Today's Dinosaurs

Middle School
NGSS: MS-LS4-2

Background

Lesson Description

Students investigate similarities and differences in anatomy across living and extinct organisms. Students use their observations and prior knowledge about hereditary traits to form inferencfes about evolutionary relationships.

Driving Phenomenon

The unity and diversity of life is recorded in a visual representation called the tree of life. It is important to note that the tree of life is not static; scientists are constantly re-evaluating how each organism fits onto each branch of the tree. When new species are discovered, what they are is really determined by their place on the tree. **A penguin may not seem similar to a *Tyrannosaurus rex* , however when we look carefully at traits like leg bones, back bones, and skull forms, we find many similarities.** As we study similarities and differences in plant and animal forms or body features, we can infer how organisms are related to one another from those patterns.

Driving Questions

- Can we find dinosaurs alive today?
- What are dinosaurs closest living relatives in the animal world?

Learning Objectives

- Students practice making inferences and constructing explanations about animal relationships based upon observations gathered through an investigation comparing and contrasting anatomical features of select animals.
- Students engage in an argument from evidence based upon the explanations that they construct.

Time Requirements

- 125 minutes

Prerequisite Knowledge

- Plants and animals have traits inherited from their parents.
- Some kinds of plants and animals that once lived on Earth are no longer found anywhere.
- Animals all come from a common ancestor.

Teacher Resources

1. Animal Relationships Tree
2. Station Guide and Photo Resources
3. Exit Slip Copy Master (3 slips/page)
4. Venn Diagram Example

Student Resources

1. Data Observations Table
2. Organizing and Showing Data
3. Claim, Evidence, Reasoning

What are dinosaurs closest living relatives in the animal world?

Engage | 10 minutes	
Students will analyze and draw meaning from an image of a cladogram using the Visual Thinking Strategies (VTS) protocol.	Notes
Teacher Resource: 1	
Explore | 45 minutes	
Students rotate through six stations, each focusing on different area of anatomy. At each station they make and record observations about similarities and differences across the animal specimens.	Notes
Teacher Resource: 2 & 3 Student Resource: 1	
Explain | 25 minutes	
Students will use a Venn diagram to organize the observational data obtained in the prior activity.	Notes
Teacher Resource: 4 Student Resource: 2	
Elaborate | 25 minutes	
Students make a scientific claim supported by evidence and reasoning about the relationships between the animals that they have been studying.	Notes
Student Resource: 4	
Evaluate | 20 minutes	
Using their scientific claim as a basis, students construct an argument for the inclusion of a penguin in the ranks of the dinosaurs.	Notes

Pre-Lesson Preparation

Materials

NOTES

- iPads or tablets for stations
- Projector
- Chart paper or board space

Materials Preparation

- Make copies of Student Resources for each student.
- Copy the following Teacher Resources:
    - Exit Slip Copymaster
- Print or prepare to project the following Teacher Resources:
    - 1. Animal Evolutionary Trees
    - 2. Station Guide Example
    - 4. Venn Diagram Example
- Set-up anatomical investigation stations as suggested in Teacher Resource 2
- Gather chart paper and markers or prepare to use board space.

Lesson Enrichment Ideas

DO

Play Mission to the Mesozoic, an online game, where players team up with a scientist to explore plants and animals from Earth that lived millions of years ago during the Mesozoic Era.

Rent real specimens, and bring them to your classroom. If you live in the Chicago area, the *N. W. Harris Learning Collection* at the Field Museum offers numerous specimens that can be rented for study in the classroom.

- Skulls and Limbs
- Beaks and Feet

READ

Boy Were We Wrong About Dinosaurs
by Kathleen Kudlinski
An engaging introduction to the nature of science through the lens of dinosaur discoveries.
http://worldcat.org/oclc/221152330

WATCH

What Makes a Dinosaur a Dinosaur?
Field Museum Curator of Dinosaurs, Dr. Peter Mackovicky, outlines one of the most essential body features that defines whether or not an animal is considered a dinosaur or not.
https://www.facebook.com/watch/?v=10154418996282273

Procedure

Engage

1. Project or display Teacher Resource A: Animal Relationships Tree, and facilitate a discussion using the Visual Thinking Strategies (VTS) method. For additional information about VTS refer to vtshome.org.

2. Direct students to observe the image closely and allow a minute or two to pass in silence while they observe and think.

