



## Module 4: Plant Growth, Management & Pest Control

### Student Notes

These notes are designed to help you understand the main ideas, vocabulary, and concepts from Module 4. Each section matches the learning outcomes and activities discussed in class. Use these notes to study for quizzes, complete projects, and participate in discussions.

**Note:** Vocabulary words marked with an asterisk (\*) are required knowledge. Unmarked words are included for personal enrichment.

#### Lesson A – How a Plant Grows & Fights

Learning Outcomes:

- **Explain:** how photosynthesis supplies energy and how source–sink dynamics allocate sugars to growth or defense.
- **Differentiate:** between jasmonic acid and salicylic acid pathways and the types of pests/pathogens they target.
- **Create:** a “mini circular loop” of plant metabolism, showing how resources are cycled within the plant under stress.

Key Concepts:

##### 1. Photosynthesis & Growth

- Plants convert sunlight into chemical energy via photosynthesis.
- Sugars created in source tissues (like leaves) are transported to sink tissues (like roots, fruits, and growing tips).

##### 2. Source–Sink Dynamics

- Photosynthates (sugars) move from sources (mature leaves) to sinks (developing tissues, storage organs).
- This movement shifts when plants experience stress.

##### 3. Growth and Hormones

- Growth is regulated by phytohormones:
  - Auxin promotes elongation.
  - Cytokinin promotes cell division.
  - Gibberellin promotes germination and stem growth.

##### 4. Stress Responses & Tradeoffs

- When stressed by pests, drought, or disease, plants reduce growth and activate defense mechanisms.
- This reallocation of resources is called the growth–defense tradeoff.

##### 5. Defense Hormones

- Jasmonic Acid (JA): triggered by insect chewing and wounding.
- Salicylic Acid (SA): activated by biotrophic pathogens (e.g., viruses, fungi).
- Ethylene: coordinates stress and ripening responses.

##### 6. Volatile Organic Compounds (VOCs)

- Some plants emit airborne signals (VOCs) to warn neighbors or attract insect allies that attack herbivores.

Think About:

- Why can't a plant maximize growth and defense at the same time?
- How does stress (e.g., heat or drought) change a plant's priorities?

#### Important Vocabulary to understand and use:

- A. Triose Phosphate
- B. Source [Tissue]\*
- C. Sink [Tissue]\*

- D. Jasmonic Acid\*
- E. Salicylic Acid\*
- F. Phytohormones\*
- G. Volatile Organic Compound (VOC)
- H. Photosynthate
- I. Defense Tradeoff
- J. Systemic Acquired Resistance

**Vocabulary in Context: Fill in the Blanks**

1. Sugars made in the leaves travel to fruits and roots, also known as \_\_\_\_\_ tissues.
2. The hormone \_\_\_\_\_ helps plants defend against chewing insects.
3. When infected with a virus, plants trigger \_\_\_\_\_ pathways to signal resistance.
4. A \_\_\_\_\_ is a plant chemical signal that can attract insect predators to help defend the plant.
5. \_\_\_\_\_ describes how plants reduce growth to activate immunity when under threat.
6. The \_\_\_\_\_ pathway is associated with biotrophic pathogen defense.
7. Sugars formed in the Calvin Cycle are initially stored as \_\_\_\_\_ phosphate.
8. \_\_\_\_\_ are natural signaling chemicals that regulate plant functions.

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**Self-Test:**

1. The movement of sugars from source to sink tissues supports plant \_\_\_\_\_.
2. A key stress hormone activated by insect attack is \_\_\_\_\_.
3. \_\_\_\_\_ is the hormone commonly triggered by viral infections.
4. The tradeoff between plant growth and immunity is called the \_\_\_\_\_.
5. Airborne signals like \_\_\_\_\_ allow plants to communicate danger.
6. The molecules transported from leaves to roots and fruits are called \_\_\_\_\_.
7. Auxin, cytokinin, and gibberellin are all examples of \_\_\_\_\_.
8. \_\_\_\_\_ phosphate is the simple sugar formed after photosynthesis.

