LT: I can create histograms to describe how populations change over time. 4.3.1

Examining Adaptive Changes Through Generations

You may have learned about a famous biologist named Charles Darwin and his discovery of natural selection on the Galapagos Islands. Darwin's encounter with the tortoises on the islands led to one of the most important discoveries in science: animals adapt to their environment to ensure their survival. On one island, tortoises had their food source low to the ground and were able to easily eat the vegetation; however, on a neighboring island, the vegetation was higher up off the ground. Tortoises that could raise their heads high and reach the food were those that succeeded in reproducing. This led to an adaptation for tortoises to develop a high dome on their shell near the neck; this allowed them to crane their heads high and reach food. Eventually, the two islands developed two distinct types of tortoises based on the adaptation.

Adaptations are changes in species that allow them to increase chances of survival in their habitat. Natural selection is one way that adaptations can emerge. Examples of this include the red-eyed tree frog that uses the bright red coloring of its eyes to deter predators and the chameleon that can change colors to blend into its environment.

Mimicry is a special type of adaptation some animals use. Mimicry is where an animal will adapt to look like a different animal, copying its advantageous traits that protect it from predators. In nature, the monarch butterfly deters predators by the color and pattern on its wings. The monarch butterfly is toxic to other animals. The viceroy butterfly has adapted to this by copying the monarch. If you look closely at the two butterflies, it is hard to distinguish one from the other. It's beneficial to the viceroy to possess this color and pattern because predators will assume it is a toxic monarch and ultimately stay away.

The data set below shows a fictional example of how adaptation moves slowly through generations. Recall the Galapagos tortoises from the beginning of the text. Assume that before one island adapted to reaching high vegetation, there was a mix of all types of tortoises. Every five generations, a sample of 10 tortoises had the height of their shells (near the neck) measured. For each data set, compute the mean and examine the variation among the data. Using a bar graph to plot the data may lead to better insights into the distribution of the data. What observations do you notice about how changes move through a species over generations?

Generation 1	
Sample Number	Height of shell in Inches
1	10
2	8
3	7
4	9
5	8
6	1
7	0
8	0
9	10
10	4

Generation 5	
Sample Number	Height of shell in Inches
1	4
2	6
3	10
4	1
5	7
6	8
7	8
8	7
9	4
10	9

Generation 10	
Sample Number	Height of shell in Inches
1	7
2	9
3	3
4	7
5	7
6	8
7	6
8	5
9	8
10	6

Generation 15	
Sample Number	Height of shell in Inches
1	7
2	6
3	8
4	7
5	8
6	6
7	7
8	8
9	6
10	7

1. For each generation of turtles, record the mean height of the shell:

Generation 1:____________________________

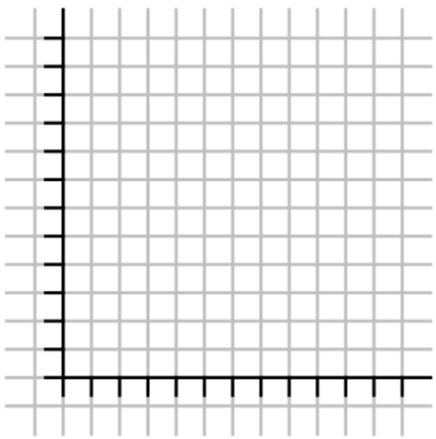
Generation 5:____________________________

Generation 10:____________________________

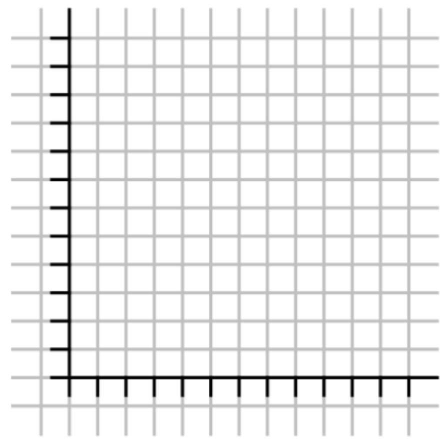
Generation 15:____________________________