3. Ask students, **"What relationships are displayed by this diagram?"**

4. Elicit responses openly. Do not encourage or discourage any particular answers.Instead, with each student response, ask the student to back-up their statement with evidence that they see in the diagram. To illicit the evidence from the student, **"What do you see that makes you say that?"** Try to keep students' focus on seeking evidence in the cladogram in front of them rather than previous knowledge and experience regarding these animals.

5. To elicit additional responses without negating anything that has been shared thus far, ask the students, **"What more can we find?"**

6. Once you get the sense that students have collectively found all that they can, thank them for sharing as a group. Refrain from making any indication that certain responses are "correct" at this point. Overall, this activity is meant to reveal students' misconceptions and prior knowledge on this topic.

7. Leave the projection up as much as possible throughout the other activities.

Explore

What similarities and differences can we find across animals?

1. Provide students with the following prompts:

2. Give students the opportunity to share what they know about these animals. Answers will vary depending students' prior experiences. Record students' ideas on the board.

3. Once students have shared their thoughts, explain that today they are going to make observations to help determine the evolutionary history between these three animals. Ask if anyone has an idea about what evolutionary history means.

4. Ask the students if they can define what evolutionary history might mean. Listen to what the class knows about this topic. Students may be familiar with the following concepts related to evolution:
    a. All life has a common ancestor
    b. Living things have features or traits inherited from their parents.
    c. Living things have changed over time to diversify into all of the organisms that we find throughout the Earth today.

    Some concepts that you may need to introduce include:
    a. Evolution is the concept that life slowly changes over time generation after generation.
    b. Living things that share more traits are more closely related in this history.

5. Pass out Student Resource A: Observations Table to each student.

6. Gather students into six small groups, and assign each group a different station to begin. Station prep is described in the materials preparation section above.

7. Each station will focus on examining a different area of the body across all three of the organisms. Each station will give you some general information about the body part, and then you can explore the example from each organism to note similarities and differences.

8. As students visit each station, encourage them to look for patterns of similarities and differences across the three specimens. Inform students that they are each responsible for recording their own observations on the graphic organizers, however, also encourage them to share their observations with fellow group members verbally. Allow five to eight minutes per station.

Explore

9 Once all groups have visited each station, bring students back to the full group. Ask a representative from each group to share one observation their group made about the animals that was surprising or made them change their ideas about any of the three animals.

10 Explain to students that scientists who designed the tree of life diagram that they viewed earlier in the lesson were making a claim about relationships between the organisms. The claim is based on evidence found by exploring the body features of the various animals. Ask students to think about why scientists study body features (or traits) to understand relationships between animals? Have students write their ideas on an exit slip (see Teacher Resource 3: Exit Slip Copy Master), or if your class period allows, they can share their ideas with the class.

Explain

1 Project Teacher Resource 4: Venn Diagram Examples , and review the conventions of a Venn diagram with the students. Explain that Venn diagrams are one strategy we can use to organize and communicate information visually.

2 Pass out Student Resource 2: Organizing and Showing Data per group so that students can work together to synthesize their observations and organize the data regarding similarities and differences among the animals.

3 Once each group has created a Venn Diagram, invite them to use discussion questions on the back of Student Resource 2: Organizing and Showing Data to further analyze the data and decide as a group what it says about the animals and their evolutionary relationships.

4 After completing and discussing the Venn Diagram as a group, students will work on their own to construct an explanation using Student Resource 3: Claim, Evidence, Reasoning.

Elaborate

1. Show this video on Mammal Phylogeny from the Griffin Halls of Evolving Planet exhibition at the Field Museum - https://vimeo.com/203209895.

2. Lead the class in a discussion about the video guided by the following questions about phylogeny and cladograms.
    a. How did your process with the Venn diagram compare to the sorting process described in the video?
    b. What does the video say about where animals characteristic feature come from?

3. Ask students to revisit the claim that they made about the the bird, reptile, and dinosaur with their small groups. Students may either choose to change their claim or further support their original claim by adding new evidence or reasoning.

4. Re-introduce the cladogram (Teacher Resource 1) to students. Ask students to state the name of this diagram based upon the information in the video. Further highlight the concept that a cladogram is a way for scientists to visually communicate how animals are related to one another.
    a. A group of animals that can all be represented on one of these diagrams with a single stem at the bottom, it's called a clade.
    b. The single stem at the bottom represents a common ancestor that all the animals share.
    c. Where a branch emerges, this is called a node.
    d. Nodes are ordered along the main trunk according to the relative time in which organisms with those corresponding traits appeared in the fossil record. That means nodes near the bottom branched off a longer time ago.

