



Aquatic Insect Guide

What physical traits do all insects share and what adaptations do aquatic insects use to survive?

◆ Grade Level(s)

9th-12th grades

◆ Subject Areas

Biology, Ecology, and,
Environmental Science

◆ Key Topics

Insects, anatomy, adaptation,

◆ Duration

Preparation Time: 30 min

Activity Time: 4 x 50 min

◆ Setting

Classroom (Individual)

◆ Skills

Gathering, applying, and
communicating information

◆ Standards

NGSS & MT Science Std.:

HS-LS4-4: Construct an explanation based on evidence for how natural selection leads to adaptation of populations over time.

LS1.A: Structure and Function

LS4.C: Adaptation

CROSSCUTTING CONCEPT(S):

Structure and Function

SCIENTIFIC & ENGINEERING PRACTICE(S):

Obtaining, Evaluating, and
Communicating Information

Common Core:

W.9-10.4: Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience.

L.9-10.1: Demonstrate command of the conventions of standard English grammar and usage when writing or speaking.

Overview

Students will be introduced to aquatic insects, a unique and diverse group of animals that serve as an important food source for freshwater fish. Each order of insects have adaptations that allow them to survive in their respective habitats. The insects also have a series of life cycle stages that they go through as they mature into their sexually mature adult stage.

Objectives

Students will be able to:

- describe the physical traits all aquatic insects have in common.
- identify adaptations used by 10 aquatic insect orders to survive.
- Create an Aquatic Insect Guide and use it for insect identification.

Materials

Warm Up / Activity / Wrap Up

- Computer, projector, student worksheets, & student resources
- White 8 ½" x 11" paper cut in half width-wise (one ½ sheet/student plus extras for teacher demonstrations)
- A selection of colored 8 ½" x 11" paper cut in half width-wise (enough for each student to have twelve ½ sheets of paper)
- Scissors (1/student), glue sticks (1/pair), colored pencils
- 1-2 staplers
- Computer, chromebook, or tablet w/printer access (1/student)

Advanced Preparation

- Copy the student worksheets #1-3 (double-sided) and #4 (single-sided). Copy the student resources #1-4 (double sided).
- Prior to class,
 - Pre-cut the white and colored 8 ½" x 11" paper in half.
 - Gather the scissors, glue sticks, stapler, and colored pencils.
 - Pre-load the "Aquatic Insect Guide" presentation found on the FLBS website:
<https://flbs.umt.edu/newflbs/k12teachingmaterial>
- *NOTE - If going on the optional field trip, copy and laminate 12 copies of the UWEX Key to the Macroinvertebrate Life in the River (see online resources) and gather materials (see lesson procedure).*



Background

There are more than one million species of insects in the world. Insects are part of the Phylum Arthropoda, which is a group of animals that have an exoskeleton or hard shell-like exterior that protects their inner organs. Insects are cold-blooded animals that have an open circulatory system, three main body regions (head, thorax, and abdomen), paired antennae on their head, and three pairs of legs. They have a wide variety of physical adaptations that allow them to live in diverse terrestrial and aquatic habitats. This lesson will provide the students with an opportunity to learn about 10 orders of insects that live in or along local rivers or streams.

These aquatic insects all have unique characteristics that help them to survive in their environment. Some have mouthparts adapted to scrape algae off of rocks while others have elongated front legs that allow them to hold on to each other in the air while they mate. Some live under rocks while others skate along the surface of the water. The life cycle stages for each order of insect allow them to physically develop in a time frame and manner that is the most beneficial for the species survival. Students will investigate the anatomical features that make each insect order unique, the habitats in which they reside as larvae and adults, and the time of year that the adult insects develop, emerge, and mate.

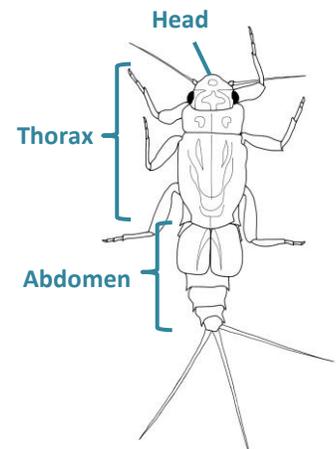


Photo credit: Holly Church

Insects have unique adaptations that allow them to live in diverse habitats.

Lesson Vocabulary

Anterior – The head end of a body.

Antennae – Paired, segmented appendages of the head that typically arise between the eyes.

Abdomen – The third body region of an insect that is generally the longest and composed of several segments (often from 8 to 11).

Dorsal – The upper or top surface of a body.

Fore wings – The first pair of wings typically located on the second thoracic segment.