2. Create a histogram of each generation below:

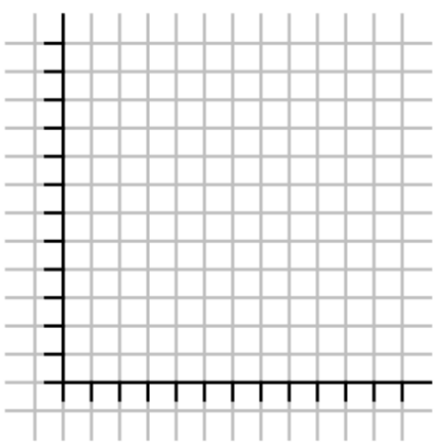
Generation 1



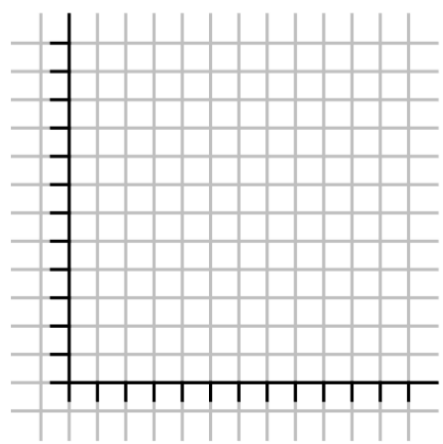
Generation 5



Generation 10



Generation 15



3. What observations can you make about how the population is changing over time?

LT: I can use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in a population over time. 4.3.1

How Birds Adapt

Have you ever noticed how bird beaks don't all look the same? The hummingbird has a long thin beak, but robins have short stout beaks. This is no accident. Natural selection has made it possible for birds to adapt their phenotype (what something looks like based on its genetics) to be advantageous to their environment.

Imagine trying to sit down and eat a steak with the beak of a hummingbird. You probably wouldn't be able to chew much or even get the steak in your mouth. Luckily hummingbirds primarily eat the nectar from flowers. Their long thin beaks are well suited for retrieving this nectar. Occasionally, they will also eat insects, although this is not their primary food.

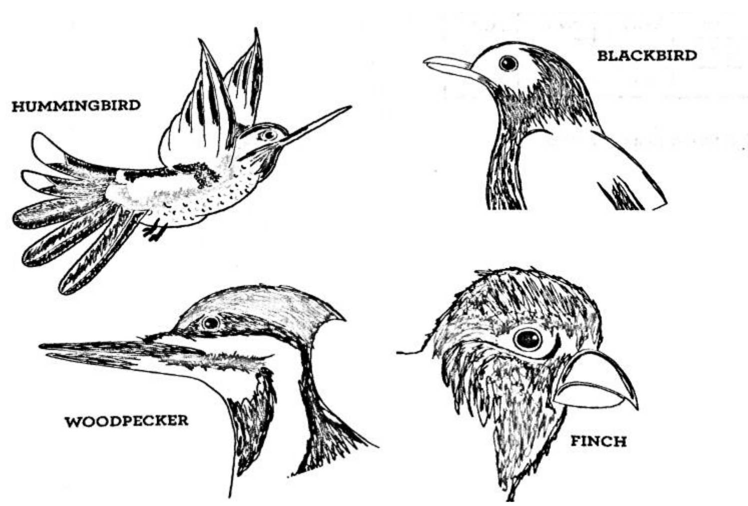
Blackbirds have a diet that includes nuts, seeds, earthworms, spiders, and insects. As you can imagine, their beak must be adapted for this diet. It is certainly shorter than the hummingbird, but also must be long enough to retrieve worms from the ground.

Finches, on the other hand, eat primarily seeds and nuts. While they have the capability of eating insects, you will usually find backyard bird feeders packed with seeds to attract this type of bird. The cone-shaped beak allows finches to better crack open and eat nuts and seeds.

Other birds have very specialized beaks for their unique needs. One example of this is the woodpecker. The woodpecker drills rapidly into the sides of trees using its beak at a rate of about 20 pecks per second. It uses its extra-long tongue to reach into the holes and pull out insects living in the trees. Woodpeckers typically eat bugs like ants, termites, spiders, and even caterpillars.