**Reflection Questions**

Why can't a plant maximize growth and defense at the same time, and how does stress (like drought or pests) change its priorities? How do hormones like jasmonic acid (JA) and salicylic acid (SA) help plants defend against different types of attackers? Do you think plants that send out volatile organic compounds (VOCs) to "call for help" from insects are more likely to survive than those that don't? Why?

**Lesson B – IPM as a System**

Learning Outcomes:

- **Describe:** the four tiers of IPM (cultural, mechanical/physical, biological, chemical) and how each supports circular-economy principles.
- **Design:** an IPM plan for a chosen crop that incorporates at least one tactic per tier and a monitoring strategy.
- **Evaluate:** the sustainability of a chemical-only approach versus an IPM plan using environmental, economic, and social criteria.

Key Concepts:

### 1. What Is IPM?

- IPM stands for Integrated Pest Management — a layered, ecological approach to managing pests. Instead of just using pesticides, farmers use a range of methods depending on the pest and crop.

### 2. The IPM Pyramid

- Cultural: prevention via crop rotation, planting time, resistant varieties.
- Mechanical/Physical: traps, row covers, barriers, pruning.
- Biological: beneficial insects, fungi, and bacteria.
- Chemical: targeted pesticide use only when thresholds are met.

### 3. Economic Threshold

- Pesticides are only applied when pests cause damage that outweighs the cost of treatment.

### 4. Biocontrol [Agent]

- Biocontrol includes beneficial insects (lady beetles, parasitic wasps), fungi (Borneman Lab fungal strains), and microbes that naturally suppress pest populations.

### 5. Benefits & Challenges of IPM

- Reduces chemical use
- Long-term pest control
- Supports biodiversity
- Requires knowledge and monitoring
- Slower than chemical-only methods
- Labor-intensive in some systems

Think About:

- Which IPM tactics work best for your local crop?
- Why might a farmer still choose chemical sprays?

### Important Vocabulary to understand and use:

- Integrated Pest Management (IPM)\*
- Cultural Control\*
- Mechanical Control\*
- Biological Control\*
- Chemical Control\*
- Economic Threshold\*
- Beneficial Insect
- Biocontrol Fungus\*
- Pesticide Resistance
- Monitoring

### Vocabulary in Context: Fill in the Blanks

1. Placing sticky traps to catch adult whiteflies is an example of \_\_\_\_\_ control.
2. Rotating between different crop species is an example of \_\_\_\_\_ control.
3. Only spraying pesticides after pest populations exceed the \_\_\_\_\_ keeps chemical use lower.
4. A lady beetle that eats aphids is an example of a \_\_\_\_\_ insect.
5. Spraying every week regardless of pest pressure may lead to \_\_\_\_\_ over time.

6. Releasing a fungus to suppress a root pathogen is a form of \_\_\_\_\_ control.
7. Choosing tomato varieties resistant to leaf curl virus is an example of \_\_\_\_\_ control.

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Self-Test:

1. The four tiers of IPM are cultural, mechanical, \_\_\_\_\_, and \_\_\_\_\_.
2. An example of biological control is releasing \_\_\_\_\_ to eat pests.
3. A \_\_\_\_\_ insect helps reduce pest populations without chemicals.
4. Using crop rotation is a form of \_\_\_\_\_ control.
5. Chemicals should only be used when pests exceed the \_\_\_\_\_.
6. Relying too much on pesticides may cause \_\_\_\_\_ in pest populations.
7. \_\_\_\_\_ helps farmers know when action is needed in an IPM system.
8. Fungi from the \_\_\_\_\_ Lab are used as biocontrols in soil.
9. \_\_\_\_\_ is needed to identify pest threats before spraying.
10. Multi-tactic \_\_\_\_\_ strategies are more sustainable but also more complex.

