Introduction:

The following formative assessment exemplar was created by a team of Utah educators to be used as a resource in the classroom. It was reviewed for appropriateness by a Bias and Sensitivity/Special Education team and by state science leaders. While no assessment is perfect, it is intended to be used as a formative tool that enables teachers to obtain evidence of student learning, identify gaps in that learning, and adjust instruction for all three dimensions (i.e., Science and Engineering Practices, Crosscutting Concepts, Disciplinary Core Ideas) included in a specific Science and Engineering Education (SEEd) Standard.

In order to fully assess students' understanding of all three dimensions of a SEEd standard, the assessment is written in a format called a cluster. Each cluster starts with a phenomenon, provides a task statement, necessary supporting information, and a sequenced list of questions using the gather, reason, and communicate model (Moulding et al., 2021) as a way to scaffold student sensemaking. The phenomenon used in an assessment exemplar is an analogous phenomenon (one that should not have been taught during instruction) to assess how well students can transfer and apply their learning in a novel situation. The cluster provides an example of the expected rigor of student learning for all three dimensions of a specific standard. In order to serve this purpose, this assessment is NOT INTENDED TO BE USED AS CURRICULUM.

Because this assessment exemplar is a resource, teachers can choose to use it however they want for formative assessment purposes. It can be adjusted and formatted to fit a teacher's instructional needs. For example, teachers can choose to delete questions, add questions, edit questions, or break the tasks into smaller segments to be given to students over multiple days.

General Format:

Each formative assessment exemplar contains the following components:

1. Teacher Facing Information: This provides teachers with the full cluster as well as additional information including the question types, alignment to three dimensions, and answer key. Additionally, an example of a proficient student answer and a proficiency scale for all three dimensions are included to support the evaluation of the last item of the assessment.
2. Students Facing Assessment: This is what the student may see. It is in a form that can be printed or uploaded to a learning platform. (Exception: Questions including simulations will need technology to utilize during assessment.)

Accommodation Considerations:

Teachers should consider possible common ways to provide accommodations for students with disabilities, English language learners, students with diverse needs or students from different cultural backgrounds. For example, these accommodations may include: Providing academic language supports, presenting sentence stems, or reading aloud to students. All students should be allowed access to a dictionary.

References:

Moulding, B., Huff, K., & Van der Veen, W. (2021). *Engaging Students in Science Investigation Using GRC*. Ogden, UT: ELM Tree Publishing.

Standard: 7.5.4

Analyze data to compare _patterns_ in the embryological development across multiple species to identify similarities and differences not evident in the fully formed anatomy. (LS4.A)

Assessment Format: Printable or Online Format (Does not require students to have online access, if a printable version is used two videos must be shown to the students)
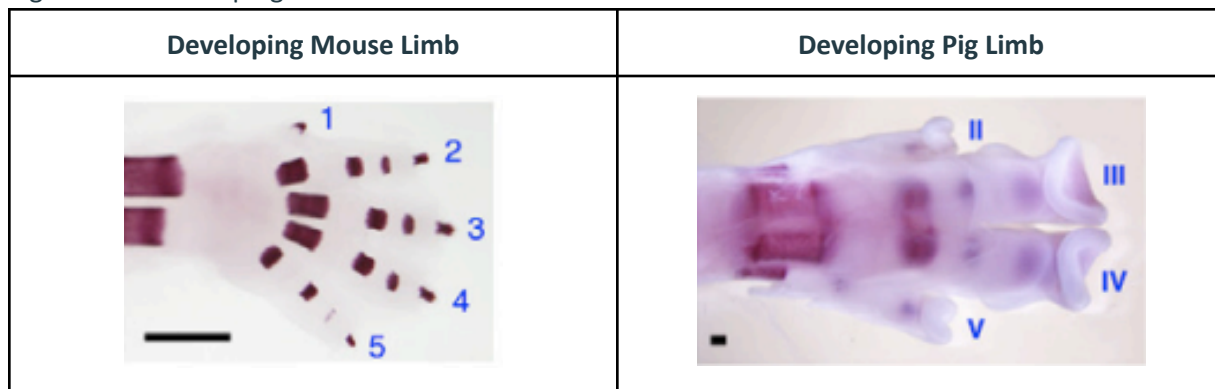
Phenomenon	
The structure of a pig's foot must function to support the large amount of weight that a pig has. While the structure of a mouse's foot does not need to be able to support a lot of weight.	Proficient Student Explanation of Phenomenon: In embryological development the mouse limb, which starts out very similar to the pig limb develops along different pathways as development continues. These changes likely contributed to the evolution of the pig limb skeleton. This development aids bearing weight (compared to the mouse) and one less digit per foot.