Beak adaptations aren't the only thing that help the woodpecker. Consider if you tried to drill away at a tree with your teeth as fast as a woodpecker. You would surely get a headache or even brain damage. So how does a woodpecker peck without damaging their brains? Woodpeckers have a special adaptation that makes their skull spongy, which absorbs the force of the impact from pecking, Additionally, their brains are covered tightly in their skulls. Woodpeckers have also adapted their eyes to the wear of pecking. A special eyelid called a nictitating membrane covers the bird's eyeballs as it pecks, preventing its eyes from popping out or facing damage from debris.

There are many ways birds have adapted to their environments. These few examples are only the beginning. The next time you see a bird in your backyard, consider how it may not be as simple of a creature as it seems!



LT: I can use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in a population over time.

You are a biologist and have discovered a small remote island populated with hummingbirds. Over time, the island went through geological changes that caused it to become two distinct islands. On Island A, the vegetation was rich with plant life of all kinds- nuts, seeds, and flowers- as well as plentiful insects. Island B, however, was devoid of much of the plant life the hummingbirds were used to and was filed mainly with nuts and seeds, although insects were also prevalent there. Upon your return to the islands after these changes, you monitor the birds for adaptations. You return many times to assess multiple generations looking for changes.

1. Based on the background texts, write a hypothesis that describes which trait will most likely show the greatest change over time: beak size, height or speed.
2. Analyze the data you have collected and determine if the hummingbirds on Island B have adapted to the changes in their environment. For each generation, determine the mean for the selected trait.
3. Present your data by creating a graph that illustrates how the trait has changed over time.
4. Write a scientific conclusion.

ADAPTATION DATA SET Beak Size

BEAK SIZES (in cm)						
	Generation 1	Generation 10	Generation 20	Generation 30	Generation 40	Generation 50
1	9.86	9.09	8.35	9.18	8.38	7.54
2	9.40	10.03	8.89	7.95	8.11	7.44
3	9.60	9.82	9.10	8.64	8.35	7.79
4	10.42	9.69	9.12	8.99	7.89	7.60
5	10.05	9.19	8.68	8.00	8.33	7.84
6	10.32	9.76	9.30	8.19	7.82	7.55
7	9.83	9.12	9.34	8.96	7.89	7.55
8	10.00	8.91	8.63	8.68	7.58	7.87
9	9.37	9.38	8.90	8.10	8.38	7.85
10	10.02	9.30	9.87	9.22	7.50	7.94
11	9.62	9.71	8.30	9.14	8.34	7.52
12	9.80	9.20	9.25	8.33	8.33	7.55
13	10.07	9.63	9.56	8.46	8.33	7.47
14	9.76	10.14	8.06	7.75	8.06	7.69
15	10.52	9.35	8.42	8.14	7.65	7.11
16	9.92	9.40	9.14	8.16	8.12	7.40
17	10.70	9.76	8.84	8.11	7.27	7.64
18	9.24	9.93	8.61	8.57	7.60	7.36
19	10.54	10.49	8.93	8.62	7.78	7.25
20	10.15	9.18	9.49	9.03	8.07	7.41
21	10.05	9.51	8.67	8.49	7.20	7.86
22	9.69	9.52	10.16	9.07	7.77	7.81
23	9.78	9.69	9.02	8.55	7.64	7.44
24	10.10	9.75	9.61	9.38	7.35	7.52
25	9.80	9.77	8.76	7.66	8.81	7.45

BEAK SIZES (in cm)						
26	9.96	9.94	8.82	9.00	7.83	6.99
27	10.00	9.41	8.89	8.40	7.65	7.08
28	10.20	8.84	9.12	8.72	8.11	7.52
29	9.90	9.19	9.54	8.59	8.63	7.28
30	10.19	10.32	8.36	8.47	8.34	7.50
31	10.22	8.82	9.11	8.05	7.82	7.70
32	9.95	9.35	8.99	9.30	8.83	7.94
33	9.82	9.75	9.46	8.84	7.99	7.28
34	9.68	8.95	9.03	8.86	7.68	7.40
35	9.86	9.20	8.51	8.33	7.78	7.23
36	10.39	9.29	9.22	7.76	7.63	7.59
37	10.07	9.39	8.97	8.28	7.86	7.47
38	9.90	9.31	9.26	8.77	7.89	7.47
39	10.09	9.12	9.39	8.16	7.52	7.50
40	10.08	9.03	8.71	8.68	7.85	7.72
41	9.87	10.01	9.32	8.43	7.62	7.42
42	9.93	9.56	9.38	9.03	8.33	7.48
43	10.54	9.45	9.82	8.62	8.34	7.88
44	10.24	9.36	9.46	8.22	7.54	7.11
45	10.46	8.95	9.13	8.87	8.15	7.67
46	9.60	9.23	8.22	7.57	8.17	7.72
47	10.34	9.36	9.11	8.75	8.46	7.53
48	10.25	9.52	9.35	8.82	8.21	7.49
49	10.25	9.44	9.46	8.09	8.02	7.69
50	10.19	9.22	8.77	9.47	7.74	7.22
51	9.98	9.19	8.80	8.23	8.08	7.63