Head – The first body region of an insect that contains the feeding apparatus and other sensory organs.

Hind Wings – The second pair of wings typically located on the third thoracic segment.

Posterior – The tail end of a body.

Thorax – The second body region of an insect that contains the appendages for moving and is composed of three segments: the prothorax (1st segment), the mesothorax (2nd segment), and the metathorax (3rd segment).

Ventral – The lower or bottom surface of a body.

Procedure

◆ Warm Up (10 minutes)

- Turn on the projector, display the “Aquatic Insect Guide” presentation, and pass out the student worksheets (#1-4).
- Slide 2: Display the collection of insect photographs in the provided presentation and ask them what traits or characteristics all of these insects have in common.
 - Write the student answers on the board.
- Slides 3-5: Discuss the distinguishing traits that all insects share.
- Slides 6-10: Discuss the adaptations many aquatic insects have that allow them to live in the different habitats. Benthic (bottom-dwellers) insects can cling, sprawl, climb, and burrow. Plankton and nekton can float, drift and swim. Lastly, neuston (surface dwellers) can skate or jump along the surface. Their unique body design helps them to move, reproduce, get food, and avoid predators.



FLATHEAD LAKE
BIO STATION
UNIVERSITY OF MONTANA

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Aquatic Insect Guide

◆ Part I: Build the Insect Classification Guide (40 minutes)

- Explain that the students will be creating an Aquatic Insect Guide of 10 specific orders of insects that are found living in and along rivers or streams in the region.
- Slides 11- 25: Pass out the “Student Resources” packet. Use the provided directions to walk the students through the process of building their 12-page booklet. Be sure to emphasize the need for using straight, nicely creased folds as they create their paper template in steps A-F.
 - (Steps A-F) As you go through each step of the template formation, walk around to help each student and to make sure they are folding the template correctly. Do not move on to step G until all of the students are finishing with the template.
 - (Step G) When ready ask the students to pick out 12 half sheets of colored paper. They may select 12 of the same color or select a combination of colors that gives them a repetitive pattern of their choice. Next have the students arrange the half sheets in the order they will occur in their foldable booklet.
 - (Steps H-M) Demonstrate steps H through K to the entire class and then walk around to help the students. As the students finish, they may add staples the left side of the booklet (remind them to keep the staples close to the edge of the booklet).
 - Ask the students to label the tabs of their booklet with the provided list in the “Student Resources” packet and to decorate the front cover of their booklet.

◆ Part II: Insect Classification Guide (3 x 50 minutes)

- Slides 26-36: As you display the slides, the students record the order “nickname” and the types of organisms in each insect order on their worksheet.
- Slide 37: Guide the students to complete the “Basic Insect Anatomy” page of their booklet. They must NEATLY cut out, arrange, and glue the provided text boxes and diagrams provided on the “Lesson Materials” student worksheet. They can attach the materials to the inside of the front cover and the Basic Insect Anatomy page.
- Slide 38: Ask the students to use reliable (.org/.gov/.edu) websites and/or other resources to research all 10 insect orders. Each page (pages 3-12) of the booklet must include the following:
 - A list of 3 or more animals that share the same order (list common names).
 - At least 5 adaptations or distinguishing physical traits for the insect order. These are the physical traits that allow you to distinguish the different groups of insects from each other.
 - A description of the preferred habitats.
 - Seasons or when during the year the insects will appear in the different stages of development.
 - One diagram of the anatomy of one insect in the order.
 - A diagram of the stages of development/life cycle for insects in the order.
 - At least 2 photographs of animals in the insect order.
- Slides 39-40: Review the “Tips for Success” and Project Rubric
- Slide 41: As the students work, ask them to create two alphabetical lists of references: one for the photographs and diagrams and one for the content they collect. Remind them that they must include what the source was used for and the website they retrieved the materials from. Instruct them to attach both lists to the back page of the foldable.

◆ Wrap Up (10 minutes)

- Slide 42: Pair up the students and ask them to review their booklets and to pick one unique trait for each insect order that they think will help them to remember the order and the type of insects in it.



Aquatic Insect Guide

◆ (OPTIONAL) Field trip Excursion (3-4 hours depending on the amount of sampling)

- Take the students to a local stream, river, or wetland. Have the students collect, sort, and identify the aquatic insects using their Aquatic Insect Guides and the UWEX Key to Macroinvertebrate Life in the River (see online resources).
- Recommended field trip materials:
 - 6 large white plastic trays, 12 Forceps, 12 white plastic spoons, 6 disposable plastic pipettes, 6 ice cube trays, 12 laminated freshwater stream insect keys (see online resources), 1 D-net, 6 buckets, 1 tarp for students to sit on, 1 pop-up tent for shade and/or increment weather, hip waders for instructor (and 3-4 students if possible), 6 clipboards, pencils, and data sheets.

