| **The Entomologist’s Insect LifeCycle: From Hungry Caterpillars to Insect Pest Management** Author: Madison Gits |
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| **Unit Overview**  |
| **Target Audience:** 6-8th grade | **Est. Time:** Three 55 minute class periods | **Content Area(s):** Science, Agricultural Science |
| **Abstract:**In this unit students critically investigate how the insect lifecycle and integrated pest management techniques are used to control insect populations. The unit begins with discussing the stages of the insect life cycle and completing vocabulary activities. The unit then transitions into several activities using the Environmental Protection Agency’s database of pesticide labels and using real data from researchers at Purdue University to explore different management plans in corn insect pests. Using this data students work through the scientific inquiry process of asking questions; formulating predictions; gathering data; revising predictions; using additional data and information to interpret results; and developing theories. Along the way students explore how individual insect species respond to different management plans and investigate why they respond that way. Finally, students use the engineering design process to decide as a class the best management plan for an insect pest. This interdisciplinary lesson integrates the middle school Indiana Science Standards through an inquiry-based learning approach. Throughout the three lessons in this unit students investigate a current and important insect problem by: 1) using the scientific method to gain knowledge and answer questions, 2) applying that knowledge to the engineering design process, and 3) coming up with a viable management solution given the constraints and tradeoffs discovered earlier in the lesson. |
| **Unit Goals/Objectives:**After this unit students will be able to…1. Analyze how an integrated management plan affects insect pests living in agriculture habitats
2. Explain how and why an insect’s life stages influences how it thrives in an agriculture habitat
3. Describe how to use outside information to interpret scientific data
4. Design an appropriate insect pest management plan based on investigation of scientific data
5. Identify key characteristics of pesticide labels; critique and explain how the news can be misleading; and describe how to check for misinformation
6. Explain why integrated pest management is important and why it is important to not rely on only pesticides to manage agriculture insect pest populations
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| **Lesson Summaries:**Lesson 1: From caterpillar to butterfly: The stages of the insect life cycle1. Identify the main insect body parts, changes as they grow, and what insects do in the natural world
2. Recognize that insect life cycles are like and different from human life cycles
3. Identify how seasonal timing affects different stages

Lesson 2: What is a pesticide label?1. Understand a pesticide label, especially the trade name, common name, and chemical name
2. Identify the general classification of pesticides by understanding what they control
3. Identify the classification of insecticides by understanding the chemical makeup

Lesson 3: A day in the life of an entomologist: creating an IPM plan1. Evaluate data about an agriculture insect pest to propose and justify appropriate management techniques
2. Explain why integrated pest management is important and why it is important to not rely on chemical insecticides
3. Describe the process they used to develop an appropriate management plan
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| **Lesson Timeline:**Lesson 1 (55 minutes):* Introduction: 5 minutes
* Pre-assessment notecards: 10 minutes
* Butterfly video: 10 minutes
* Insect Life Cycle Activity: 25 minutes
* 3-2-1 Notecards and wrap-up: 5 minutes

Lesson 2 (55 minutes):* Introduction: 5 minutes
* Review: 5 minutes
* Why Pesticides? Activity: 15 minutes
* Pesticide Label Activity: 25 minutes
* 3-2-1 Notecards and wrap-up: 5 minutes

