SCIENCE·3D

DESERT BATTLE: NINJA RAT VS RATTLESNAKE

In the packet below, answers are red and notes to teachers are blue.

In this **Science Mission**, students will use data from field experiments to explore the interaction between rattlesnakes and kangaroo rats. They will describe the body systems involved in each step of an interaction and investigate how reaction times affect the success of snake attacks and kangaroo rat evasion. Finally, students will analyze and synthesize data on each animal's movements to explore how rattlesnakes might help disperse plant seeds by consuming kangaroo rats.

If the environmental conditions in the desert change – for example, the temperature increases or the amount of rain changes – then plants may need to get their seeds to new locations for the baby plants to survive! Could rattlesnakes help disperse the seeds of plants in the desert? If they could, they would help plants spread across the landscape. They could help plant populations move as conditions change.

For rattlesnakes to move seeds, there are a few important steps that need to happen. First, the seed has to survive ingestion by kangaroo rats or other rodents (e.g. mice). Second, the rattlesnake has to successfully capture and eat a kangaroo rat or other rodent with seeds in them. Third, the rattlesnake has to move away from the parent plant. Finally, the seed has to survive passing through the digestive system of rattlesnakes!

We know that many rodents don't immediately swallow and digest seeds. Because seeds are not around all year, they need to store some to eat later. Rodents, like kangaroo rats, collect many seeds and store them in their cheek pouches. Then, they bury them for safe keeping. When they get hungry, they know where to find the seeds. That means that many rodents have seeds inside them that aren't being digested! It also means that forgotten seeds can germinate and grow.

ACTIVITY I: RATTLESNAKE VS KANGAROO RAT

A number of steps have to occur for a predator to successfully capture and eat its prey.

- Predator finds prey.
- Predator gets close enough to try to catch prey.
- Predator catches prey.
- Prey doesn't escape once it is caught.
- Predator eats prey successfully.

Extend the lesson: Have students construct an equation that would let you determine the total probability that a predator eats its prey.

Probability that a predator gets a meal = P(predator finds prey) • P(predator gets close enough) • P(predator catches prey if it gets close enough) • P(prey does not escape once it is caught) • P(predator can eat prey it has caught)

Have the class discuss the factors that might influence each of these steps in the process to reinforce specific learning objectives related to population sizes, body systems, behavior, etc.

Animals change their behavior and use their sensory and body systems to give them the best chances of catching a meal or avoiding becoming one. The scientists at ninjarats.com have used high-speed video cameras to study parts of this interaction! The data in Table 1 show the results of 20 instances in which snakes tried to catch kangaroo rats.

Table 1: Results of rattlesnake strikes at kangaroo rats

Strike number	Was strike accurate?	If accurate, did rat dodge or did snake bite successfully?	If bitten, did snake release fangs or did rat knock snake off?	Did snake eat rat?
1	No	-	-	No
2	Yes	Dodge	-	No
3	Yes	Dodge	-	No
4	Yes	Bite	Release	Yes
5	Yes	Bite	Knock off	No
6	No	-	-	No
7	Yes	Dodge	-	No
8	Yes	Dodge	-	No
9	Yes	Bite	Knock off	No
10	Yes	Dodge	-	No
11	Yes	Bite	Knock off	No
12	Yes	Dodge	-	No
13	Yes	Bite	Knock off	No
14	No	-	-	No
15	Yes	Bite	Knock off	Yes
16	Yes	Bite	Knock off	Yes
17	Yes	Dodge	-	No
18	Yes	Bite	Knock off	Yes
19	No	-	-	No
20	Yes	Bite	Release	Yes

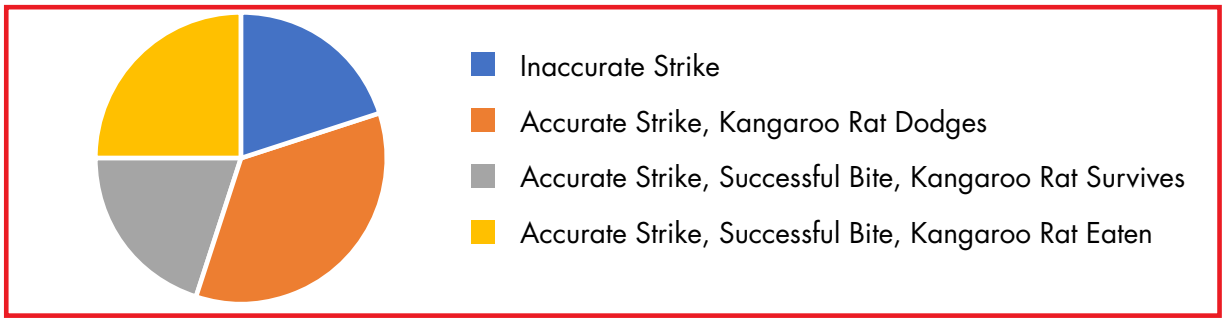
1. Use the data in Table 1 to calculate the percentage of snake strikes for each outcome listed in Table 2 below.