Evaluate

1 Students must convince a committee at a local museum to display their animal client, a Penguin, in a Dinosaur exhibit by presenting the confirming evidence that they know for why this animal is a living dinosaur.

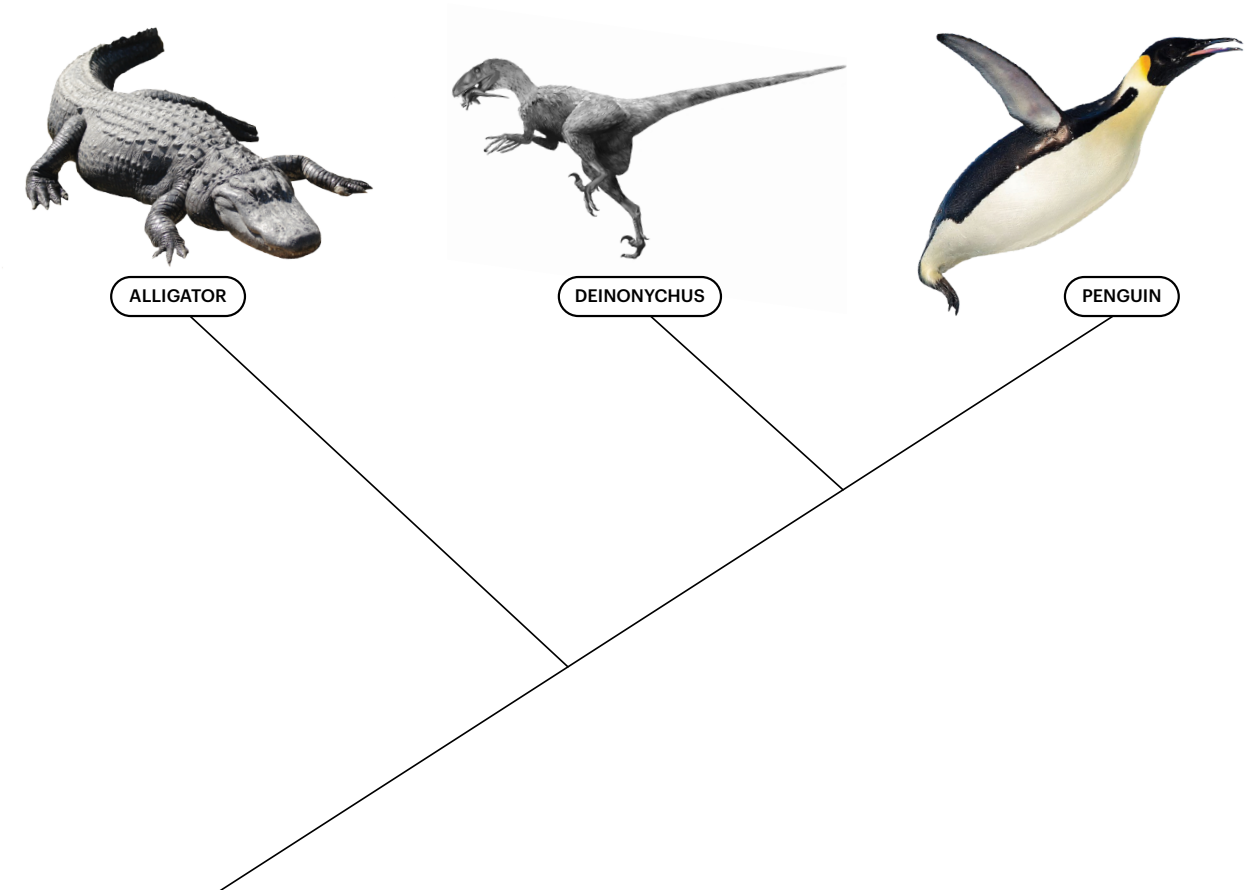
2 Students will develop a campaign on the penguin's behalf to be considered for the exhibit.