Cluster Task Statement
(Represents the ultimate way the phenomenon will be explained or the design problem will be addressed)   In the questions that follow, you will use data to analyze and look for patterns in the embryological development of a mouse and a pig to identify similarities and differences not evident in the fully formed anatomy.

Supporting Information

Figure 1: Pig Foot and Mouse Foot (Wikimedia Wikimedia)

These images show a foot of a pig and a mouse.

Video 1: Pig Walk - YouTube

Video 2: [Mouse walking on wall](#)

Scientists were trying to provide insights into the emergence of the pigs feet over time. Scientists compared the development of pigs feet in embryos to mice feet in embryos. Unlike a pig's foot, a mouse's foot does not have a need to support a large amount of weight.

Digit loss/reductions (fingers and toes) are evolutionary adaptations in mammals such as pigs. To gain insight into these processes, you will perform a comparative analysis of limb development in mouse and pig embryos.
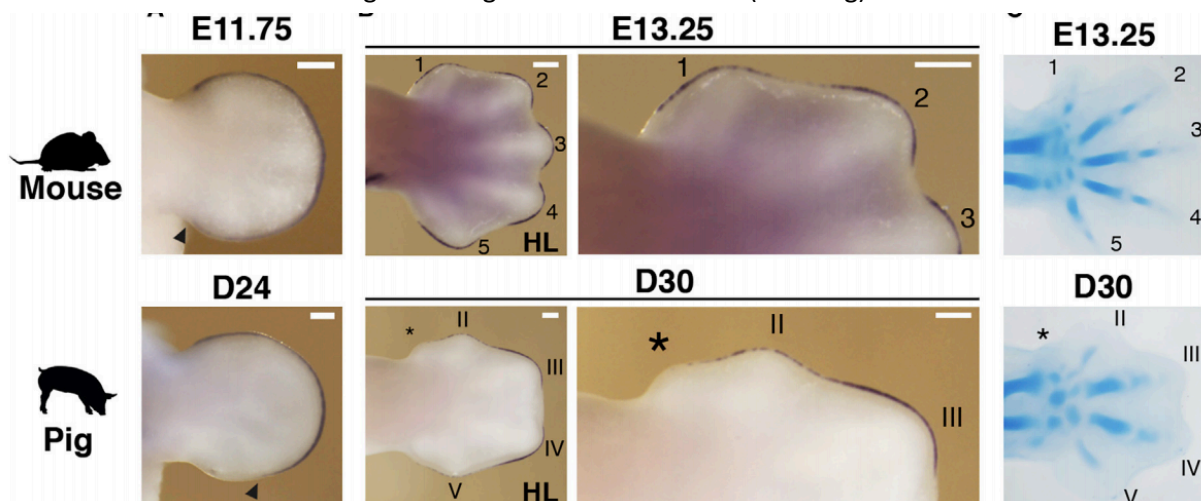
Figure 2 - A Developing Limb

Developing Mouse Limb	Developing Pig Limb

 ([Gene Regulatory and Expression Differences between Mouse and Pig Limb Buds Provide Insights into the Evolutionary Emergence of A](#))

This image shows the developing digits, fingers/toes, of a mouse and a pig.

Figure 3 - Pig and Mouse Forelimb(front leg)

This image shows the comparison of mouse forelimb to pig forelimb in embryo development. ([Gene Regulatory and Expression Differences between Mouse and Pig Limb Buds Provide Insights into the Evolutionary Emergence of A](#)) in the pig roman numerals correspond with numbers 2-5 on mouse hand.

