

OCSHP Detailed Instructional Lesson Sequence for General Biology Class (grades 9-10)

Hummingbird Project Student Learning Objectives:

Learners will understand:

1. Hummingbirds play a vital role in pollination (sexual reproduction) of many plant species, perpetuating plant biodiversity.
2. Variations of genetic traits of different hummingbird species have provided different adaptations and enabled them to fill different ecological niches.
3. Flowers have many structures, each with a vital role in reproduction.
4. Structure of flower attracts different types of pollinators
5. Genetic traits determine structure and are inherited by offspring through reproduction.
6. Rufous Hummingbird populations have steadily been declining since 1966.
7. Biodiversity of hummingbirds affects other species in ecosystems, including humans.
8. Conservation of hummingbird habitats and migration routes are critical to maintaining hummingbird populations.

Day 1: (70 min.)

Learning Objective:

Learner will be able to –

- *Define biodiversity and discuss the importance of maintaining biodiversity through partner and class discussion, and watching a documentary and taking notes.*
- *Describe general characteristics of hummingbirds and their role in pollination through watching a documentary and taking notes.*
- *Compare different traits, variations, and adaptation of hummingbirds.*
- *Diagram, label, and describe functions of parts of a flower.*

Intro/Hook (~10 min.):

1. Discuss meaning of biodiversity in groups and share group perspective to whole class.
2. Write definition of biodiversity in lab journal: “Biodiversity is the extraordinary variety of life on our planet” (Zervanos & McLaughlin, 2003, p. 683). (See Biodiversity Intro PowerPoint.)
3. Write response in journal: “I think biodiversity is important because....”
4. Project image of Peck’s penstemon (*Penstemon peckii*) (endemic trumpet shaped flower, only lives in Central Oregon). (See Biodiversity Intro PowerPoint.)
5. Ask students to name flower and discuss in pairs how this flower is pollinated.
6. As a class discuss role of insects, bats, and hummingbirds in transferring genetic material from flower to flower so plants can reproduce sexually and diversify genetics. Highlight that pollinators play key role in maintaining biodiversity of plant species in an ecosystem.

Hummingbirds and Traits/Variations/Adaptations (~55 min.):

1. Tell students we will be learning about genetics through studying hummingbirds and their role in the ecosystem, starting with watching “Hummingbirds: Magic in the Air”, a 53

min. PBS documentary on hummingbirds (Prum, 2010).

2. Instruct students to create chart in lab journal:

Title: "Hummingbirds: Magic in the Air"

Trait: _____ Variations: _____ Adaptations: _____ Current Research: _____

(Ex: beak length long ability to suck nectar from deep flower HB flight patterns)

As students watch documentary, they should write the traits they observe, list variations of those traits, and what adaptations each variation provides the species. They should record examples shown of current research studies highlighted in the documentary, not necessarily connected to traits listed in adjacent columns.

Instructor NOTES:

- 1) Video gives great opportunity to introduce Rufous Hummingbirds and the Citizen Science Hummingbird Study. Highlight connections at appropriate times during video.
- 2) Video shows excellent examples of career opportunities in biology and of possible research studies (hummingbird nest placement, courtship flight of male Anna's Hummingbird, banding hummingbirds, flight patterns of hummingbirds, male vs. female Purple-throated Carib and Heliconia flowers, and nesting relationship of Black-chinned Hummingbirds and hawk species), as well as use of technology to conduct studies (high speed video to capture hummingbirds in action, banding and database organization, infrared cameras to study torpor and metabolism).

Plant Reproduction/Flower Anatomy (~5 min./remaining class time):

1. To understand how hummingbirds pollinate and to understand sexual reproduction and biodiversity of plants, students will dissect a flower the next day. In preparation, students will diagram and label parts of a perfect flower and write the functions of the parts (refer to pg. 665 of Biggs et al., 2002). Students should use color and complete in lab journal. Due at beginning of next class.

Assessment:

1. Traits, variations, and adaptations recorded in journal,
2. Observation of student partner discussions
3. Diagram of flower with appropriate labels and functions

Materials needed: text book (Biggs et al., 2002), internet and access to "Hummingbirds: Magic in the Air" (Prum, 2010), image of Peck's penstemon

Day 2: (70 min.)