3 Invite students to use their creativity to express the claims they want to make supported by the facts they have uncovered in this investigation. The final deliverables of the campaign could be in the form of

1. a poster
2. a presentation
3. a written letter
4. a speech/skit

Animal Relationships Trees

Teacher Resource 1.0

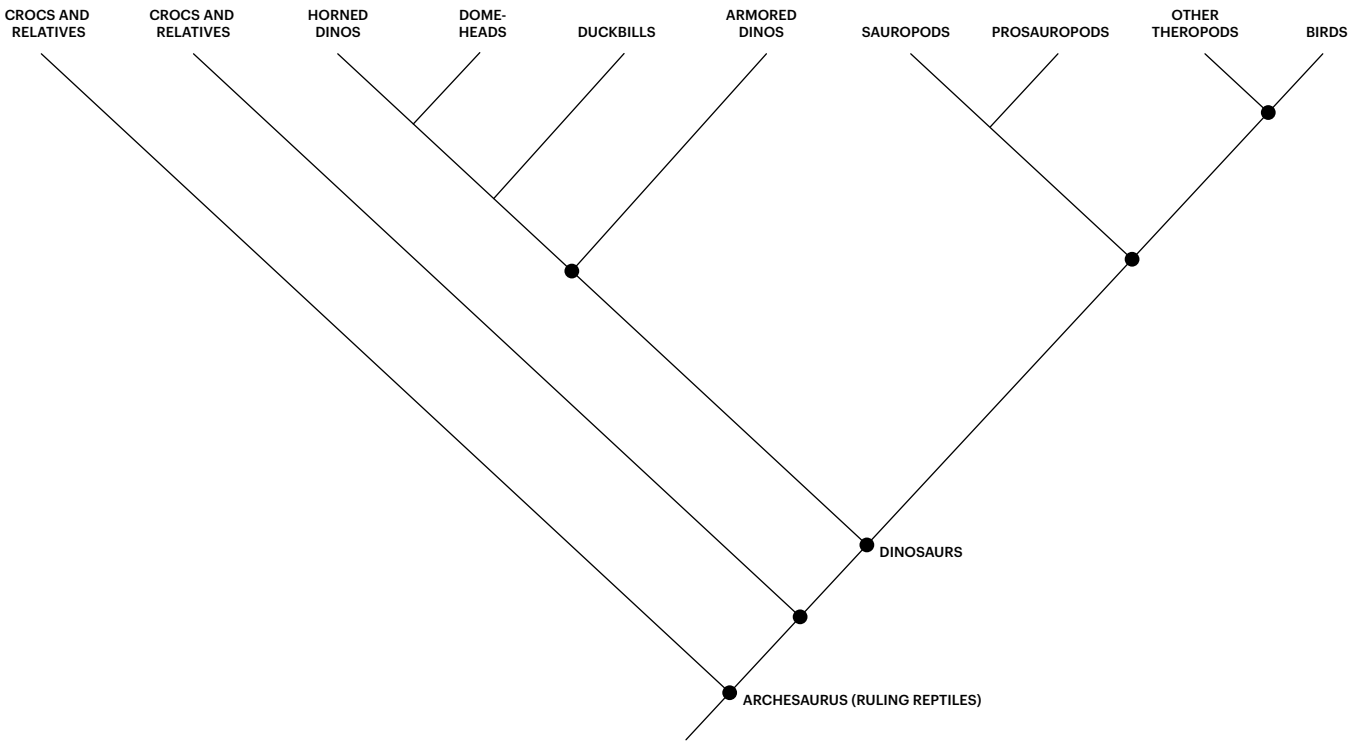


Alligator: Matthew Field - http://www.photography.mattfield.com [CC BY-SA 3.0]
Deinonychus: Karen Carr © 2006 Field Musseum.
Penguin: Christopher Michel [CC BY 2.0]

Teacher Resource

Teacher Resource 1.0: Animal Relationships Trees

Cladogram: a diagram showing how animals are related, it is similar to a family tree



Cladogram: By Petter Bøckman (Own work) [Public domain], via Wikimedia Commons

Teacher Resource

Station Photo Resources

Teacher Resource 2.0

Estaciones
Eggs
Body covering
Ankle and feet
Skull and brain
Overall body plan

Eggs

Specimen or Media Evidence

Western Rockhopper Penguin Egg
Eudyptes chrysocome chrysocome
FMNH 1681

Eggs are made of Calcium carbonite — calcite.

Eggs

Specimen or Media Evidence

American Alligator Eggs
Alligator mississippensis

Photographer: Kevin Walsh from Oxford, England (Flickr)
[CC BY 2.0, via Wikimedia Commons]

Fossilized Dinosaur Eggs
Unknown species
FMNH GEO79901

© The Field Museum, GEO79901, Photographer: Charles Carpenter

Body Covering

Specimen or Media Evidence

Gentoo Penguin feather texture
Pygoscelis papua

Photographer: Bernard Spragg from Christchurch, New Zealand [CC0]

American Alligator Skin and Scale texture
Alligator mississipiensis

Photographer: Matthew Field - http://www.photography.mattfield.com
[CC BY-SA 3.0]

Body Covering

Specimen or Media Evidence

Skin Impression from *Edmontosaurus* mummy

Edmontosaurus annectens

AMNH 5060

Image Source: Osborn, Henry Fairfield (1912). "Integument of the Iguanodont Dinosaur Trachodon" (PDF). Memoirs of the American Museum of Natural History v. 1: Plate VII. Retrieved on 2009-03-11 by A.E. Anderson [Public domain]

Fossil cast showing feathers, bird or dinosaur?