Cluster Questions

Gather:

Cluster Question #__1____

Question Type: Table Grid
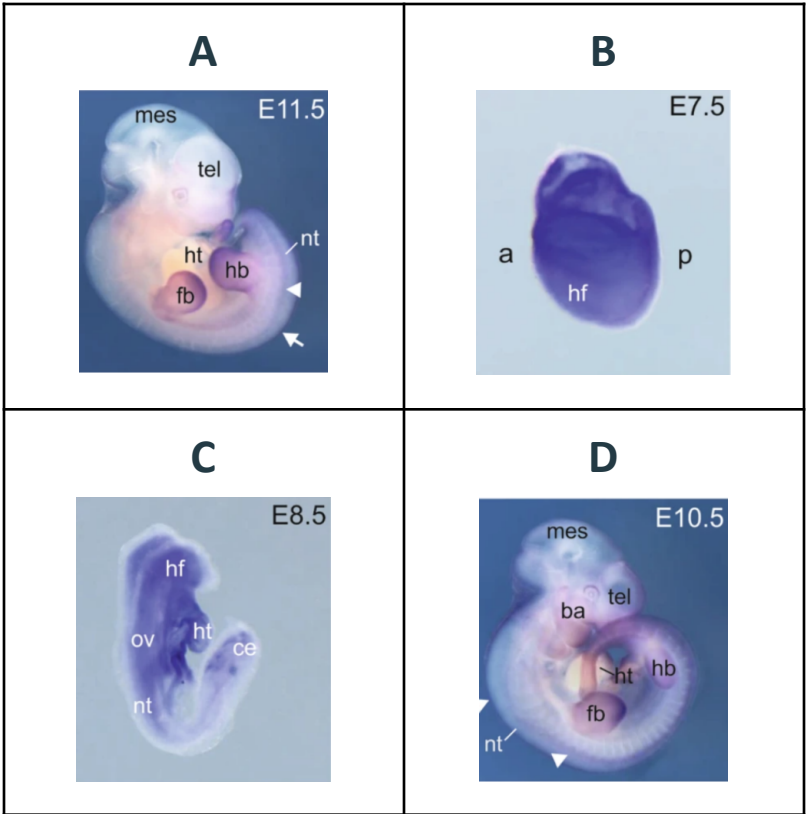
Addresses:

__X__ DCI (LS4.A)

__X__ SEP (analyzing and interpreting data)

____ CCC (patterns)

Answer:

Photo	Order	Supporting Evidence (observations) *(Be sure to use data from the figure to support your answer.)*
A	last	increased definition of limbs and head region
B	first	ball of cells
C	second	elongated body, development of a tail
D	third	formation of leg buds and head

Question 1:

developing embryo (creative commons)

Analyze the anatomical patterns in the photos of the embryo at different developmental stages above, and order the photos by stage. Use the table below.

Photo	Order	Supporting Evidence (observations) *(Be sure to use data from the figure to support your answer.)*
A		
B		
C		
D		

Gather: Cluster Question #__2____ Question Type: short answer Addresses: _____ DCI __x__ SEP (Gathering information) __x__ CCC patterns Answer: | Mouse forelimb function	Pig forelimb function
Able to climb and Uses foot like a hand to grab onto things	Walk on the ground support large amount of weight		Question 2: Based on the information in **Video 1 and 2**, **describe** the functions (jobs) of a pig's forelimb (front leg) and a mouse's forelimb (front leg). Think about the different sizes of the animals. | Mouse forelimb function	Pig forelimb function
Reason: Cluster Question #__3____ Question Type: Addresses: __X__ DCI (LS4.A) __X__ SEP (analyzing data) __X__ CCC (patterns) Answer: | Similar Traits	Different Traits
Multiple fingers general shape same pattern of development, wedge to individual fingers webbed feet at first	picture 2 different number of fingers color mouse foot is wider		Question 3: Compare the images of **Figure 3** and identify similarities and differences. List at least 2 traits for each column. | Similar Traits	Different Traits
Communicate: Cluster Question #__4____ Question Type: Long answer Addresses: __x__ DCI (LS4.A) _____ SEP __x__ CCC (patterns) Answer:	Question 4: Look at the information you have in **Question 2 and 3** and list the evidence you have collected about how pigs and mice may be related: Using the evidence you have collected, answer the following question: How does the patterns in the data support the

answers may vary possible answers should include: structural comparisons limb functions possible relationships	conclusion that pigs are related to mice?
Communicate: Cluster Question #___5___ Question Type: Short answer Addresses: __x__ DCI (LS4.A) ____ SEP __x__ CCC (patterns) Answer: answers may vary possible answers should include: structural comparisons limb functions possible relationships	**Question 5:** Using the above image of the embryological development of another organism, how do you think this organism is related to a pig and a mouse? What are the possible functions of this forelimb?