Teacher Resources

Assessment Options

Have students:

- **complete the Aquatic Insect Guide** as described.
- **collect, sort, and identify** aquatic insects at a local stream, river, or wetland using their Insect Classification Guides.

Modifications

- Students can use a Google Docs template for gathering their online information and sources.
- The worksheets can be enlarged for students in need of larger text.

Extensions

Students can:

- **create a photo guide** of common aquatic insects in the area.
- **conduct a research project** on one specific aquatic insect species that lives in the area.
- **design a solution** design a solution to an environmental issue that impacts a local population of aquatic insects.

Books

W. P. McCafferty (1983). *Aquatic Entomology: The Fishermen's and Ecologists' Guide to Insects and Their Relatives*. Jones & Barlett Publishing, Massachusetts.

Online Resources

Montana Field Guide: <http://fieldguide.mt.gov/>

UWEX Key to Macroinvertebrate Life in the River:
<http://clean-water.uwex.edu/pubs/pdf/riverkey.pdf>

Acknowledgements

Many thanks to Abigail Schmeichel for her contributions to this lesson.



Photo credit:
AnemoneProjectors (CC BY-SA 2.0)

Water boatmen are a unique aquatic insect with modified legs that allow them to paddle and swim through the water quickly.



Photo credit: Dave Huth (CC BY 2.0)

Mayflies spend a majority of their lifespan as larval nymphs. They briefly emerge from the water as flying adults, reproduce, and then die.



Aquatic Insect Guide

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Warm Up

Complete the question below as you view the presentation.

What do all insects have in common?

Part I: Build the Aquatic Insect Guide

Follow the “Assembly Instructions” in the provided Student Resources packet.

Part II: Fill the Aquatic Insect Guide

1. While viewing the presentation, record the “nickname” and the types of organisms in each order.

Order:	“Nickname”	Types of organisms:
Ephemeroptera	_____	_____
Odonata	_____	_____
Plecoptera	_____	_____
Hemiptera	_____	_____
Megaloptera	_____	_____
Neuroptera	_____	_____
Coleoptera	_____	_____
Trichoptera	_____	_____
Lepidoptera	_____	_____
Diptera	_____	_____

2. Complete the Basic Insect Anatomy page. Cut out, arrange and glue the diagrams and text boxes provided on the “Lesson Materials” worksheet. This page of your booklet should include the following:

- A list of the physical distinguishing traits that all insects share.
- A diagram of the dorsal view of an insect.
- A diagram of an insect’s mouthparts.
- A diagram of an insect leg.
- A diagram of incomplete and complete insect metamorphosis.
- A list of aquatic insect habitats and adaptations.

NOTE: These materials can be arranged neatly on the inside cover and on the “Basic Insect Anatomy” page.

3. Use the internet and/or other resources to research each insect order in your booklet. Each insect order page (pages 3-12) of your foldable must include the following:

- A list of 3 or more animals that share the same order (list specific common names).
- At least 5 adaptations or distinguishing physical traits for the insect order. These are the physical traits that allow you to distinguish the different groups of insects from each other.
- A description of the habitats the insects in the order can be found in.
- Seasons or when during the year the insects will appear in the different stages of development.
- One diagram of the anatomy of one insect in the order.
- A diagram of the stages of development/life cycle for insects in the order.
- At least 2 photographs of animals in the insect order.



TIPS FOR SUCCESS:

- Your booklet must be creative, colorful, and typed and/or neatly handwritten. Use the example on the next page as reference but also feel free to layout the booklet using your own style and creativity.
- Keep track of your sources as you conduct your research and gather your images. You will need to list the sources on the back of your booklet (see below).
- Use copyright free photographs and diagrams OR make your own.
- Use the provided rubric as you complete the classification guide.

Example page of an insect classification guide:

Ephemeroptera	Odonata	Plecoptera	Hemiptera	Megaloptera	Neuroptera	Coleoptera	Trichoptera	Lepidoptera	Diptera
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Order: Ephemeroptera (Mayflies)

Examples of insects in the order:

- Blue winged olive mayflies, western March brown mayflies, pale morning dun mayflies, little green drake mayflies

Ephemeroptera adaptations or distinguishing physical traits:

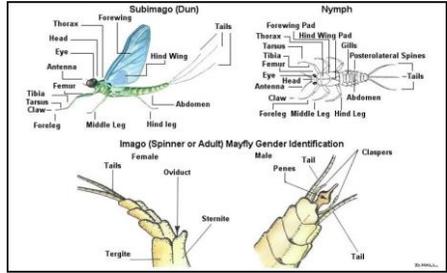
- The three thorax segments each have a pair of legs and the abdomen consist of 10 segments.
- Nymphs often have 7 pairs of gills along the abdomen.
- Subimagos are fully winged sexually immature mayflies that molt into adults.
- Adult males have long front legs to hold a female in the air while mating.
- Adults (imagos) have transparent wings that sit along their backs when at rest and 3 long tail filaments that do not fold flat over the abdomen.