HEIGHT (in cm)

	Generation 1	Generation 10	Generation 20	Generation 30	Generation 40	Generation 50
1	13.12	11.92	12.31	12.78	12.11	12.92
2	12.91	11.81	12.25	13.02	12.27	13.11
3	13.61	12.27	12.56	13.17	12.80	13.25
4	13.14	12.17	12.14	13.02	12.81	12.92
5	12.85	12.31	12.81	13.14	12.01	12.89
6	13.02	11.59	12.68	13.08	12.70	13.11
7	12.98	11.91	12.60	13.04	12.26	13.15
8	12.91	11.77	12.91	13.08	12.45	12.82
9	12.98	12.10	12.60	13.06	12.17	13.11
10	13.01	11.91	12.36	13.12	12.22	12.91
11	13.04	12.06	12.78	13.12	12.15	12.95
12	12.91	11.97	12.64	12.52	12.05	12.95
13	12.92	12.24	12.21	13.08	12.86	12.64
14	13.37	11.64	12.70	13.07	12.54	12.85
15	13.15	12.15	12.25	13.08	12.66	12.75
16	12.65	12.12	12.38	12.54	12.51	13.01
17	13.13	11.81	12.83	13.25	11.90	12.90
18	13.25	12.02	12.63	13.00	12.75	13.32
19	12.92	12.11	12.64	13.28	12.01	13.08
20	13.16	12.11	12.76	13.16	12.41	12.81
21	12.74	12.47	12.68	12.84	12.51	12.78
22	12.86	11.84	12.76	13.06	12.02	12.92
23	12.76	11.87	12.43	13.42	12.48	13.13
24	12.81	12.17	12.34	12.84	12.32	12.70
25	13.00	12.14	12.72	12.95	12.16	12.76
26	13.06	11.90	12.56	12.88	12.42	12.65
27	12.97	12.21	12.15	13.12	12.79	13.02
28	13.08	12.19	12.51	12.88	12.30	12.60
29	13.18	12.49	12.90	13.33	12.34	12.79
30	13.16	11.90	12.36	12.67	12.41	13.29
31	13.13	12.22	12.55	13.03	12.76	12.86
32	13.00	12.13	12.37	12.95	12.82	12.84
33	12.85	12.49	12.78	12.88	12.07	12.94
34	13.07	12.08	12.79	12.81	12.93	13.01
35	13.10	11.80	12.53	12.96	12.69	12.87
36	12.87	11.63	12.06	13.08	12.42	13.02
37	12.98	11.74	12.14	13.39	12.21	12.80
38	13.44	12.25	12.42	13.16	12.18	13.18
39	12.95	12.19	12.54	12.71	12.73	12.84
40	13.26	11.45	12.69	12.90	12.34	13.02
41	12.29	11.33	12.49	12.97	12.38	13.24
42	12.59	12.43	12.22	13.23	12.36	13.25
43	13.06	12.03	12.45	13.26	12.81	13.18
44	13.13	11.57	12.51	13.16	12.21	13.21
45	13.32	12.05	12.82	13.36	12.47	12.78
46	13.15	11.75	12.77	12.90	12.61	12.89
47	13.05	11.91	12.43	12.73	12.60	13.24
48	12.71	11.93	12.56	13.05	12.37	13.23
49	12.41	11.87	12.10	13.26	12.79	12.95
50	12.73	12.07	12.19	12.69	12.40	13.15
51	13.10	12.36	12.33	13.21	12.64	13.64