Lesson 3 (55 minutes):* Introduction: 5 minutes
* Review: 5 minutes
* Management Plan Activity: 35 minutes
* IPM Video: 5 minutes
* 3-2-1 Notecards and wrap-up: 5 minutes
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| **Standards:****Indiana Science Standards:*** 8.LS.7 Recognized organisms are classified into taxonomic levels according to shared characteristics. Explain how an organism’s scientific name correlates to these shared characteristics.
* 8.LS.9 Examine traits of individuals within a species that may give them an advantage or disadvantage to survive and reproduce in a stable or changing environment.
* 6-8.LST.1.1: Read and comprehend science and technical texts within a range of complexity appropriate for grades 6-8 independently and proficiently by the end of grade 8.
* 6-8.LST.2.2: Determine the central ideas or conclusions of a text; provide an accurate, objective summary of the text.
* 6-8.E.1 Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
* 6-8.E.3 Analyze data from investigations to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
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| **STEM Integration within the Unit:**Essentially, the STEM components of my lesson plan are spread across three 55-minute lessons. The science component is the biology of the insect, which is the study of the life of the insect. The technology component is insecticides, which improve the quality of human life by managing insect pest populations in agriculture environments (for example, a cornfield). The engineering component is designing a pest management plan, which requires manipulating experimental designs which may include machine equipment (like a tractor mounted boom sprayer). Finally, the mathematics component is using graphs to visualize the insect life cycle, which requires using an abstract space by manipulating numbers (like calendar months). I made these decisions on how to integrate the selected STEM and AFNR components in this lesson plan because I wanted to expose students to the exciting field of entomology, and the entomology career is not just looking at bugs all day, but it requires understanding STEM concepts to make effective insect management decisions. Food security is a trending topic right now in AFNR, and entomologists work closely with farmers to produce high-quality food. The mini-unit assignment required at least one lesson to reach a “Category 3: Advancing STEM integration” level, and I believe my “creating an insect management plan” lesson fits this level of STEM integration. My learning objectives applied STEM knowledge to solve problems. The core disciplinary STEM concepts and skills were considered as prior knowledge and were naturally and meaningfully applied to solve problems, and the use of STEM content knowledge was used to analyze and interpret the problems. The content knowledge was integrated into tools that could be transferred beyond the knowledge used to solve the problem. The learning outcomes focused on interdisciplinary concepts and skills that were woven throughout when solving problems. The instructor was a facilitator and provided enough directions to engage students to solve problems, and students determined the direction of the task that needed to be completed. AFNR served as an integrator of STEM learning by focusing on real-world problems that blended the disciplines. Finally, the student's thinking is predominantly outside of the box with few to no boundaries that limit thinking. Students demonstrated systems thinking, critical thinking, creative thinking, and complex problem-solving (Wang & Knobloch 2018). My feedback to improve the level of STEM integration rubric would essentially be useless for this course because I do not have much experience teaching STEM through AFNR. I liked using the rubric because it challenged me to think of real-world problems that entomologists face daily, and the only challenge I had when I used it was that it was my first-time creating lesson plans, let alone an entire unit. |
| **Background Information**Insect pest management has been a contentious issue for many years. On the surface it appears that insects can only be managed with chemicals, but that is frequently not the case. When using chemicals intentionally insects can be successfully managed along with non-chemical, or integrated pest management (IPM), techniques. It also does not eliminate all insect species that may be beneficial for the natural ecosystem. Careful insect pest management through IPM also provides income for entomologists that use to improve and maintain agriculture habitats through programs including: reducing invasive species; managing endangered species; reducing neonicotinoid pesticide use; creating education programs; and conducting monitoring or research projects. |

| **Lesson 1: *From Caterpillar to Butterfly: The Stages of the Insect Lifestyle*** |
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| **Est. Time:** 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Identify the main insect body parts, changes as they grow, and what insects do in the natural world
2. Recognize that insect life cycles are like and different from human life cycles
3. Identify how seasonal timing affects different stages
 | **Indiana Science Standards:****8.LS.7** Recognized organisms are classified into taxonomic levels according to shared characteristics. Explain how an organism’s scientific name correlates to these shared characteristics.**8.LS.9** Examine traits of individuals within a species that may give them an advantage or disadvantage to survive and reproduce in a stable or changing environment. |
| **Assessments****Pre-Assessment:**At the beginning of the unit teachers will gauge students’ knowledge of and experiences in insects using notecards. On one side of the card students write about their definition of an insect. On the other side students write down one reason you think insects are important and why.**Formative:**Discussion, Post-assessment 3-2-1 notecards |
| **Concept Prerequisites or Background Knowledge Needed:**Life cycle, seasons, pest management, ecosystem, graphing skills |
| **Vocabulary:**insect, IPM (integrated pest management) |
| **Materials & Technology Needed:**NotecardsComputerProjectorInternetSpeakersVideo: <https://youtu.be/O1S8WzwLPlM>Insect Lifecycle Activity PacketColored pencils or markersPencilsInsect lifecycle data |
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***15 minutes* | **Discuss Plan and Goals for Lesson (5 minutes)****Pre-assessment Notecards (10 minutes)**Have students write their definition of an insectHave students write one reason insects are important and whyHave students share to gauge knowledge of and experience with insects | NotecardsPencils |
| **Instructional Activities***35 minutes* | **Butterfly Video (10 minutes)**Watch Video: <https://youtu.be/O1S8WzwLPlM> During video:* Place pictures in order on a word document to demonstrate which part of the life cycle the movie is talking about