Archaeopteryx lithographica

PA 308

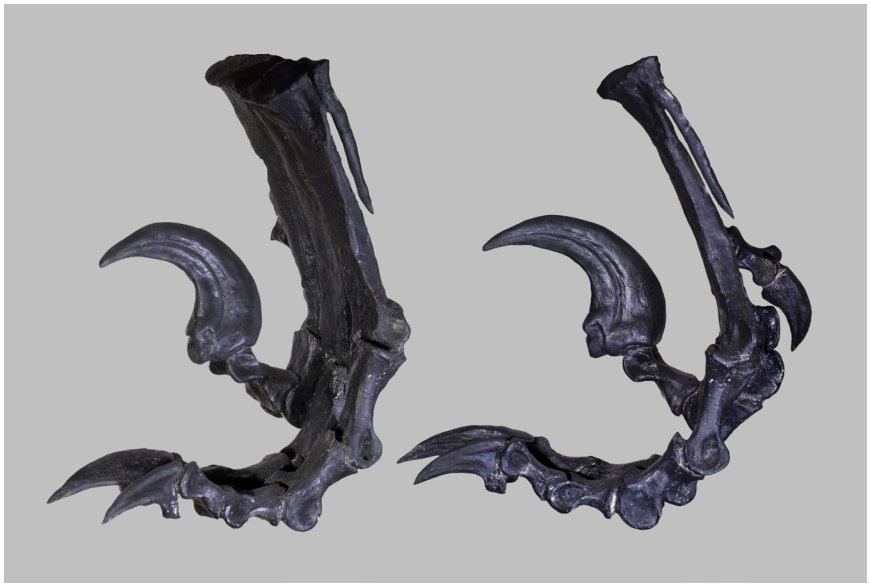
Ankles and feet

Specimen or Media Evidence

Feet of Deinonychus

Deinonychus antirrhopus

Holotype YPM 5205



Photographer: Didier Descouens - [CC BY-SA 4.0]

Feet of alligator

Alligator mississipiensis

FMNH 22027

© The Field Museum, FMNH 22027

Ankles and feet

Specimen or Media Evidence

Feet of Little Penguin
Eudyptula minor
Skeleton on display at Field Museum

Skulls and brains

Specimen or Media Evidence

Deinonychus Skull Cast
Deinonychus antirrhopus

Photographer: Didier Descouens - Own work, [CC BY-SA 4.0]
https://commons.wikimedia.org/w/index.php?curid=8317282

Skulls are made of the most complex bones in body.

Their main function is to protect the brain and other vital sensing organs.

Paleontologists can infer what a dinosaur brain was shaped like by making a cast of that cavity in the skull.

Skulls and brains

Specimen or Media Evidence

Alligator skull
Alligator mississippiensis
FMNH 22027

Skulls and brains

Specimen or Media Evidence

Penguin skull

Overall body plan

Specimen or Media Evidence

Jumping Penguin
Aptenodytes forsteri

Photographer: Christopher Michel - Own work, [CC BY 2.0]

Penguin Skeleton
species unknown

Photographer: www.opencage photographer (Open Cage) [CC BY-SA 2.5]
https://commons.wikimedia.org/wiki/File:Penguin_skeleton_black_background.jpg

Overall body plan

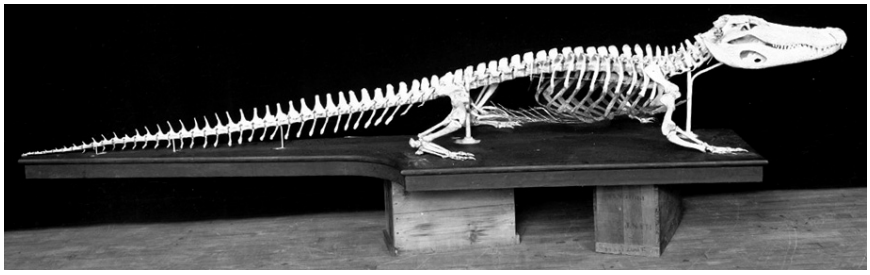
Specimen or Media Evidence

Live Alligators
Alligator mississippiensis

Photographer: Matthew Field - http://www.photography.mattfield.com (Own work) [GFDL]
https://commons.wikimedia.org/wiki/File:Two_american_alligators.jpg