Table 2. Outcomes of rattlesnake strikes at kangaroo rats

Result/Outcome	Percentage of strikes
Accurate	80% (=16/20)
Inaccurate	20% (=4/20)
Accurate strikes that are dodged	44% (=7/16)
Accurate strikes that result in a bite	56% (=9/16)
Bites that snakes release	22% (=2/9)
Bites in which rats knock snakes off	78% (=7/9)
Bites that result in rats being eaten	56% (=5/9)
Bites that rats survive	44% (=4/9)
Total strikes that lead to the rat being eaten	25% (=5/20)

Extend the Lesson: Have students create a pie chart of the proportion of bites that have the outcomes below:

1. Inaccurate strike (4/20)
2. Accurate strike, kangaroo rat dodges and survives (7/20)
3. Accurate strike, snake bites, kangaroo rat escapes and survives (4/20)
4. Accurate strike, snake bites, kangaroo rat is eaten (5/20)



Answers will vary, but below is an example. It is ok if students don't identify all of the body systems; to get full credit they should be able to describe how several key body systems are used.

2. Choose two snake strikes that have different results. **Describe** the interaction between the kangaroo rat and the snake step by step. Start with the snake detecting the kangaroo rat. Then, **describe** the body systems or senses that were important in each step of the interactions you listed.

Answers will vary, but below is an example.

Snake strike number 16

Steps of interaction:
1. The snake detects the kangaroo rat using its nervous system. It hears and smells the kangaroo rat coming. It uses its ability to sense heat to see the kangaroo rat in darkness.
2. The snake strikes. The snake's muscular and skeletal systems work together to launch the snake's body through the air.
3. The kangaroo rat tries to escape [Note: They may or may not identify this since the bite is successful. It is possible the kangaroo rat never saw it coming.] The kangaroo rat's nervous system hears the snake strike coming. The kangaroo rat's muscular and skeletal systems work together so the kangaroo rat can jump in the air and twist.
4. The snake bites the kangaroo rat. The snake's muscular system and skeletal system close the snake's jaws and inject venom.
5. The kangaroo rat knocks the snake off using its muscular and skeletal systems.
6. The venom from the snake works on the kangaroo rat to disrupt the body systems of the kangaroo rat.
7. The snake eats the kangaroo rat. Its digestive system breaks down the food.

Snake strike number

Steps of interaction: _____

The speed at which a kangaroo rat reacts to the strike of a rattlesnake might be an important factor in escaping without getting bitten.

3. **Describe** what body systems, organs, and senses are important in a kangaroo rat's reaction time. Think about detecting the strike and getting out of the way.

   The nervous system is important because the rat has to use its hearing or vision to detect the strike. It uses its eyes and its ears. Then, the brain has to tell the body to react. Next, the muscular and skeletal systems have to work together for the rat to jump out of the way. Students may not get all of the possibilities correct; good answers should highlight the nervous system and sensory systems (or at least one sense) in detection and then the body systems and organs (at least one or two organs) moving the rat away.

4. Using Tables 3 and 4, calculate the average reaction time for kangaroo rats that were bitten and those that avoided being bitten.

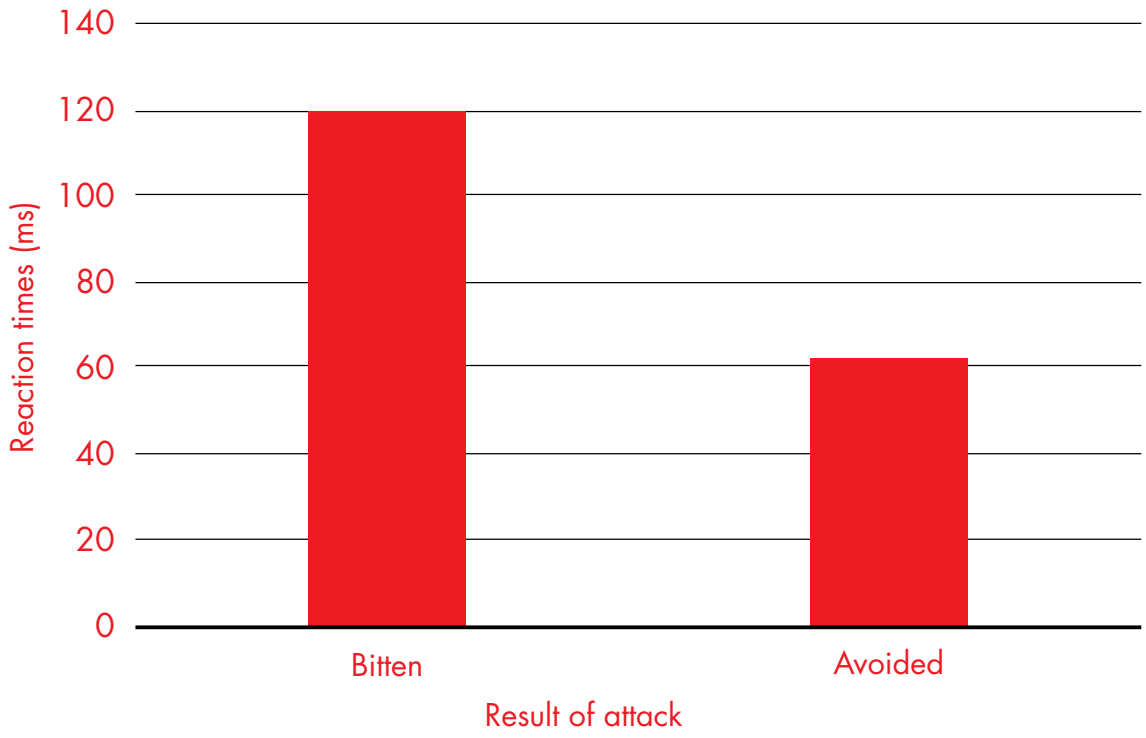
Table 3. Reaction times (in milliseconds) of kangaroo rats that were bitten by a snake