Pause the video each time you want to move an image into the correct order in your word document | ComputerProjectorInternetSpeakersVideo: <https://youtu.be/O1S8WzwLPlM> |
| **Insect Life Cycle Activity (25 minutes)*** Read activity background information to students and hand out copies of papers
* Go through the worksheet/definitions together with the class
* Ask: Do you think time affects how an insect goes through each life stage?
* Explain you are going to use graphing to predict what you think will happen. Throughout the activity you will be able to revise your predictions just like real scientists
* Ask students:
	+ What do they know about graphs from math class?
	+ What are important parts of a graph?
	+ How can scientists use math and graphing to understand their data?
* Project random stages of life cycles on screen
* Guide students on how to create a graph with life cycle on y-axis and season on x-axis. Instruct students to write their prediction for how the different stages at each season will change using words increase, decrease, or stay the same
* Reveal students the final graph and allow students to revise their prediction if desired
* After all the data is revealed ask:
	+ Did the data match their original prediction?
	+ How were your predictions similar/different from the final results?
	+ Why do you think researchers got these results?
* Explain that scientists frequently get really interesting results, but don’t fully understand them so they have to do more focused research to figure out why they got the results they did
	+ Ask students: What questions do you need to answer to better understand why scientists got these results?

Explain that in the next lesson we are going to introduce insecticides and why we need to understand the lifecycle to apply them | Insect Life Cycle Activity PacketColored pencils or markersPencilsComputerProjectorInsect lifecycle data |
| **Wrap Up,****Synthesis/Closure***5 minutes* | Post-assessment 3-2-1 notecards:* 3 things they learned
* 2 things they thought were interesting
* 1 question they still have
 | NotecardsPencils |
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| **Resources:** Insect data: <https://blandy.virginia.edu/sites/blandy.virginia.edu/files/Ed-LepidopteraTimelineLessonPacket.pdf>  |

| **Lesson 2: *What is a pesticide label?*** |
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| **Est. Time:** 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Understand a pesticide label, especially the trade name, common name, and chemical name.
2. Identify the general classification of pesticides by understanding what they control.
3. Identify the classification of insecticides by understanding the chemical makeup.
 | **Indiana Science Standards:****6-8.LST.1.1:** Read and comprehend science and technical texts within a range of complexity appropriate for grades 6-8 independently and proficiently by the end of grade 8.**6-8.LST.2.2:** Determine the central ideas or conclusions of a text; provide an accurate, objective summary of the text. |
| **Assessments****Formative:**Discussion, 3-2-1 Notecards, activity worksheet |
| **Concept Prerequisites or Background Knowledge Needed:**Lesson 1 content, insect pests |
| **Vocabulary:**Pesticide, trade name |
| **Materials & Technology Needed:**WhiteboardsDry erase markersWhite board block erasersWhat are Pesticides? Activity packetIndividual computersPencils/Colored pencilsProjectorNotecardsPencils |
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***10 minutes* | **Discuss plan and goals for lesson (5 minutes)****Review (5 minutes)**Recall what students learned in lesson 1, Ask:* Who can tell me what we did in lesson 1?
* What did we discover in lesson 1?
* What questions did we still have at the end of lesson 1?