Habitats Ephemeroptera live in:

- Immature nymphs or naiads live in streams under rocks, in decaying plants or in the sediments. Adults mate either above the water or in the water.

Seasons:

- Adult mayflies have a synchronized emergence for 1-2 days (spring to autumn)






4. Create two alphabetical reference lists: one for the photographs and diagrams and one for the content you collect. Include a DESCRIPTION OF THE RESOURCE and the WEBSITE you retrieved the materials from. Attach both lists to the back page of the classification guide.

For example:

Photo/Diagram List of References

Anatomy diagram of a stone fly: list website

Life cycle diagram of a stone fly: list website



Aquatic Insect Guide

Student Worksheet (3 of 4)

Wrap Up With a Partner

Review each order and record ONE unique trait that will help you to remember the insects in that order.

Order:	Distinguishing Trait:
Ephemeroptera	_____
Odonata	_____
Plecoptera	_____
Hemiptera	_____
Megaloptera	_____
Neuroptera	_____
Coleoptera	_____
Trichoptera	_____
Lepidoptera	_____
Diptera	_____

Aquatic Insect Guide Rubric

Use the follow rubric as a guide as you complete your project.

	REQUIREMENTS	SCORE
CONTENT (50 pts)	Includes: <input type="checkbox"/> A list of 3 or more animals that share the same order. <input type="checkbox"/> A list of 5 or more adaptations or distinguishing traits for each order of insects. <input type="checkbox"/> A description of the habitats insects in each order can be found in. <input type="checkbox"/> A description of the seasons during the year in which the insects in each order will appear in the different stages of development.	
GRAPHICS (30 pts)	Contains: <input type="checkbox"/> One diagram of the anatomy of one insect in each order. <input type="checkbox"/> Two or more pictures of the animals in EACH insect order. <input type="checkbox"/> One diagram of the stages of development/life cycle for each insect order.	
DESIGN (10 pts)	<input type="checkbox"/> Creative, colorful design	
FORMAT (5 pts)	<input type="checkbox"/> Typed or <u>NEATLY</u> handwritten	
REFERENCE LIST (5 pts)	<input type="checkbox"/> Includes a complete list of sources for each photograph and/or diagram used in the booklet. <input type="checkbox"/> Includes a complete list of sources for the content used in the booklet. <input type="checkbox"/> Both reference lists are alphabetized.	
Comments:		Total: _____/100



Aquatic Insect Guide

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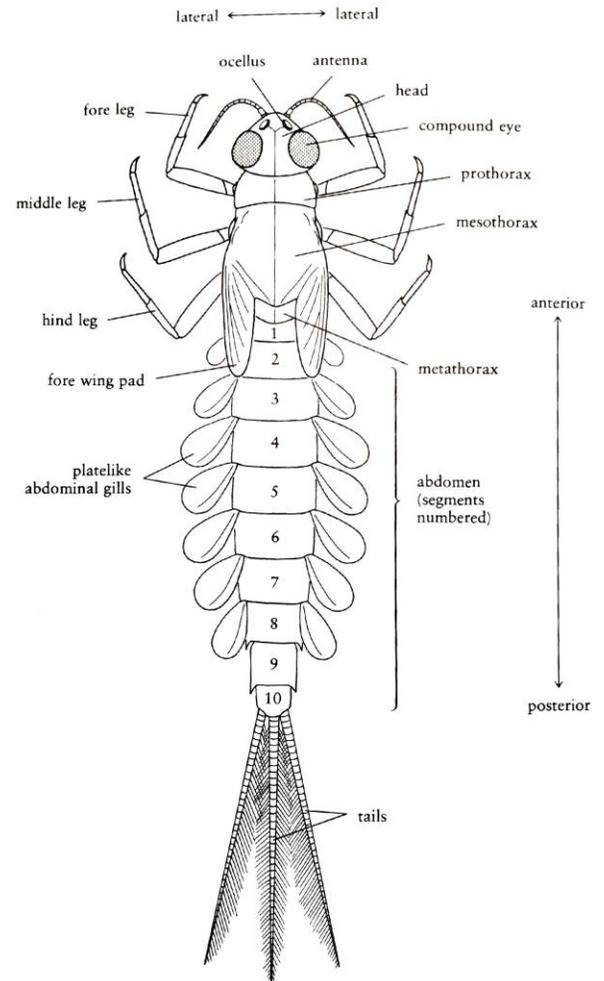
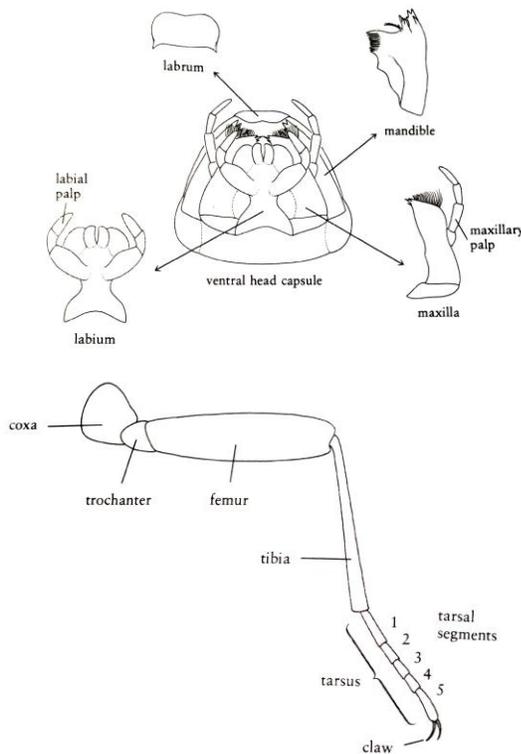