Alligator cast, diorama
Alligator mississippiensis
FMNH

Alligator skeleton
Alligator mississippiensis
FMNH 22027



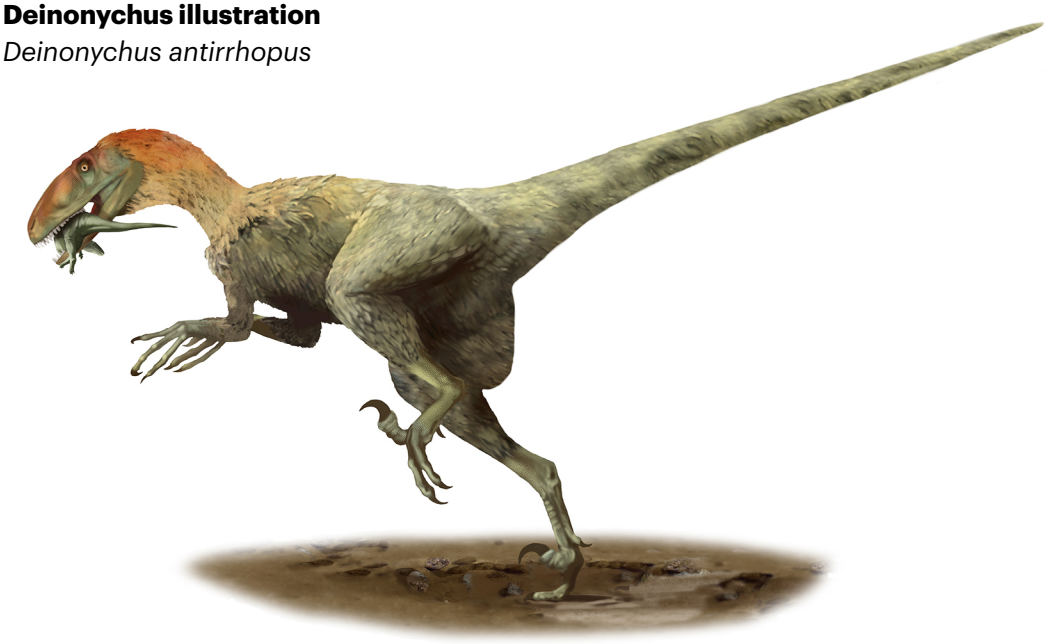
Overall body plan

Specimen or Media Evidence

Deinonychus skeleton
Deinonychus antirrhopus
FMNH

Photographer: AStrangerintheAlps - Own work, [CC BY-SA 3.0]
https://commons.wikimedia.org/wiki/File:FMNH_Deinonychus_white_background.JPG

Deinonychus illustration
Deinonychus antirrhopus



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Exit Slip Copy Master

Teacher Resource 3.0

Today, we examined body features of three different animals in order to determine how they are related in evolutionary history.

Why do you think studying body features is important to understanding relationships between animals?