Reflection Questions

Which tier of the IPM pyramid (cultural, mechanical, biological, or chemical) do you think is most important for your local crops, and why? Why might some farmers still choose chemical sprays even though IPM offers more sustainable solutions? If you had to design an IPM plan for a school garden, what tactics would you include at each tier of the pyramid?

**Lesson C – Fast Diagnostics**

Learning Outcomes:

- **Compare:** traditional (agar, PCR) and rapid (paper microfluidic, LAMP/CRISPR) diagnostic methods on speed, cost, and field practicality.
- **Calculate:** potential financial and resource savings gained by early detection with rapid testing tools.
- **Integrate:** a rapid diagnostic protocol into an IPM plan to show how timely information closes the loop and reduces waste.

Key Concepts:

**1. Why Fast Matters**

- Faster diagnosis = faster response = less crop loss.
- Diseases often spread before symptoms are visible.
- Monitoring with technology allows farmers to act earlier.

**2. Common Diagnostic Tools**

- ELISA (enzyme-linked immunosorbent assay): Detects pathogens using antibodies. Like a pregnancy test for plants.
- PCR (polymerase chain reaction): Identifies pathogen DNA quickly and accurately, even at low levels.

**3. Traditional vs. Lab-Based Monitoring**

- Visual inspection and sticky traps are important but may miss early infections.
- Fast tools confirm which pathogen is present and inform treatment options.

**4. Limitations**

- Cost of lab tools and training
- Time to collect and submit samples
- Some pathogens evolve faster than the te

Think About:

- How could fast diagnostics prevent a food supply crisis?
- Who should pay for rapid testing: the government, the farmer, or the consumer?

**Important Vocabulary to understand and use:**

- A. Fast Diagnostics
- B. Pathogen\*
- C. Polymerase Chain Reaction (PCR)
- D. ELISA
- E. Visual Monitoring
- F. Threshold\*
- G. Symptom vs. Sign
- H. Molecular Detection
- I. Sampling
- J. Field Test Kit

**Vocabulary in Context: Fill in the Blanks**

1. A fungus, virus, or bacteria that causes plant disease is a \_\_\_\_\_.
2. Tools like \_\_\_\_\_ identify pathogens by copying specific DNA sequences.
3. \_\_\_\_\_ tests use antibodies to detect proteins from plant pathogens.
4. Looking for visible changes in the plant is known as \_\_\_\_\_ monitoring.
5. Early \_\_\_\_\_ can reduce the need for chemical sprays.
6. The test that works like a pregnancy test but for plant viruses is called \_\_\_\_\_.
7. \_\_\_\_\_ allows you to find a virus even when symptoms haven't shown up.

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**Self-Test:**

1. Rapid diagnostic tools help farmers detect \_\_\_\_\_ earlier.
2. The test known as \_\_\_\_\_ uses antibodies to find pathogen proteins.
3. \_\_\_\_\_ is a method for copying DNA and detecting specific organisms.
4. Spotting disease before symptoms appear is known as early \_\_\_\_\_.
5. A \_\_\_\_\_ is the point at which treatment becomes necessary.
6. A \_\_\_\_\_ kit is a portable tool used for onsite pathogen detection.
7. \_\_\_\_\_ monitoring relies on seeing changes in the plant's appearance.
8. Early diagnosis helps reduce the overuse of \_\_\_\_\_ in IPM systems.
9. Using PCR and ELISA improves diagnostic \_\_\_\_\_.
10. One downside to fast lab-based diagnostics is their high \_\_\_\_\_.

### Reflection Questions

How could rapid diagnostic tools (like ELISA or PCR) prevent crop losses before diseases spread too far? Who do you think should be responsible for paying for rapid testing—farmers, governments, or consumers—and why? If you had access to a portable field test kit, how would you use it to make pest and disease management more sustainable?