Strike number	Reaction time (ms) Bitten
1	130
2	150
3	160
4	60
5	110
6	140
7	130
8	70
9	130
10	120
Average	120

Table 4. Reaction times (in milliseconds) of kangaroo rats that successfully avoided a bite

Strike number	Reaction time (ms) Avoided
1	60
2	50
3	50
4	40
5	60
6	120
7	90
8	50
9	50
10	60
Average	63

5. **Draw** a bar graph of the average reaction time of kangaroo rats that were bitten and kangaroo rats that avoided strikes. Label the axes and caption the figure.



Average reaction times of bitten and non-bitten kangaroo rats

6. Is reaction time important for avoiding a strike? Use evidence from your graph. Remember, lower numbers mean the rat is faster!

   Yes, reaction time is important. Rats that avoided a strike reacted more quickly than those that did not avoid a strike.

7. Based on the data in Tables 3 and 4, do you think that reaction time is the only thing that is important in avoiding being bitten? Support your answer with information from the tables.
   Hint: Look at kangaroo rats 4 and 8 in Table 3 and kangaroo rat 6 in Table 4.

   It doesn't look like reaction time is all that matters. Some rats that reacted quickly were bitten and some that reacted slowly escaped. There must be other important factors.

ACTIVITY 2: HOW FAR COULD SEEDS TRAVEL?

How far seeds are dispersed by kangaroo rats or rattlesnakes depends on how far they travel. How far do kangaroo rats carry seeds before they bury them? How far do snakes move between having a meal and excreting the waste?

Let's start with the kangaroo rats.

1. **Calculate** the average and median distances in Table 5. Then, use the data in the table to answer the following questions.

Table 5. Dispersal distances for seeds carried by kangaroo rats

Kangaroo rat number	Distance between parent plant and seed being buried (meters)
1	1
2	1
3	3
4	10
5	5
6	0
7	8
8	3
9	2
10	0
Average	3.3
Median	2.5

2. Do kangaroo rats move seeds long distances? Use evidence in Table 5 to support your answer.

   No, kangaroo rats don't move seeds very far. Most seeds only move 0-3 meters from the parent plant. Some students may notice that some seeds are moved pretty long distances, especially kangaroo rats 4 and 7.

3. Why was it important that the scientists who collected the data in Table 4 followed more than one kangaroo rat? Cite specific evidence from the table to support your answer.

   Even though kangaroo rats moved seeds an average of 3.3m, some moved them much shorter distances. Rats 6 and 10 didn't move seeds away at all. Other rats moved seeds much farther, like rats 4 and 7. If only one rat had been studied, it might not have represented what most kangaroo rats do.

Now, let's look at the snakes. It is important to know how far snakes might travel over the time it takes for the seeds that they ingest (when they eat kangaroo rats and other rodents) to pass through their digestive systems. It takes around two weeks for food to pass through a snake.

4. Use the data in Table 6 to calculate an average and median. Then, answer the following questions.

Table 6. Distances between points where snakes were observed feeding and where they were relocated after 14 days

Snake Pit Tag ID #	Distance moved (m)
4147	0
4148	2100
4152	1300
4155	300
4156	0
4157	100
4162	400
4164	1300
4165	1900
4169	1100
Average	850
Median	750

1. Why was it important to collect data on more than just one or two snakes?

   Individual snakes moved very different distances. If only one or two snakes had been studied, the answer might not have been very accurate. For example, one snake moved more than 2000 meters while two were found in the same place.

2. **Compare** the movements of rattlesnakes and kangaroo rats. **Predict** which one would move seeds further if they both were dispersing seeds.

   Rattlesnakes move a lot further than kangaroo rats. Rattlesnakes would be expected to move seeds hundreds of meters further than kangaroo rats if they are both dispersing seeds. Some students might make the excellent observation that some snakes may not move seeds further because they appear to stay very close to the same place.