Learning Objective:

Learner will be able to –

- *Explain how plants reproduce, including function of each part in role of fertilization.*
- *Dissect a flower and identify each part.*
- *Describe the role of hummingbirds and other pollinators in pollination and plant reproduction.*

Intro/Hook (~10 min.):

1. Have students take out journals and text books.
2. Instruct students to review traits recorded from “Hummingbirds: Magic in the Air” (previous day) in pairs and make additions based on partner discussion.
3. Introduce OSU Citizen Science Hummingbird Project (OCSHP) and show an example feeder. Discuss the importance of hummingbirds and their role in pollination as well as habitat loss along migration corridors. This leads into plants and what pollination is.
4. Show Beauty of Pollination (Demir, 2011) on Youtube (4:23). Briefly review role of pollinators in sexual reproduction of flowering plants. Students will dissect flowers to explore how they are fertilized.

Flower Dissection (~60 min.):

1. Show the Flower Inquiry document (see “On the web”) and instruct students to write title and questions in journal. Review the process of the flower dissection exploration as well as the assignment that follows the dissection.
2. Review lab safety and maturity with use of razor blades and stereomicroscope.
3. Instruct students to form pairs (by choice), bring lab journal and Biology text (Biggs et al., 2002) to lab station. Students will follow instructions of “Examining the Structure of a Flower” pg. 678-679 (Biggs et al., 2002). Each student needs one flower, a microscope slide and coverslip, and a razor blade. Groups need access to a stereomicroscope, eye droppers, colored pencils, scotch tape and water.
4. Demonstrate how to dissect a flower to the whole class and go over the parts of the flower and their roles in pollination and reproduction.
5. Students should follow the directions for conducting the dissection, examining each part and taping and labeling one of each part of the flower in their journal and sketching the part in color in their journal. They should refer to their diagrams as they work. (NOTE: as students work, teacher circulates to check and record completion of flower diagram.)
6. When finished, students clean area, answer Analyze and Conclude #1-3 pg. 679 (Biggs et al., 2002), and write a well-written conclusion (due at the beginning of the next class) addressing:
 - a. How do plants reproduce sexually to make seeds? Include role of stamen, anther, pollen, stigma, style, pistil, ovary, ovule, and seed in answer.
 - b. What is the role of pollinators, such as hummingbirds, in the reproduction of flowering plants?

Assessment:

1. Observations of students in lab and verbal responses to questions from instructor
2. Lab performance and work in journal, question responses, and written conclusion

Materials needed: 1 Peruvian lily (*Alstroemeria*) (or other perfect flower) per student, razor blades (1 per student), stereomicroscope and/or hand lens per group, colored pencils, 1 microscope slide and coverslip per student, droppers, water in container, paper towels

Day 3 (45 min. short period):

Learning Objective:

Learner will be able to –

- *Describe general characteristics of hummingbirds, their role in the ecosystem and pollination, and importance of maintaining biodiversity through reading infographic and article and taking notes, discussing information, and writing a summary.*
- *Describe evolution of hummingbirds.*
- *Explain specific characteristics of Rufous Hummingbirds and threats to population they are facing.*

Intro (~5 min.):

1. Students should take out journals, and in pairs, read/listen to each other's flower dissection conclusions.

Hummingbird characteristics (~20 min.):

1. Project and pass out All About Hummingbirds infographic (Fulton, 2013), and instruct students to read page in pairs noting traits unique to hummingbirds, by highlighting or underlining info on sheet and then attach sheet neatly in journal with date and title.
2. Using Chrome Books (or other computer with internet access), in pairs students should read "Hummingbird Evolution" (Michelson, 2014) (see: <http://www.calacademy.org/explore-science/hummingbird-evolution/>), and "Tropical plant knows whose bill is in its flowers: Choosy shrub takes pollen only when the right hummingbird comes calling" (Baggaley, 2015) (see: <https://www.sciencenews.org/article/tropical-plant-knows-whose-bill-its-flowers>), and summarize what was learned in each article (correctly citing source) in journal.
3. If students finish early, they can begin looking at Rufous Hummingbird webpage at Arizona-Sonora Desert Museum (2015) (website: <https://www.desertmuseum.org/pollination/hummingbirds.php>)