Lesson Materials

Cut out the following and arrange them neatly onto the inside cover and "Basic Insect Anatomy" page of your Aquatic Insect Guide.

Distinguishing traits that ALL insects share:

- Cold-blooded invertebrates
- Open circulatory system
- Exoskeleton or hard shell-like covering
- Three main body sections:
 - Head, thorax, and abdomen
- Pair of antennae on their head
- Three pairs of legs
- They go through either a complete or incomplete metamorphosis as they develop



Benthic (bottom dwelling) Aquatic Insects:

- Clingers, sprawlers, climbers, or burrowers

Plankton (drift w/currents) Aquatic Insects:

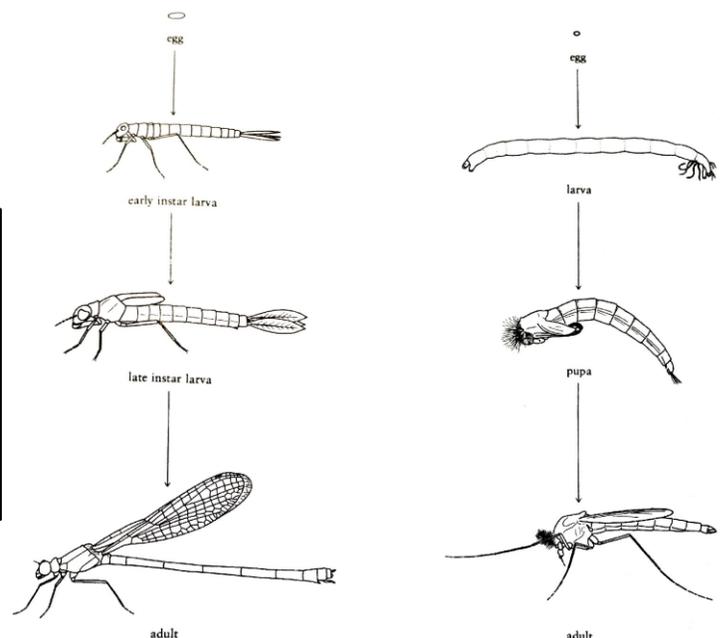
- Floaters or drifters

Nekton (swim against currents) Aquatic Insects:

- Swimmers

Neuston (surface dwelling) Aquatic Insects:

- Skaters or jumpers



Illustrations above were created by Arwin V. Provonsha.
Retrieved from *Aquatic Entomology* (1983).