Review what the insect lifecycle is, what they were trying to test, and what results they found. You can also review why insects are important and why people do not like them. |  |
| **Instructional Activities***40 minutes* | **Why Pesticides Activity (15 minutes)*** Discuss with students that there are a number of types of chemical products a person can buy when they go to the store and the use of chemicals has helped people and the environment in many ways
* Ask students why chemicals are important on a whiteboard
* Discussion should be guided with AFNR goals (preservation of food, medicine, plastics, rubber, clothing, preservation of wood, and protection of crops, animals and people from pests. Students should think of reasons how chemicals can be harmful
 | WhiteboardsDry erase markersWhite board block erasers |
| **Pesticide Label Activity (25 minutes)*** Explain to students what a pesticide is and the important of chemistry in pesticides
* Explain the parts of a pesticide label. Focus on the trade name, common name, chemical name, and chemical formula
* Have each student complete “The Pesticide Label” exercise
* Explain the classification of pesticides
* Explain the classification of pesticides according to their chemical makeup
 | What are Pesticides? Activity packetIndividual computersPencils/Colored pencilsProjectorEPA Label Parts Activity: <https://www.epa.gov/pesticide-labels/label-review-training-module-2-parts-label-page-5>  |
| **Wrap Up,****Synthesis/Closure***5 minutes* | **Post-assessment 3-2-1 Notecards:*** 3 things they learned
* 2 things they thought were interesting
* 1 question they still have
 | NotecardsPencils |
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| **Resources:** EPA Label Review Training: <https://www.epa.gov/pesticide-labels/label-review-training-table-contents> EPA Pesticide Labeling: <https://www.epa.gov/pesticide-labels/pesticide-labeling-questions-answers> Interpreting Pesticide Labels: <https://www.acpsd.net/cms/lib/SC02209457/Centricity/Domain/3256/Interpreting%20Pesticide%20Labels.pdf>  |

| **Lesson 3: *A day in the life of an entomologist: creating an IPM plan*** |
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| **Est. Time:** 55 minutes |
| **Lesson Learning Goals/Objectives:**1. Evaluate data about an agriculture insect pest to propose and justify appropriate management techniques
2. Explain why integrated pest management is important and why it is important to not rely on chemical insecticides
3. Describe the process they used to develop an appropriate management plan
 | **Indiana Science Standards:****6-8.E.1** Identify the criteria and constraints of a design to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.**6-8.E.3** Analyze data from investigations to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. |
| **Assessments****Formative:**Discussion, Post-assessment 3-2-1 Notecards**Summative:** * Management Plan Activity: After researching information about the armyworm, students will create a management plan in order to control the armyworm species in corn. Students must include the life stages they learned in lesson 1. The second part of this activity requires students to include a timeline to implement their preferred control methods. Finally, the students must explain why they chose their control methods, which they learned in lesson 2 and lesson 3. The purpose of this lesson unit is for students to incorporate different management plans into different insect life stages. This tool should be used to check on student understanding instead of grading students. Students will be evaluated based on criteria included in the rubric contained in unit additional resources.
* Students will take a test containing multiple choice, matching, fill in the blank, and true or false questions. Example questions are in the unit additional resources. These questions can be part of a final exam for this unit or integrated into an exam for a larger unit.
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| **Concept Prerequisites or Background Knowledge Needed:**Lesson 1 and 2 content, insect lifecycle, pesticide purpose |
| **Vocabulary:**IPM (integrated pest management), pesticidescultural, mechanical, biological, and chemical controls |
| **Materials & Technology Needed:**Management plan activity assignment and rubricPencils/colored pencilsWhite printer paperComputerProjectorNotecardsPencils |
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| **Lesson Component** | **Instructions** | **Materials** |
| **Introduction***10 minutes* | **Discuss plan and goals for lesson (5 minutes)****Review (5 minutes)*** Review what students learned in lessons 1 and 2, Ask:
* What did we discover in lesson 1 when we looked at the butterfly life stages?
* What questions did we have after lesson 1 that we answered in lesson 2?
* Can someone summarize what we learned in lessons 1 and 2 in two sentences?
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| **Instructional Activities***40 minutes* | **Management Plan Activity (35 minutes)*** Ask students: Does anyone know what insect pests would be most common in a corn or soybean field
* Introduce IPM definition and explain cultural, mechanical, biological, and chemical controls. This will be essential for students to understand these definitions in order to proceed with the rest of the activity.
* Ask students: Have you had any experience with these control methods? Have you seen farmers spray pesticides before?
* Have students form groups of 5 in order to create a management plan for the armyworm (Pseudaletia unipuncta) in corn. Students need to create a timeline (with calendar months and seasons) of the different life stages. Once students create a timeline, have students apply what control methods they think will work in controlling armyworm populations. When students are done, have them present to the class their management plan
* Display a current IPM plan for the armyworm in Indiana. Emphasize that real life entomologists are creating management plans today in order to control agriculture insect pest species.
 | Management plan activity assignment and rubricPencils/colored pencilsWhite printer paper |
| **IMP Video (5 minutes)*** Have students watch video to learn how farmers manage insects today: <https://youtu.be/dbn_7svSj5E>
* Mention the main point again that real life entomologists are creating management plans today in order to control agriculture insect pest species.
 | ComputerProjector |
| **Wrap Up,****Synthesis/Closure***5 minutes* | Post-assessment 3-2-1 Notecards:* 3 things they learned
* 2 things they thought were interesting
* 1 question they still have
 | NotecardsPencils |
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| **Resources:** EPA IPM Principles: <https://www.epa.gov/safepestcontrol/integrated-pest-management-ipm-principles>  |

