

The Science Behind Their Size

OVERVIEW

Students will explore what it means to be big and how an animal's size affects just about everything it does. They will examine how body systems functioned in the biggest dinosaurs that ever lived, and how these sauropods ate, breathed, and reproduced.

BACKGROUND FOR EDUCATOR

The fossil record indicates that many animal species got bigger over evolutionary time, and that the body systems of bigger animals function somewhat differently than those of smaller ones. Bigger animals are generally stronger than smaller animals, have fewer predators, and live much longer. However, there are disadvantages to being big. For instance, the more an animal weighs, the more energy it requires to move and perform other life functions. For more information on the world's biggest dinosaurs read "Living Large: How Did Sauropods Get So Big?" (*Rotunda*, Spring 2011), downloadable at amnh.org/join/rotunda/AMNH_RotundaSpring_2011.pdf

BEFORE YOUR VISIT

Activity: Size Matters

In this activity, students will explore the differences between big and small animals by charting how specific body systems are affected by body size.

Tell students that size affects just about everything an animal does — from eating and producing waste to breathing and reproducing. (See Background paragraph, above). Have students use the information provided in the chart below to create one graph per set of data, plotting body weight as the independent variable on the x-axis, and each data set (body weight, daily food intake, heart rate, life span, birth weight) as the dependant variable on the y-axis. (Note: In the exhibition, students will collect data for sauropods.)

NYS Science Core Curriculum

LE 1.2b: Humans are complex organisms. They require multiple systems for digestion, respiration, reproduction, circulation, excretion, movement, coordination, and immunity. The systems interact to perform the life functions.

Plan how your students will explore *The World's Largest Dinosaurs* using the student worksheets.

Distribute copies of the worksheets to students before coming to the Museum. You may want to review the worksheets with them to make sure they understand what they are to do.

Species	Adult Body Weight	Daily Food Intake	Heart Rate (beats per minute)	Life Span (years)	Birth weight or size of eggs
A - Hummingbird	0.2 oz	0.4 oz	250	5-9	0.018 oz.
B - African Elephant	11,000 lbs	400 lbs	30	40	200 lbs
C - Blue Whale	400,000	8,000	20	85	6,000 lbs
D - Average Adult Human	150 lbs	4.7 lbs	72	68 (world average)	7 lbs

After students create their graphs, have them independently answer the following questions. Then use their answers to lead a class discussion:

- Make predictive statements about the patterns you see in the graphs. For instance, as body weight increases, how are other variables affected? How does daily food intake compare to body weight? How do adult sizes compare to baby sizes?
(Answers may include: As body weight increases, daily food intake increases, heart rate decreases, and life span increases.)
- Why might it be better for an animal to be bigger?
(Answers: Bigger is safer. Predators think twice about targeting the biggest animal in a group. If the biggest animal in a group is more likely to survive and reproduce, their offspring will grow larger as well. This is an example of natural selection favoring large size. An exception is the hummingbird, the smallest bird and living dinosaur.)
- Are the individual cells in the body of a big animal the same size as those in a small animal?
(Answer: Yes, it's just that big animals have many more cells. The amount of energy required to keep these cells alive is an organism's metabolism, which varies across species. Smaller animals have higher metabolisms than larger ones, requiring them to consume more calories relative to their size. A tiny hummingbird must drink three times its own weight every day. Its metabolic rate is one of the highest of any animal.)

DURING YOUR VISIT

The World's Largest Dinosaurs Exhibition

4th floor (45 minutes)

As students explore the exhibition, have them use the student worksheet to collect observations about the body systems of extinct sauropods and their living relatives. They will use this evidence to determine how size affects body systems.

Hall of Reptiles and Amphibians

3rd floor (20 minutes)

Have students visit two reptile dioramas: Defense & Feeding (diorama #4) and Komodo Dragon (diorama #10). As they explore each diorama, ask them: How do reptilian species use size for defense? Is there an advantage to being small?
(Answers may include: Some reptiles may exaggerate their size to appear more aggressive and/or larger when threatened by a predator.)

BACK IN THE CLASSROOM

Activity: Exhibition Wrap-Up

Have students add the sauropod data from their worksheets to the table provided in the Before Your Visit activity. Next have them plot the sauropod data on three graphs: Adult Body Weight, Daily Food Intake, and Heart Rate.

Students should then independently answer the following questions, and share their answers in a class discussion.