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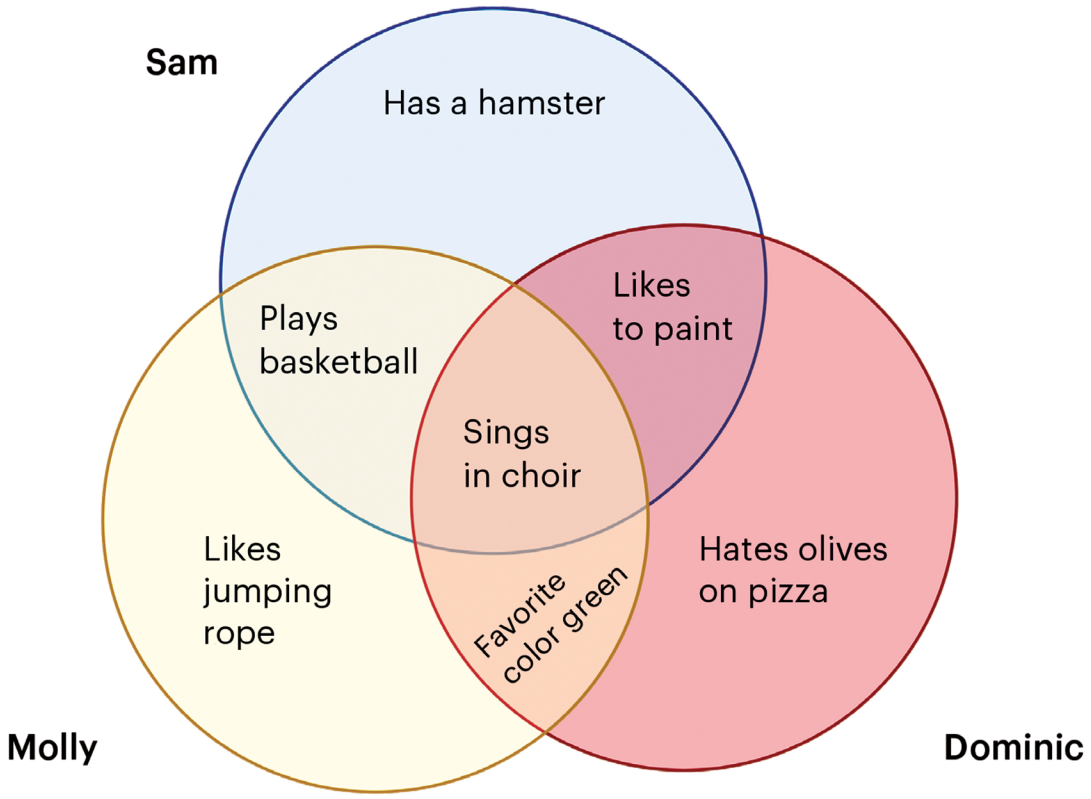
Why do you think studying body features is important to understanding relationships between animals?

Venn Diagram Example

Teacher Resource 4.0

	Play basketball	Likes to paint	Likes jumping rope	Sings in choir	Favorite color green	Hates olives on pizza	Has a hamster
Sam	Y	Y	N	Y	N	N	Y
Molly	Y	N	Y	Y	Y	N	N
Dominic	N	Y	N	Y	Y	Y	N



Teacher Resource

Data Observations Table

Student Resource 1.0 **Name:** _____ **Per.** _____

Directions:
Make observations about the animals' features at each station. Pay particular attention to similarities and differences between the different animals. Discuss your observations with your fellow group members, and make a detailed record in the table below using words and images.

	Bird (Penguin)	Reptile (Alligator)	Dinosaur (Deinonychus)
Eggs			
Skin body cover			
Ankle			