Aquatic Insect Guide

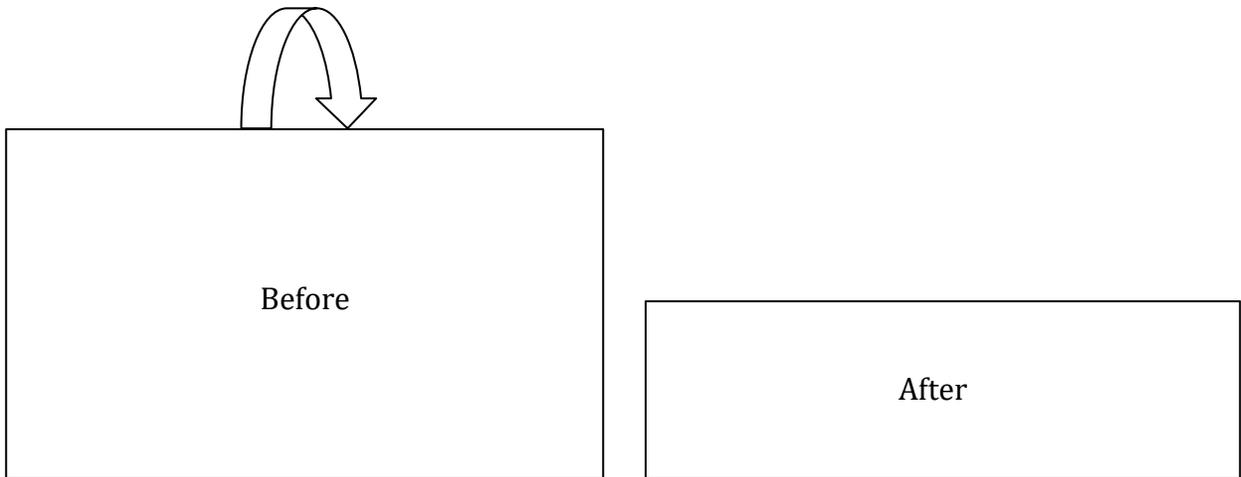
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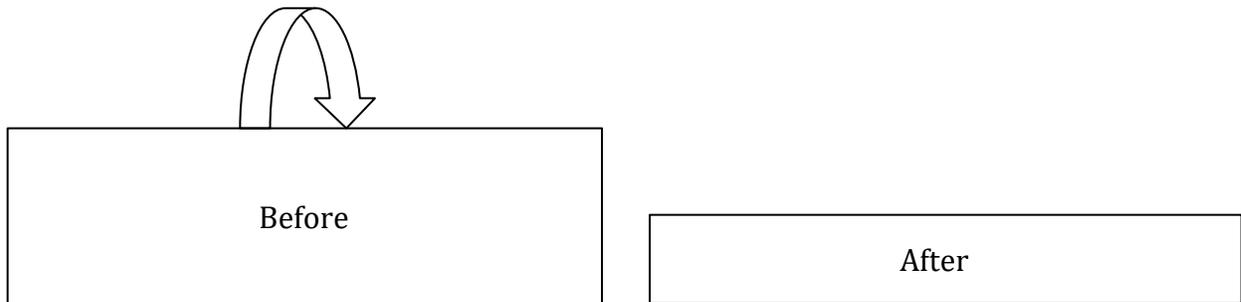
Assembly Instructions

1.) Follow the directions below to create a twelve-tab foldable booklet.

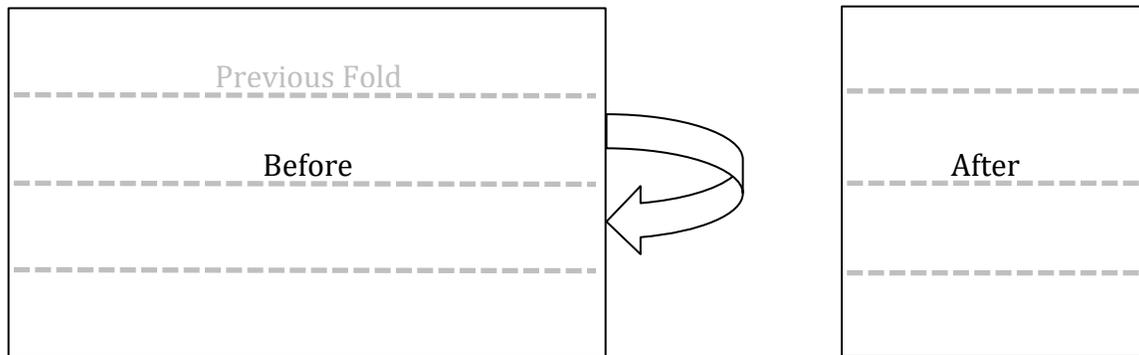
A. Fold the provided 1/2 sheet of paper in half lengthwise (hot dog fold)