Proficiency Scale

Proficient Student Explanation:

In embryological development the mouse limb, which starts out very similar to the pig limb develops along different pathways as development continues. These changes likely contributed to the evolution of the pig limb skeleton. This development aids bearing weight (compared to the mouse) and one less digit per foot. Both organisms would be related because they share early embryological structures.

Level 1 - Emerging	Level 2 - Partially Proficient	Level 3 - Proficient	Level 4 - Extending
SEP: Does not meet the minimum standard to receive a 2.	**SEP:** Analyze and interpret data to make sense of phenomena, using	**SEP:** Analyze and interpret data to provide evidence for	**SEP:** Extends beyond proficient in any way.

	logical reasoning.	phenomena.	
CCC: Does not meet the minimum standard to receive a 2.	**CCC:** Uses patterns as evidence to support an explanation.	**CCC:** Uses images to identify patterns in data	**CCC:** Extends beyond proficient in any way.
DCI: Does not meet the minimum standard to receive a 2.	**DCI:** Some kinds of plants and animals that once lived on Earth are no longer found anywhere. Fossils provide evidence about the types of organisms that lived long ago and also about the nature of their environments.	**DCI:** Comparison of the embryological development of different species also reveals similarities that show relationships not evident in the fully-formed anatomy.	**DCI:** Extends beyond proficient in any way.

(Student Facing Format on following page)

Name: _____ Date: _____

Stimulus

The structure of a pig's foot must function to support the large amount of weight that a pig has. While the structure of a mouse's foot does not need to be able to support a lot of weight.

Figure 1: Pig Foot and Mouse Foot (Wikimedia Wikimedia)

These images show a foot of a pig and a mouse.

Video 1: Pig Walk - YouTube

Video 2: Mouse walking on wall

Scientists were trying to provide insights into the emergence of the pigs feet over time. Scientists compared the development of pigs feet in embryos to mice feet in embryos. Unlike a pig's foot, a mouse's foot does not have a need to support a large amount of weight.

Digit loss/reductions (fingers and toes) are evolutionary adaptations in mammals such as pigs. To gain insight into these processes, you will perform a comparative analysis of limb development in mouse and pig embryos.
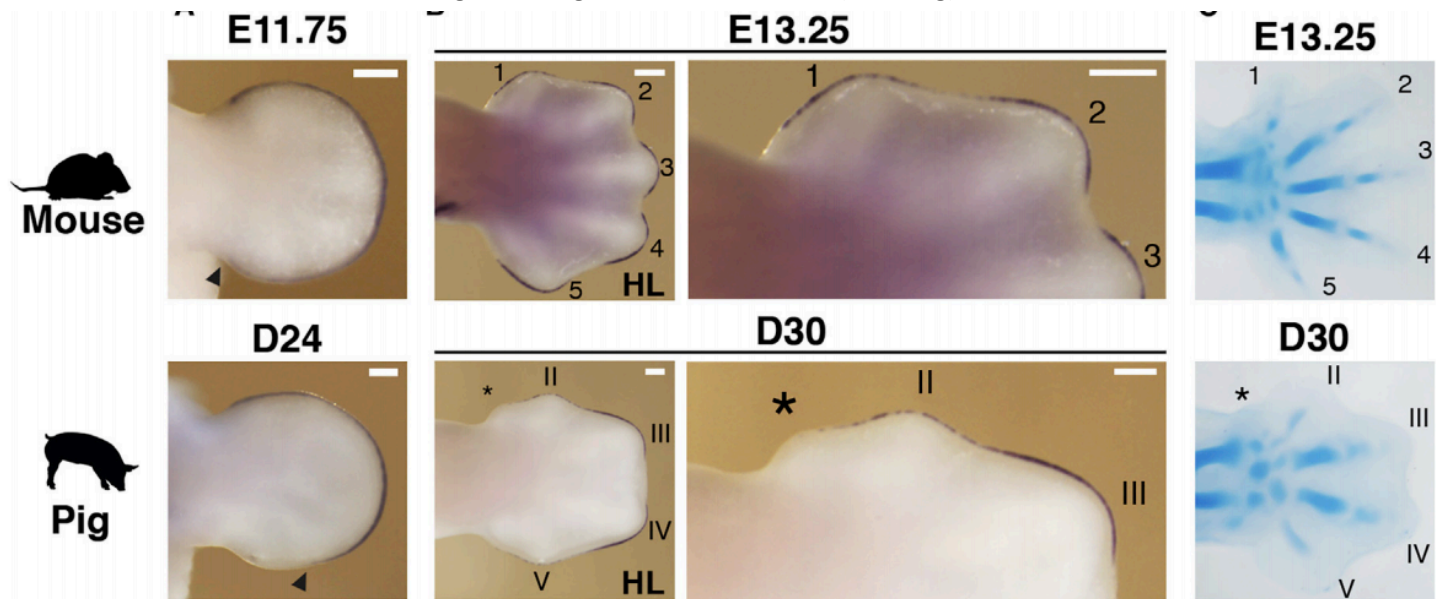
Figure 2 - A Developing Limb

