EVOLUTION BY NATURAL SELECTION IN-CLASS ACTIVITY

Instructions:

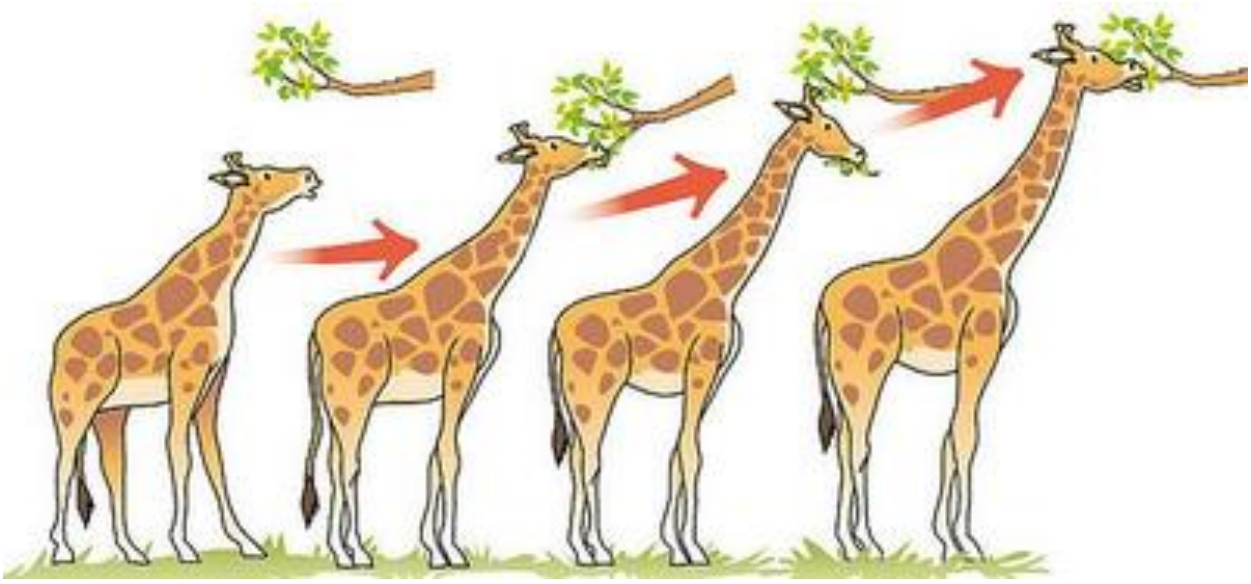
This handout has images representing natural selection. Please do not write on this page.

In a small group (2-3):

1. Discuss how each image shows evolution by natural selection occurring, according to the three steps of natural selection (variation, survival and reproduction of the fittest, evolution).
2. Assign each group member to one image. Individually, each person writes down a detailed, step-by-step description of how natural selection occurred in that population.
3. Share and critique descriptions within your groups.
4. Select one description from your group to revise and hand in. Write your names on it, as well as the title of the image.

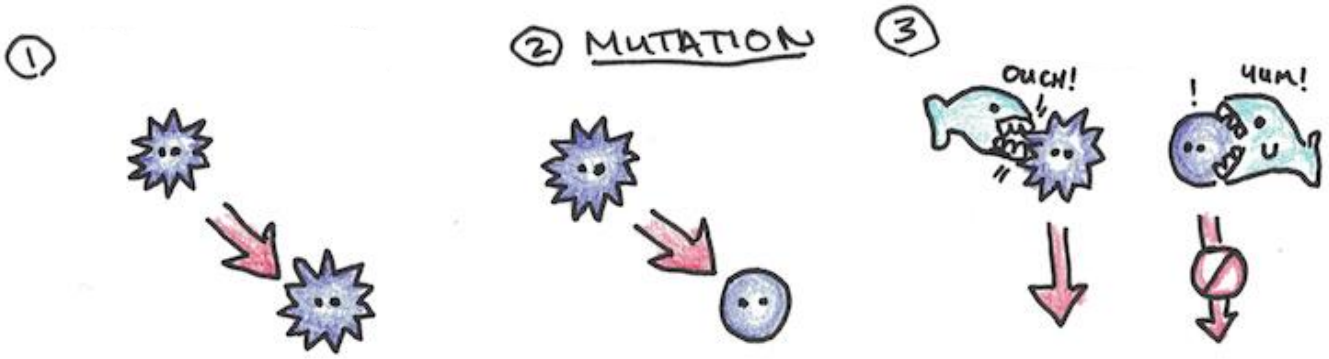
*Note: none of the images are perfect. Some may show certain step(s) of natural selection better than others.