Rufous Hummingbirds (20 min.):

1. Instruct students to write date and title: "Rufous Hummingbirds (*Selasphorus rufus*)"
2. Show Cornell Lab of Ornithology (2011) website about Rufous Hummingbird characteristics (http://www.allaboutbirds.org/guide/rufous_hummingbird/id). Point out general characteristics of Rufous Hummingbirds, and instruct students to write them in journal.
3. Show Rufous Hummingbird page on Arizona-Sonora Desert Museum (2015) website (<https://www.desertmuseum.org/pollination/hummingbirds.php>) on Smart Board. Instruct students to read information and record Cornell notes about Rufous Hummingbirds, role in ecosystem, and threats to biodiversity in lab journal. When finished, students should write summary of what was learned, and consider ways they can personally reduce negative impacts. (Due by beginning of next class).
4. Tell students they will be learning about and beginning the OSU Citizen Science Hummingbird Project focusing on local populations of Rufous Hummingbirds tomorrow.

Assessment: Verbal response in discussion, Cornell notes and written summaries

Materials needed: copies of infographic (Fulton, 2013), access to computers or tablets with internet (or class set of printed articles)

Day 4 (70 min.)

Learning Objective:

Learner will be able to –

- *Describe Rufous and Calliope Hummingbird identification characteristics.*
- *Describe the purpose of the OSU Citizen Science Hummingbird Project.*
- *Write and explain the question, hypothesis, and methods of the hummingbird project.*

Intro/Hook: (~5 min.)

1. Have students take out journals and discuss summaries of articles in groups.
2. Each group briefly report consensus to class to help gain perspective of students' background knowledge.

OSU Citizen Science Hummingbird Project (65 min.)

1. Students prepare new entry on a clean page in journal (write title on white board for students: OSU Citizen Science Hummingbird Project) and instruct students to take notes.
2. Project overview powerpoint highlighting:
 - a. Rufous Hummingbird and pollination background
 - i. Note: refer to flower inquiry to help set context for students.
 - b. Question of study – write in journal
 - c. Students write hypothesis (I think..... because I know
 - d. Protocol and data sheets – pass out to each student and review
 - e. Review of materials
 - f. Past data portrayed in graph and map
3. Show students OSU Citizen Science Hummingbird Project website (<https://hummingbirdpollinationproject.wordpress.com>) and Sisters Hummingbird Project website (<http://sistershummingbirdproject.wordpress.com>)
4. Instruct students to read through both websites and write main points of every page in site in Cornell notes in journal – Due tomorrow
5. Remind students of expectations for outdoor field studies for the following day (wear layers, warm clothes, and close-toed shoes, and bring camera and journal)

Assessment: Notes in journal, interaction in discussion and presentation

Materials needed: hummingbird feeders (1 per group) (made and delivered by OSU students), permanent markers, protocol sheets , data sheets, Rufous Hummingbird PowerPoint presentation. (See “On the web” or Sisters Hummingbird Project website:

<http://sistershummingbirdproject.wordpress.com/about/> for identification sheet, Rufous Hummingbird PowerPoint presentation, data sheet, and protocols.)

Day 5 (70 min.)

Learning Objective:

Learner will be able to –

- *Describe Rufous and Calliope Hummingbird identification characteristics.*
- *Describe the purpose of the OSU Citizen Science Hummingbird Project.*
- *Complete protocols of filling, cleaning, and setting up hummingbird feeders*
- *Complete data sheets and Google form with data collected*

Intro/Hook: (~5 min.)