Data Observations Table

Student Resource 1.0 **Name:** _____ **Per.** _____

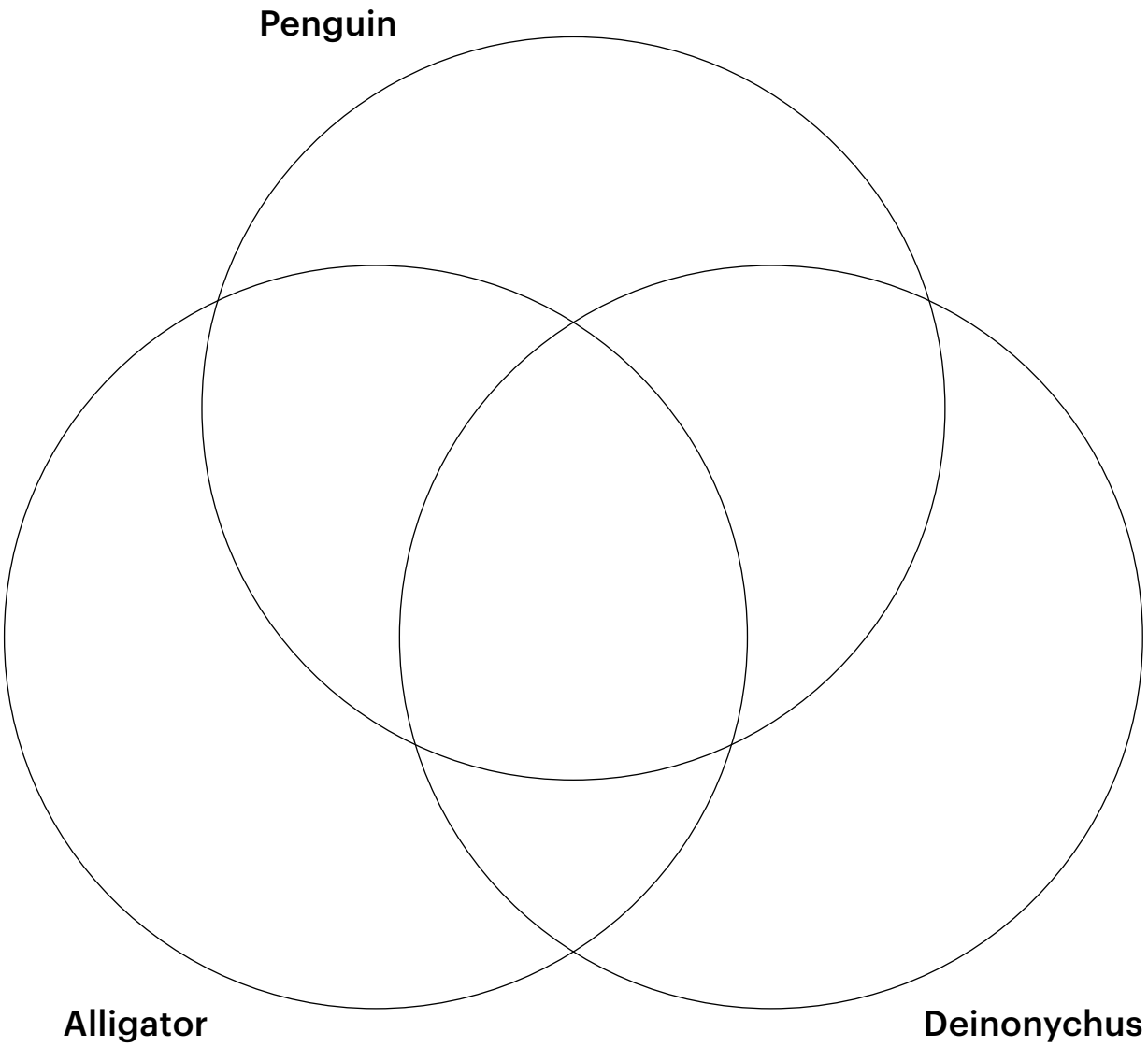
Directions:
Make observations about the animals' features at each station. Pay particular attention to similarities and differences between the different animals. Discuss your observations with your fellow group members, and make a detailed record in the table below using words and images.

	Bird (Penguin)	Reptile (Alligator)	Dinosaur (Deinonychus)
Skull			
Tail			
Hips			

Organizing and Showing Data

Student Resource 2.0

Directions:
Look at the information in the graphic organizer you completed during the animal investigation of the three animals. Fill in the Venn diagram below by writing things that the animals have in common in the overlapping parts of the circles. Write features that are different from the other two animals in the non-overlapping regions of the circles.



Organizing and Showing Data

Student Resource 2.0 **Name:** _____ **Per.** _____

Small Group Discussion Ground Rules

1. Think before speaking. It's ok for there to be some silence.
2. Give each member a chance to speak.
3. Listen to each member's opinions and ideas with equal attention.
4. If you don't understand what some is talking about, ask for clarification.
5. Critique ideas, not people.

Use these sentence stems to help you express what you are thinking during the group discussion.

In my opinion...	En mi opinion...
I think that...	Yo pienso que...
I discovered that...	Descubrí que...
I agree because...	Estoy de acuerdo porque...
I do not agree because...	No estoy de acuerdo porque...

Small Group Discussion Questions

1. Name something that changed your thinking about these animals once you looked at the data in the Venn Diagram format.
2. Which two animals are most closely related? Share evidence from the data you collected to support your ideas.
3. Which of these three types of animals came along first in the evolution of life reptiles, dinosaurs, or birds?

Claim, Evidence, Reasoning

Student Resource 3.0 **Name:** _____ **Per.** _____

Directions:
Choose one of the claims to complete. Then, provide evidence from your data to support that claim. Finally, use reasoning to explain why the evidence you listed connects to and supports your claim.

Student Resource

CLAIM

Out of the three animals we have investigated, _____ and _____ are the most closely related.

The animal _____ came from the _____ group of animals.

Dinosaurs walk the Earth today in the form of _____ .

EVIDENCE #1

_____

_____

_____

_____

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EVIDENCE #2

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EVIDENCE #3

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REASONING #1

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REASONING #2

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REASONING #3

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THE GRIFFIN DINOSAUR EXPERIENCE

FIELD MUSEUM

The Educator Toolkit is part of the Griffin Dinosaur Experience, made possible by the generous support of the Kenneth C. Griffin Charitable Fund.

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