Developing Mouse Limb	Developing Pig Limb

(Gene Regulatory and Expression Differences between Mouse and Pig Limb Buds Provide Insights into the Evolutionary Emergence of A)

This image shows the developing digits, fingers/toes, of a mouse and a pig.
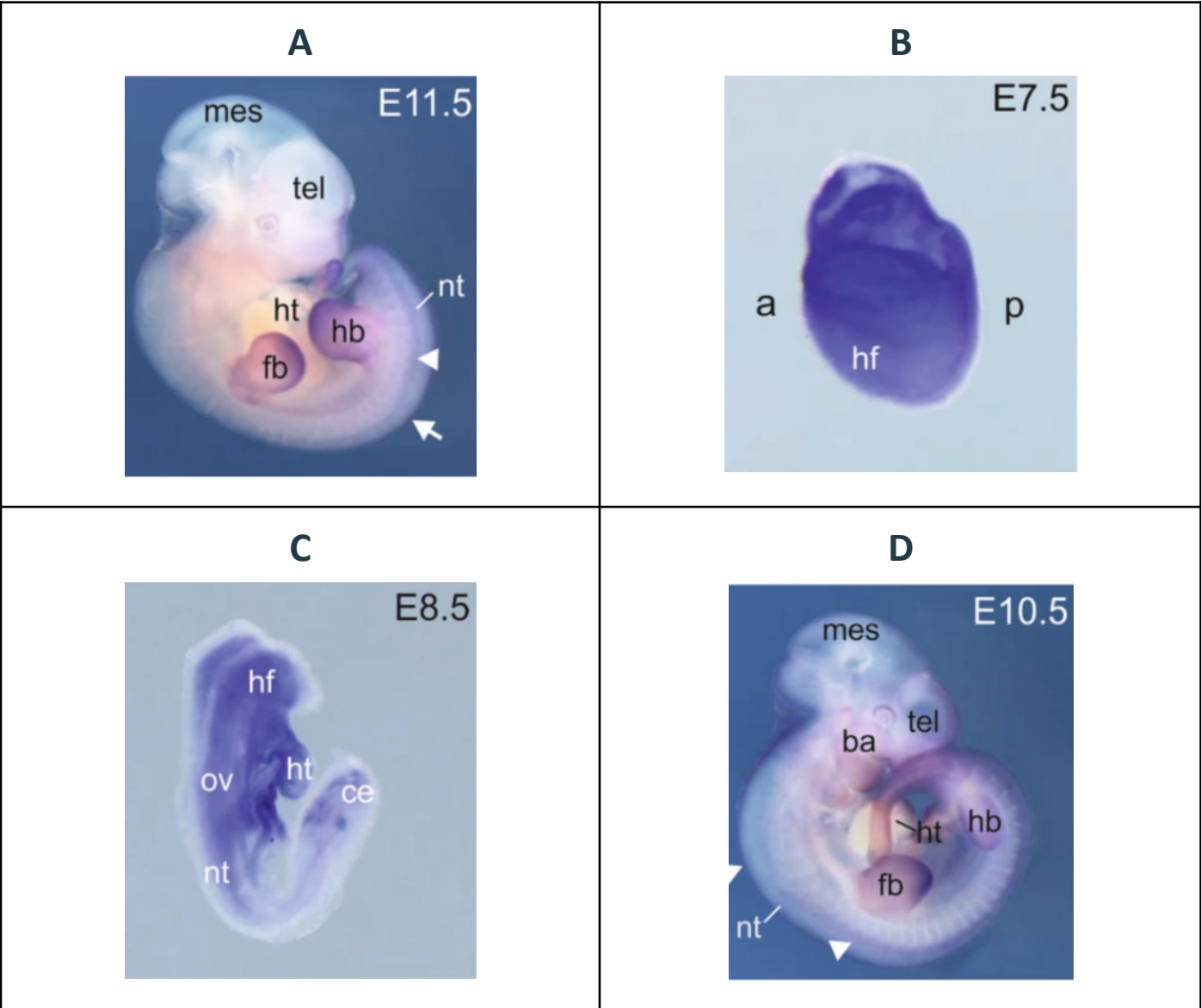
Figure 3 - Pig and Mouse Forelimb(front leg)