1. Have students take out journals and review Question and Hypothesis in pairs

OSU Citizen Science Hummingbird Project

2. Pass out hummingbird identification sheets and complete identification practice – see Rufous Hummingbird PowerPoint presentation (Greer, 2015)
3. Review protocol and data sheets (see “On the web”)
4. Review materials – have feeders prepped
5. Demo and practice filling feeders in groups of two
6. Prep for setting up study in forest (check appropriate field clothing/shoes, bring camera and journal) and review appropriate behavior (remind that field is extension of classroom)
7. Go outside and set up feeder as class.
8. Review methods of checking feeder:
 - a. 10 minute observation (following 3 min. settle time) from as far away as possible while still being able to identify and record hummingbirds at feeder
 - b. Note general impression of area
 - c. Note level of syrup in feeder and record on data sheet
 - d. Refill to 45 ml
9. Practice completing observation for 10 min.
10. Take photo at feeder with class.
11. Return to classroom and demo completing protocol sheets and Google form on Sisters Hummingbird Project website (<http://sistershummingbirdproject.wordpress.com>)
12. Assign each student a feeder to set up at their home. Provide nectar to students who need it. Students should set up feeder, take photo of feeder in location and “selfie” with feeder, and complete the feeder protocol setup data sheet and return the next day to be checked.
13. Photos should be emailed to instructor using school email.

Assessment: Participation in lab and outside, protocol data sheet completion

Materials needed: hummingbird feeders (1 per student) (made and delivered by OSU students), 50 ml nectar for each student, permanent markers, protocol sheet per student, data sheet per student, Rufous Hummingbird presentation

(See Sisters Hummingbird Project website:

<http://sistershummingbirdproject.wordpress.com/about/> (Givot, 2014) for identification sheet, Rufous Hummingbird PowerPoint presentation, data sheet, and protocols.)

Day 6: (70 min.)

Learning Objective:

Learner will be able to –

- *Accurately set up the hummingbird study.*
- *Make observations of the feeder location.*
- *Reflect on experience through a journal reflection and a group blog post.*

Intro: (~10 – 15 min.)

1. Practice identifying hummingbirds on Smart Board (use images from internet)
2. Show and discuss figures made from data collected last year (discuss errors in measurement and not following protocols, importance of accurate data collection, continuing study as long as possible, need to give hummingbirds time to find feeders)

Blog and Data entry (55 – 60 min.)

3. Show OSU and Sisters Hummingbird Project websites. Lead to blog site on Sisters website.
4. Instruct students to complete an entry (using Chrome books or other internet connected device) that includes:
 - a. Description of feeder location, including information from setup protocol data sheet (completed as homework)
5. Students should copy blog entry to document, insert feeder photos into document and print to attach in journal.
6. Instruct students to complete a Google form entry for the feeder setup date.
7. Students should prep journal with title and date: Citizen Science Hummingbird Project Reflection
8. Students should write a reflection discussing:
 - a. The purpose of the Citizen Science Hummingbird Project.
 - b. The methods for addressing question, including location of his/her feeder.
 - c. How the study might contribute to hummingbird conservation and why it is needed.
 - d. What you have learned and completed so far to contribute to the study.
 - e. How you plan to continue to contribute.
 - f. What you hope to learn from this experience.
9. Reflection is due following day.

Assessment: Written reflection, blog post, Google form data entry.

Materials needed: Computer per student

Ongoing, every three days for at least one month:

- Monitor feeder, record data, take photos, refill, and post data to blog.
- Every two weeks, bring feeder to classroom to wash with soapy water and then refill.
- After six weeks, students will analyze data in groups, write individual conclusions, give peer feedback, and present findings in small groups at local student Watershed Summit.

Continuing lesson sequence content:

Students completed other activities to learn genetics standards and then completed a unit assessment. To continue studying evolution and inheritance concepts, in small groups, students conducted a project based science study on other local bird species of their choice. The students decided what project to pursue based on the discoveries and interests of the group. All groups incorporated adaptations of specific bird species and their ability to find a living in their habitat, biodiversity and success of the species in the current times, and conservation themes that could be addressed surrounding the bird species. All students presented their projects to the class in May, 2015, and some groups improved their presentations and presented them at the Watershed Summit on May 12, 2015.