Image 1: Giraffe



1) Variation. This is not explicitly shown in this image. However, we can assume that the beginning, there is a population of giraffes whose neck lengths vary. We can also assume that neck length is a heritable trait, since variation in a trait must be heritable in order to evolve.
2) Natural Selection. Giraffes with longer necks would have had an advantage in their environment and be able to access food sources not accessible by those with shorter necks. Therefore, the fitness of longer-necked giraffes is higher, since their ability to find food and survive is improved.
3) Evolution. Over many generations, the average neck length of the giraffes will increase as natural selection continues to favour giraffes with long necks.

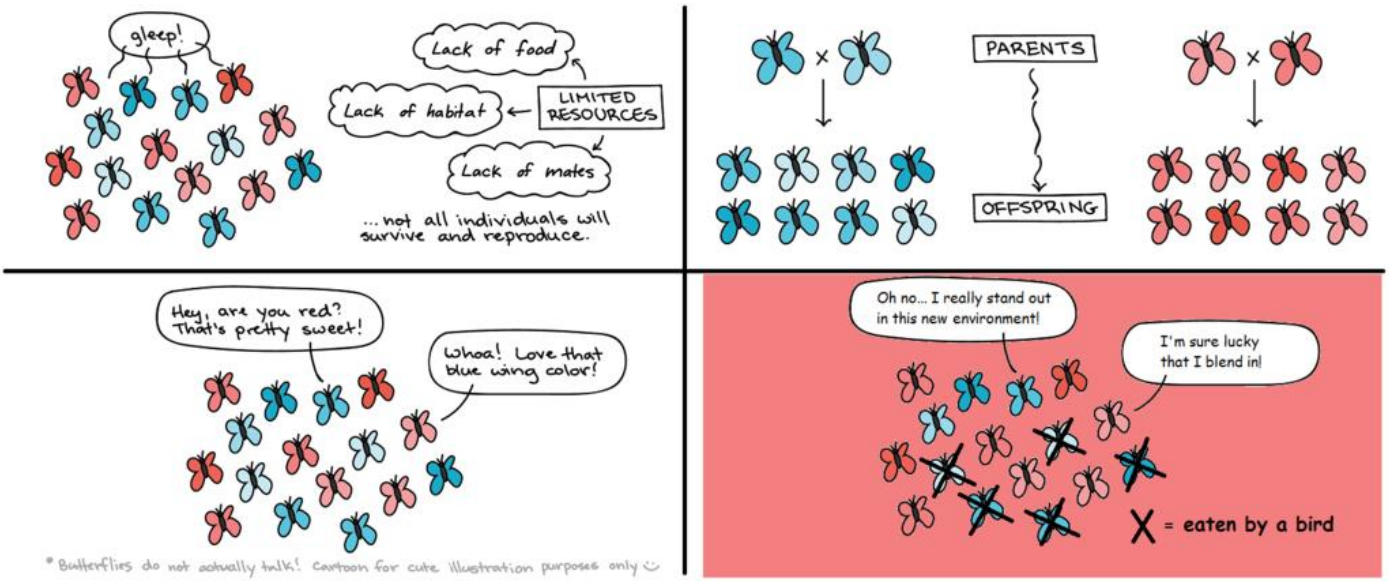
Image 2: Sea Urchin



Note: this was possibly the trickiest of the images since there was a lot of "reading between the lines" required. However, it was included in the activity to remind students of the fact that mutations are not always helpful; in fact, often they are harmful or have no effect whatsoever. Natural selection works on whatever variation it is faced with…good or bad as the traits might be.