B. Fold the paper again in half lengthwise



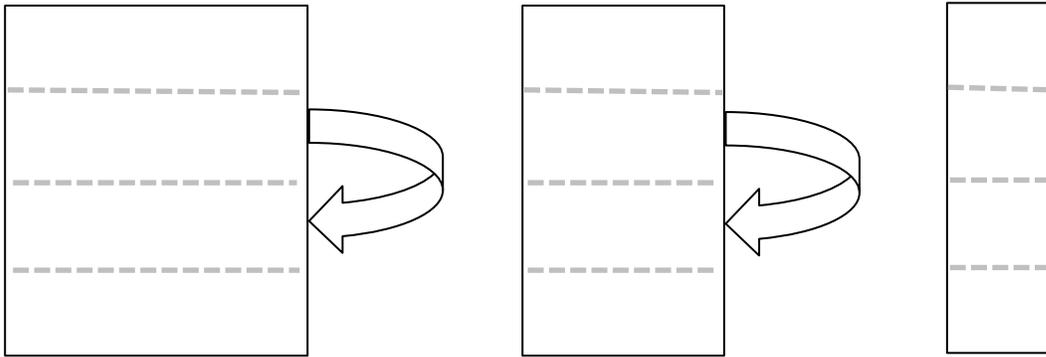
C. Open the 1/2 sheet of paper back up and fold in half widthwise (hamburger fold)



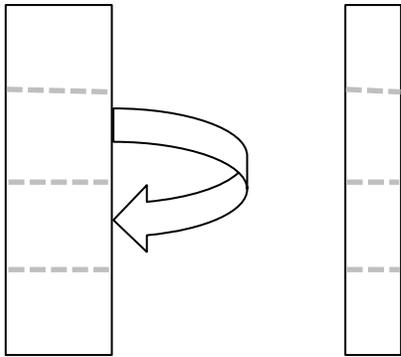
Aquatic Insect Guide

Student Resources (2 of 4)

D. Fold this over again EQUALLY IN THIRDS.



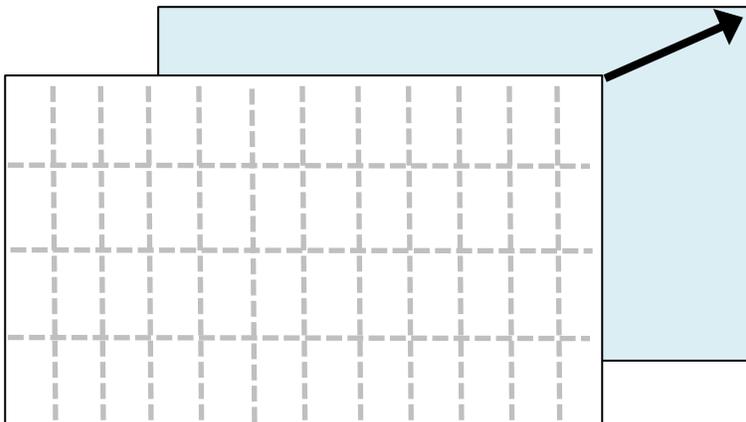
E. Fold one last time in half.



F. Open up the half sheet of paper so that you can use it as a cutting template. RECREASE all of the vertical and horizontal folds.

G. Gather 12 NEW half sheets of paper (colors of your choice). Arrange the 12 sheets into a pattern of your choice. Set the bottom (12th) page aside.

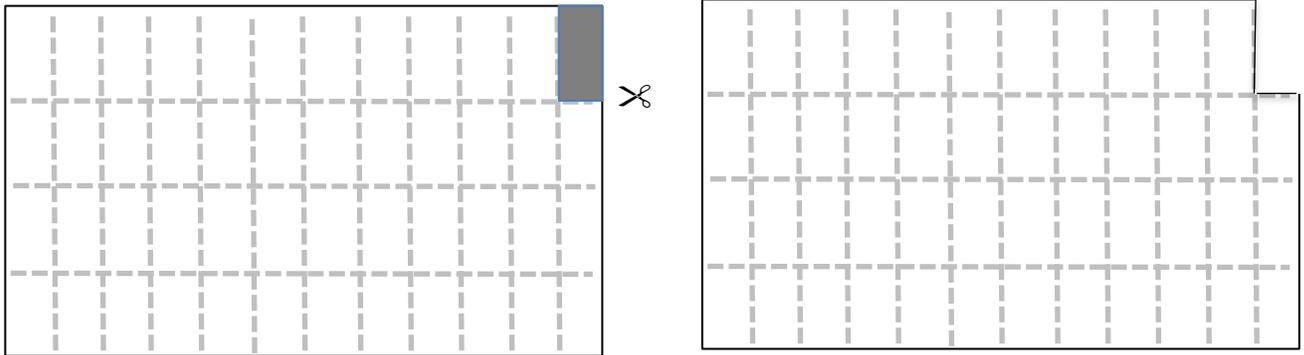
H. Place the template OVER THE TOP of the 11th page of your booklet. Carefully line up the template with the TOP RIGHT corner of the 11th page.