**Additional Resources:**

**Management Plan Activity Rubric:**

|   | Poor | Fair | Excellent |
| --- | --- | --- | --- |
| Life Stages | Student only included one or no stages of the insect life cycle | Student included a few stages of the insect life cycle | Student was able to include all stages of the insect life cycle |
| Timing | Student included one or no calendar months (ie. July) AND/OR student included one or no seasons (spring, summer, fall, winter) | Student included only some calendar months (ie. July) AND/OR student identified some seasons (spring, summer, fall, winter) | Student was able to include all calendar months (ie. July) AND identified seasons (spring, summer, fall, winter) |
| Control Methods | Student failed to identify any control methods | Student identified control methods but does not understand why student chose specific methods | Student was able to identify what control methods to use AND explain why they are the best methods for their plan |
| Presentation | Student does not understand material | Student somewhat understands material AND/OR student was somewhat organized | Student clearly understands the material AND were able to organize information in a clear and organized way |

**Example Questions for summative assessment for knowledge outcomes:**

What are the stages of the insect life cycle?

*Fill in the blank*

What are active ingredients?

*Fill in the blank or multiple choice*

Entomologists are creating Integrated Pest Management Plans for their jobs today.

*True or False*

**Understanding Insect Lifecycle Activity:**

1. The first stage of an insect’s life is an \_\_\_\_\_.
2. Another name for a young insect is a \_\_\_\_\_.
3. Before an insect turns into a butterfly it is a young insect called a \_\_\_\_\_\_ also known as a larva.
4. A developing insect inside a cocoon is called a \_\_\_\_\_.
5. Just before a caterpillar turns into a butterfly, it begins breaking through its \_\_\_\_\_.
6. An \_\_\_\_\_ is the rear part of an insect.
7. Between the head and abdomen is a \_\_\_\_\_.
8. When an insect comes out of an egg this is called \_\_\_\_.
9. When a caterpillar loses its skin, this is called \_\_\_\_\_\_.

**Words:**

Abdomen Caterpillar Chrysalis or Cocoon

 Egg Hatching

Larva Pupa Sheds Thorax

**Key:**

1. Egg
2. Larva
3. Caterpillar
4. Pupa
5. Chrysalis (cocoon)
6. Abdomen
7. Thorax
8. Hatching
9. Sheds

**Pesticide Label Activity**

1. What is the brand name of the pesticide?
2. What are the target organisms of this pesticide?
3. What are the active ingredients in this pesticide?
4. What is the signal word on the label?
5. What are the hazards to humans when using this product?
6. What are the hazards to pets or other animals?
7. What are the environmental hazards of using this pesticide?
8. Should this pesticide be applied to cooking surfaces?
9. Should this product be applied to beds?
10. When may children and pets re-enter an area where this product has been used?