This image shows the comparison of mouse forelimb to pig forelimb in embryo development. ([Gene Regulatory and Expression Differences between Mouse and Pig Limb Buds Provide Insights into the Evolutionary Emergence of A](#)) in the pig roman numerals correspond with numbers 2-5 on mouse hand.

Your Task

In the questions that follow, you will use data to analyze and look for patterns in the embryological development of a mouse and a pig to identify similarities and differences not evident in the fully formed anatomy.

Question 1

A	B
E11.5 — mes, tel, ht, hb, fb, nt	E7.5 — a, hf, p
C	D
E8.5 — hf, ov, ht, ce, nt	E10.5 — mes, ba, tel, ht, hb, fb, nt

developing embryo (creative commons)

Analyze the anatomical patterns in the photos of the embryo at different developmental stages above, and order the photos by stage. Use the table below.

Photo	Order	Supporting Evidence (observations) *(Be sure to use data from the figure to support your answer.)*
A		
B		
C		
D		

Question 2

Based on the information in **Video 1 and 2**, **describe** the functions (jobs) of a pig's forelimb (front leg) and a mouse's

forelimb (front leg). Think about the different sizes of the animals.

Mouse forelimb function	Pig forelimb function

Question 3

Compare the images of **Figure 3** and identify similarities and differences. List at least 2 traits for each column.

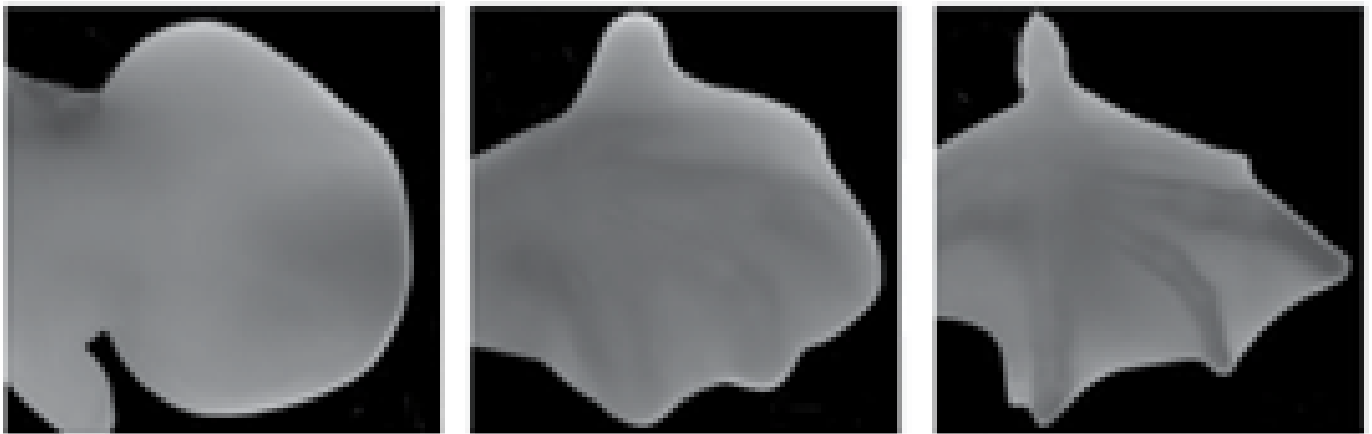| Similar Traits	Different Traits

Question 4

Look at the information you have in **Question 2 and 3** and list the evidence you have collected about how pigs and

mice may be related:

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Using the evidence you have collected, answer the following question: How does the patterns in the data support the

conclusion that pigs are related to mice?

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Question 5

Using the above image of the embryological development of another organism, how do you think this organism is

related to a pig and a mouse?

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What are the possible functions of this forelimb?

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