Instructional Resources (in order from lesson sequence):

1. Biodiversity Intro document (Givot, unpublished) (see “On the web”)
2. Prum, A. (Producer). (2010, January 10). Hummingbirds: Magic in the Air. *Nature* (Television program). Arlington, VA: PBS.org. Retrieved from: <https://www.youtube.com/watch?v=iV3D3jppjHA> or <http://www.pbs.org/wnet/nature/hummingbirds-magic-in-the-air-video-full-episode/5475/>. (~53 min. documentary)
3. Demir, M. (2011). The Beauty of Pollination. Youtube.com. (4:23). Retrieved from: <https://www.youtube.com/watch?v=xHkq1edcbk4> (Short video on flowers and pollination)
4. Flower inquiry – word doc (Givot, 2014, unpublished) (see “On the web”)
5. Fulton, K. (Producer). (2013). Infographic: All About Hummingbirds. *Nature*. PBS.org. Retrieved from: <http://www.pbs.org/wnet/nature/episodes/hummingbirds-magic-in-the-air/infographic-all-about-hummingbirds/8377/> (Visual of hummingbird characteristics)
6. Michelson, M. (2014). Hummingbird Evolution. Science Today *Beyond the Headlines*. Retrieved from: <http://www.calacademy.org/sciencetoday/hummingbird-evolution/5515004/> (Article on hummingbird evolution)
7. Baggaley, K. (2015). Tropical plant knows whose bill is in its flowers: Choosy shrub takes pollen only when the right hummingbird comes calling. Science News. Retrieved from: <https://www.sciencenews.org/article/tropical-plant-knows-whose-bill-its-flowers>. (Article and embedded video on hummingbird co-evolution with Heliconia)
8. Cornell Lab of Ornithology. (2011). Rufous Hummingbird. *All About Birds*. Ithaca, NY: Cornell University. Retrieved from: http://www.allaboutbirds.org/guide/rufous_hummingbird/id. (Characteristics of Rufous Hummingbirds)
9. Arizona-Sonora Desert Museum. (2015). Rufous Hummingbird (*Selasphorus rufus*). *Migration Pollinators Program*. Retrieved from: <https://www.desertmuseum.org/pollination/hummingbirds.php>. (Info of Rufous Hummingbirds and conservation needs and issues)

10. OSU Hummingbird ID sheet for Sisters:
https://sistershummingbirdproject.files.wordpress.com/2014/04/hummingbirdid_sistersor_osu_2014.pdf
11. OCSHP protocol sheet – word document (see “On the web”)
12. OCSHP data sheet – word document (see “On the web”)
13. OCSHP Google feeder location form -
<https://docs.google.com/forms/d/1QQfSAska7XLrOoAKpt2Xb96o1jWV37O1vsxBG6QhoNl/viewform> (info entered here one time when feeder is set up)
14. OCSHP Google data form - https://docs.google.com/forms/d/1Xg_FGSK0lqvL0LBQM85UK1qvRhgKEqVvmd8GyWKl8g/viewform (data entered after every monitoring session)
15. OSU hummingbird project website <https://hummingbirdpollinationproject.wordpress.com> (has links to most forms and many references as well as description of the project and data from previous years)
16. Sisters hummingbird project website <http://sistershummingbirdproject.wordpress.com>. (Has links to forms and references and info on the Sisters part of the project)

Lesson Sequence References

- Arizona-Sonora Desert Museum. (2015). Rufous Hummingbird (*Selasphorus rufus*). *Migration Pollinators Program*. Retrieved from:
<https://www.desertmuseum.org/pollination/hummingbirds.php>.
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<https://www.sciencenews.org/article/tropical-plant-knows-whose-bill-its-flowers>.
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<https://hummingbirdpollinationproject.wordpress.com/>.
- Biggs, A., Gregg, K., Hagins, W. C., Kapicka, C., Lundgren, L., Rillero, P., National Geographic Society. (2002). *Biology: the Dynamics of Life*. Glencoe/McGraw-Hill, Columbus, OH.
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<http://www.youtube.com/watch?v=xHkq1edcbk4>
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<http://sistershummingbirdproject.wordpress.com/>
- Michelson, M. (2014). Hummingbird Evolution. *Science Today Beyond the Headlines*. Retrieved from: <http://www.calacademy.org/sciencetoday/hummingbird-evolution/5515004/>
- Prum, A. (Producer). (2010, January 10). Hummingbirds: Magic in the Air. *Nature* (Television

program). Arlington, VA: PBS.org. Retrieved from:
<http://www.pbs.org/wnet/nature/episodes/hummingbirds-magic-in-the-air/video-full-episode/5475/>.