- How do sauropods fit into the predictive patterns you made before your visit?
(Answer: The sauropod had a very large body. Therefore, it ate more food and had a slower heart rate than the smaller animals.)
- Based on these patterns and what you learned in the exhibition, can you hypothesize where sauropods fit on the other two graphs, Life Span and Size of Eggs?
(Answer: Sauropods probably lived longer and laid larger eggs than the smaller animals. Although the sauropod eggs would be bigger than the eggs of smaller animals, they were not as big as you might think relative to their size. After hatching, sauropods ate a lot and grew very fast.)

The Science Behind their Size

As you explore the exhibition, find the sections listed below and collect evidence about sauropods. Record your data on the chart.

Section: Heart Beat	
Listen to the sound of the beating <i>Mamenchisaurus</i> heart. How many heart beats per minute to you hear?	
How many chambers did the heart have?	
List some living species that have the same number of heart chambers.	
<p>Circle the best answers:</p> <p>The bigger the animal, the bigger / smaller and more / less powerful its heart has to be.</p> <p>The bigger the animal, the faster / slower the heart rate.</p>	Write down some reasons to support your answers:
Section: Breathe	
How many air sacs did the sauropod lung probably have?	
List some living species that breathe the same way.	
Section: Fuel	
How much food did this sauropod have to eat every day?	
How long did it take to digest its food?	
<p>Circle the best answers:</p> <p>The bigger the animal, the more / less energy it uses.</p> <p>The bigger the animal, the more / less it needs to eat.</p>	Write down some reasons to support your answers:

Section: Babies

Find the magnifying station and push the button to see the chicken and Yacaré caiman eggs. Which eggs have bigger pores?

Eggs with bigger pores are found in which environment?

Circle the best answers:

The bigger the eggs, the
thicker / thinner
the shells have to be.

The wetter the environment, the
larger / smaller
the eggs' pores.

Write down some reasons to support your answers:

Section: Size

Based on the length of the adult *Apatosaurus* femur, calculate its weight in pounds.

Now measure your own femur using the ruler provided. How much would you weigh if you were a sauropod?

ANSWER KEY

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As you explore the exhibition, find the sections listed below and collect evidence about sauropods. Record your data on the chart.

Section: Heart Beat	
Listen to the sound of the beating <i>Mamenchisaurus</i> heart. How many heart beats per minute to you hear?	(Answer: 5)
How many chambers did the heart have?	(Answer: 4)
List some living species that have the same number of heart chambers.	(Answer: humans, birds, crocodilians)
<p>Circle the best answers:</p> <p>The bigger the animal, the bigger / smaller and more / less powerful its heart has to be.</p> <p>The bigger the animal, the faster / slower the heart rate.</p>	<p>Write down some reasons to support your answers:</p> <p>(Answers may include: Size of the heart will usually be relative to body size, and in bigger animals the heart needs to be more powerful to pump blood throughout the body. The heart rate is slower, or beats fewer times per minute, in bigger animals than in smaller ones.)</p>
Section: Breathe	
How many air sacs did the sauropod lung probably have?	(Answer: 2 – rear and front)
List some living species that breathe the same way.	(Answer: birds)
Section: Fuel	
How much food did this sauropod have to eat every day?	(Answer: 1,150 lbs; 100,000 calories)
How long did it take to digest its food?	(Answer: about 2 weeks)
<p>Circle the best answers:</p> <p>The bigger the animal, the more / less energy it uses.</p> <p>The bigger the animal, the more / less it needs to eat.</p>	<p>Write down some reasons to support your answers:</p> <p>(Answers may include: The bigger the animal the more energy is required to move and perform other life functions. That's why bigger animals need to eat more than smaller ones.)</p>

ANSWER KEY

Section: Babies

Find the magnifying station and push the button to see the chicken and Yacaré caiman eggs. Which eggs have bigger pores?

(Answer: Yacaré caiman)

Eggs with bigger pores are found in which environment?

(Answer: In wetter environments, or those in which eggs are covered for protection against predators. Bigger pores help the embryo breathe.)

Circle the best answers:

The bigger the eggs, the

thicker/ thinner

the shells have to be.

The wetter the environment, the

larger/ smaller

the eggs' pores.

Write down some reasons to support your answers:

(Answers may include: Bigger eggs need thicker shells so they don't crack. When eggs are laid in a wet environment (e.g. covered by vegetation or in particularly wet mud), they have reduced air flow. Thus the pores must be bigger to accommodate the reduced amount of air available.)

Section: Size

Based on the length of the adult *Apatosaurus* femur, calculate its weight in pounds.

(Answer: 42,885 lbs)

Now measure your own femur using the ruler provided. How much would you weigh if you were a sauropod?

(Answers will vary.)