Aquatic Insect Guide

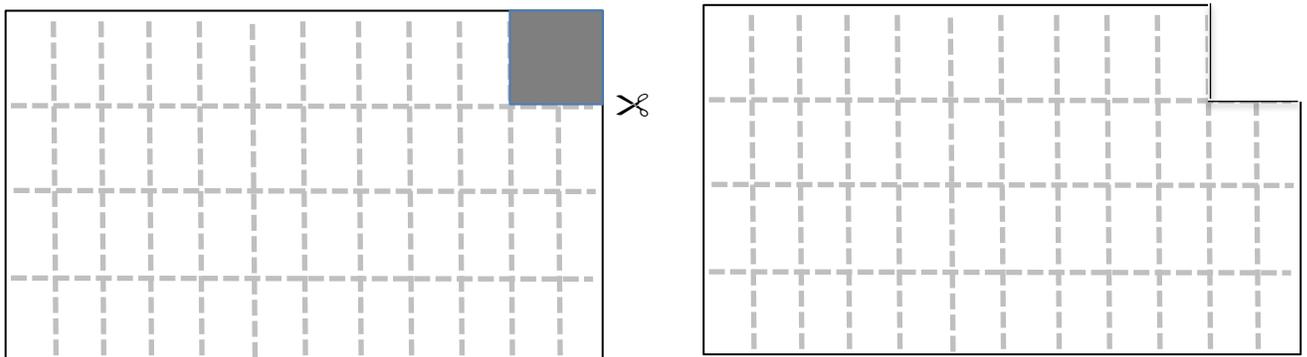
Student Resources (3 of 4)

- I. Slowly cut out the FAR TOP RIGHT box out of both sheets. Be sure to cut as close as possible to the creased folds.



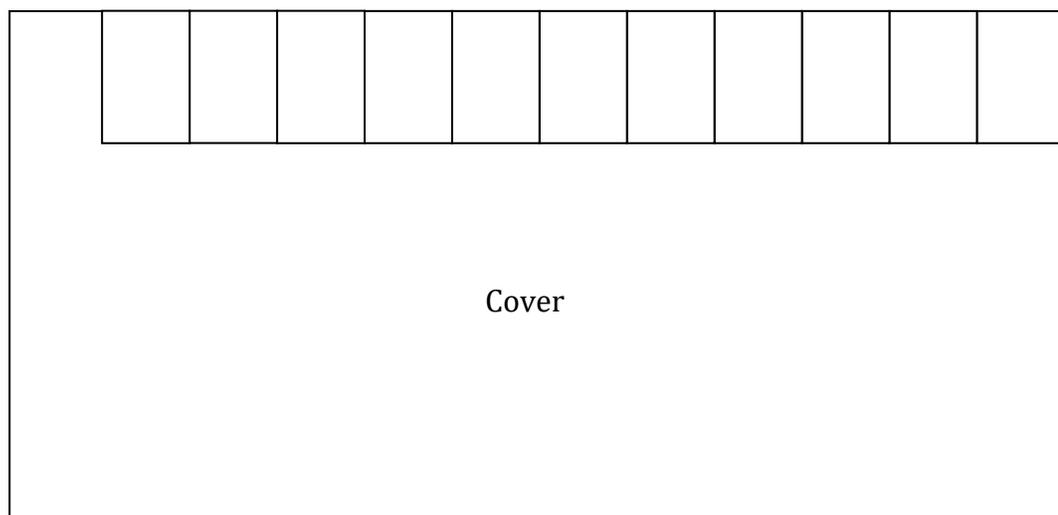
- J. Place the newly cut 11th page over the 12th page and set it aside.

- K. Line up the template with the top right corner of the 10th page. Carefully cut the FAR TWO RIGHT boxes out of both sheets. Again be sure to cut as close to the creased folds as possible.



- L. Place the newly cut 10th page over the 11th page and set aside.

- M. Repeat step K above for pages 9-2, cutting out an extra box towards the left each time until you have a booklet like the example below.



- 2.) Add identifying labels to the tabs at the top of the booklet in the following order (starting from the left to the right). See the example below.

Basic Insect Anatomy
Ephemeroptera
Odonata
Plecoptera
Hemiptera
Megaloptera
Neuroptera
Coleoptera
Trichoptera
Lepidoptera
Diptera

- 3.) Use your creativity to decorate the cover page so that the front of your booklet contains a title, name, and period. See the example below.

Basic Insect Anatomy	Ephemeroptera	Odonata	Plecoptera	Hemiptera	Megaloptera	Neuroptera	Coleoptera	Trichoptera	Lepidoptera	Diptera
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Aquatic Insect Guide
By: Insert Your Name Here
Period #?