SPEED (in mph)

	Generation 1	Generation 10	Generation 20	Generation 30	Generation 40	Generation 50
1	30.15	28.18	30.76	30.43	29.18	29.82
2	30.19	27.95	31.00	29.98	28.98	29.81
3	30.03	27.68	30.82	30.06	29.04	29.55
4	29.77	28.36	31.46	30.24	29.14	29.98
5	29.88	27.64	31.00	30.33	28.91	29.90
6	29.98	27.82	31.16	29.86	28.78	29.70
7	30.04	27.94	31.21	29.84	28.91	30.24
8	29.89	28.20	31.27	29.82	29.03	29.92
9	30.10	28.05	30.60	30.16	29.03	30.28
10	30.00	27.68	30.96	29.83	28.76	30.26
11	30.08	27.66	30.97	29.72	29.22	29.55
12	30.38	28.07	30.98	29.30	28.76	29.71
13	30.06	28.00	30.88	30.06	28.87	30.38
14	30.01	28.15	30.95	29.51	28.67	30.62
15	30.20	27.40	31.13	29.56	29.11	29.69
16	30.18	27.89	31.15	29.86	28.61	30.07
17	29.94	27.86	31.31	30.45	28.80	30.13
18	29.92	28.04	30.96	30.50	29.50	30.18
19	29.44	27.89	30.69	30.24	29.06	29.60
20	30.22	27.58	31.34	29.96	28.74	30.43
21	29.93	28.08	31.46	30.03	28.99	30.46
22	30.22	27.91	30.84	29.86	29.30	29.54
23	30.04	28.09	31.49	29.99	29.23	30.13
24	30.33	27.86	30.81	29.98	29.29	29.95
25	29.40	27.69	31.46	30.44	29.14	30.17
26	30.39	27.94	30.67	29.92	29.40	30.14
27	30.23	27.67	31.03	29.61	28.47	30.19
28	30.13	28.05	30.99	29.71	29.34	29.98
29	30.06	28.01	30.75	30.31	28.79	29.86
30	30.23	28.29	30.89	29.74	28.91	30.17
31	30.40	28.11	31.03	29.99	29.02	29.98
32	30.08	27.89	30.94	29.30	29.43	29.82
33	30.15	27.77	31.13	30.32	29.20	29.89
34	30.55	27.89	31.14	30.60	29.17	30.24
35	30.23	28.04	31.15	29.84	29.00	30.04
36	29.86	27.67	31.06	30.06	29.10	30.08
37	29.85	28.42	30.83	30.11	28.78	29.85
38	30.20	28.08	30.99	30.07	29.23	30.08
39	30.21	27.80	30.96	30.23	28.94	29.48
40	30.18	27.97	30.87	30.12	29.24	29.88
41	29.91	27.98	31.16	29.88	28.74	30.10
42	29.94	28.00	31.19	30.21	28.84	30.17
43	30.02	28.02	30.89	29.93	29.38	29.73
44	29.93	27.73	30.92	29.85	28.42	30.04
45	29.97	27.96	31.35	29.74	29.08	29.75
46	29.84	28.04	30.84	29.67	28.99	30.62
47	29.82	27.99	31.08	30.35	29.61	29.80
48	30.09	27.98	31.01	29.71	29.33	29.78
49	29.58	28.51	30.75	30.09	29.15	30.12
50	29.23	28.26	31.21	30.00	28.70	30.23
51	30.02	28.00	31.32	29.60	28.80	29.83

LT: I can design an experiment or model to teach the theory of natural selection.

You will design an experiment or model to teach the theory of natural selection.

1. Research different variations in traits that allow for natural selection to occur. (examples: color, size, height, speed, etc.)

    http://evolution.berkeley.edu/evolibrary/article/evo_25

    https://www3.beacon-center.org/blog/2012/10/01/evolution-101-natural-selection/

    http://sciencing.com/examples-natural-selection-animal-species-3667.html

    http://birds.fieldmuseum.org/stories/selection/natural-selection

2. Planning:
    a. What trait and organism will you simulate natural selection?
    b. Which variation of the trait will be most advantageous and why?
    c. Which variation of the trait will be most disadvantageous and why?
    d. What materials will you use for your simulation?