will be able to:

- Describe the fundamental principles of plant immunity, including innate and induced defense mechanisms.
- Analyze interactions between plants and pathogens at the molecular and cellular levels.
- Apply immunological methods for diagnosing and managing plant diseases effectively.
- Identify major types of plant pathogens—fungi, bacteria, viruses, and nematodes—and their disease strategies.

- Explain the concept of ISR and its role in enhancing plant defense against diverse pathogens.
- Outline key signaling pathways involved in plant defense, such as MAPK cascades and calcium signaling.
- Integrate knowledge of plant immunity to design eco-friendly and sustainable disease control measures.
- Evaluate the use of plant immunity in breeding disease-resistant crops and applying beneficial microbes or natural products.

**Unit 1: (i) Introduction to Immunological Concepts: 10 hours**

Basic concepts of immunology, Innate and Acquired (Adaptive) immunity, Human Immune system, Humoral (antibody-mediated) and cellular (cell-mediated) Immunity, Concepts of antigen, epitope, haptens, valence, antibodies (immunoglobulins)- structure, types (IgG, IgM, IgA, IgD, and IgE) and functions, antigen-antibody reaction, antisera and vaccines. Immune system in plants, Comparison between the plant and animal immune system.

**(ii) Plant Immunity:**

Plant pathogens and pests (viruses, bacteria, fungi, insects, mites and nematodes), Plant-pathogen interactions; Compatible interactions (parasite virulence and host plant susceptibility), Incompatible interactions (parasite avirulence and host plant resistance), non-host and host - resistance, Horizontal and vertical resistance, concept of host range, coevolution of plant defence and pathogen attack mechanisms: the Zigzag Model.

**Unit 2: Components of Plant Immunity: 10 hours**

**(i) Innate Immunity/ Resistance**

- **Non-specific or Basal Resistance: Passive (Constitutive defenses)** including pre-existing mechanical defences (cuticle, waxes, lignified cell wall, bark, trichomes, thorns); pre-existing biochemical defences (alkaloids, phenolic compounds, terpenoids, nutrient deprivation, phytoanticipins); **Active (Inducible Defences):** Pathogen-associated molecular patterns (PAMPs), pattern-recognition receptors (PRRs), PAMP-triggered Immunity (PTI). Popular Models of PTI in plants- Flagellin-induced Resistance, Elongation Factor (Ef-tu)-induced Basal Resistance.
- **Pathogen Race-specific resistance:** Molecular Models of specific Host-pathogen Recognition, gene-for-gene or receptor-ligand model (Flor's Model), Pathogen effectors, Intracellular nucleotide-binding leucine-rich repeat receptors (NLRs), Plant Resistance (R) genes, Avirulence (Avr) proteins/ Effectors, Effector-triggered susceptibility (ETS), Effector-triggered immunity (ETI), Hypersensitive response.

**(ii) Acquired Resistance : Systemic Acquired Resistance (SAR), Induced Systemic Resistance (ISR)**

**Unit 3: Signal Transduction Pathways activated during Plant resistance: 5 hours**

- Phytohormone signaling: salicylic acid, jasmonic acid, ethylene
- Calcium signaling: Calmodulin (CaM), Calcineurin B-like proteins (CBLs) in *Arabidopsis*
- Mitogen-activated protein kinase (MAPK) Cascades
- The Oxidative burst (ROS)
- Major transcription factor families in plant immunity (WRKY, NAC, MYB, bZIP)

**Unit 4: Applications of immunology in Plant Science: 5 hours**

Development of disease-resistant crops, enhanced nutrient uptake, engineering enhanced resistance in crops via gene editing (e.g., CRISPR-Cas9), developing novel biopesticides/biocontrol agents based on induced systemic resistance (ISR), genetic engineering strategies for broad-spectrum resistance by Pseudo-Response Regulator (PRR) and chimeric PRR transgenes. RNAi based antiviral resistance (siRNA).

**PRACTICALS 60 hours**

1. To study the structure of antibody (diagrammatic and crystal structure) digitally.
2. Study of diseased plants and identification of its causal pathogen based on visually observed symptoms (Viral, bacterial, Fungal - one disease each)
3. Analysis and interpretation of digitally represented zig-zag model
4. Analysis and Interpretation of Western blots
5. Understanding the concept of immunoprecipitation by performing immunodiffusion.
6. To study the antigen-antibody reaction by ABO blood group system and Rh factor
7. Study and applications of immunological techniques: ELISA, Immunodiffusion, Radioimmunoassay.

**Suggested Readings:**

- Dchia Bouktila and Yosra Habachi (2021) *An Introduction to Plant Immunity*: Bentham Science Publishers, Sharjah, UAE.
- Iakovidis, M., Chung, E. H., Saile, S. C., Sauberzweig, E., & El Kasmi, F. (2023). *The emerging frontier of plant immunity's core hubs*. *The FEBS journal*, 290(13), 3311–3335. <https://doi.org/10.1111/febs.16549>
- Prescott, L.M., Harley J.P., Klein D. A. (2005). *Microbiology*, 6th edition: McGraw Hill, New Delhi.

**Additional Reading:**

Agrios, G.S. (2005) Plant Pathology 5th Edition: Elsewhere Academic Press, Amsterdam.