1) Variation. At the start (Panel 1), there is no variation shown. All sea urchins can be assumed to look similar and have spikes. In Panel 2, a new mutation arises which causes the sea urchin with that allele to have a smooth exterior and not a spiky one. Panel 1 also suggests that the trait of spikiness is heritable, which is important for this trait to evolve through natural selection.
2) Natural Selection. As shown in Panel 3, the fitness of spiky sea urchins is higher than the fitness of smooth sea urchins as spiky sea urchins are less likely to be eaten by predators in their environment.
3) Evolution. Over many generations, the new mutant(s) are likely to be reduced in number or even disappear from the population entirely since their fitness is lower than the spiky sea urchins.

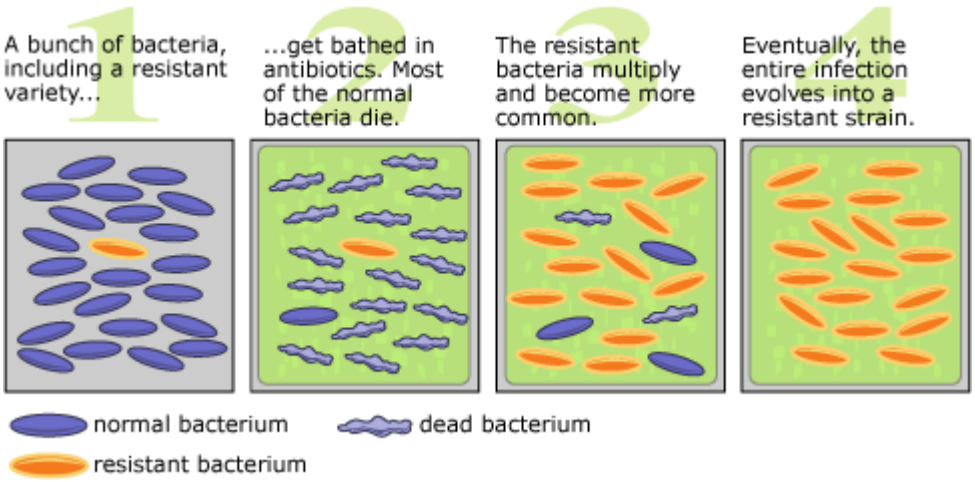
Image 3: Butterflies



1) Variation. Butterflies vary significantly in colour (red or blue) and hue (how dark their colour is). We can see in the top-right panel that colour is heritable: red butterflies have red offspring while blue butterflies have blue offspring.
2) Natural Selection.
   In the first three panels, there is no selective advantage to being any colour. All colours of butterfly are equally likely to survive and reproduce; they all have equal fitness.
   When the environment changes, the butterflies that are most likely to survive predation are the red butterflies. Overall, the red butterflies now have a higher fitness than blue butterflies. *
3) Evolution. Over many generations of continued selection, the blue-coloured butterflies are likely to decrease in frequency or possibly disappear altogether.

*This second ‘paragraph’ is more important here than the one above it, since it describes the natural selection the best. However, the first paragraph is also included to demonstrate a more complete understanding of the image.

Image 4: Antibiotic Resistance



1) Variation. The majority of the bacteria are not resistant to antibiotics, but a small percentage are. Heritability of resistance and lack of resistance is not explicitly shown or stated, but can be assumed since a variation in a trait must be heritable in order to be involved in evolution by natural selection.
2) Natural Selection. When the antibiotics are added, the fitness of the non-resistant bacteria becomes dramatically lowered as their chances of survival are very low. Meanwhile, the fitness of the antibiotic-resistant bacteria is much higher in comparison.
3) Evolution. Over many generations, we would expect that the majority of the bacteria (or all of them) become antibiotic-resistant, since antibiotic-resistance conveys a strong fitness advantage to the bacteria who have this trait.

Extension Activity:

1) Once we understand how evolution by natural selection works in the natural context, we can begin thinking about how non-living things undergo similar processes of evolution. Discuss and draw comic strips showing a modified version of the three steps of "evolution by natural selection" in one of the following:
    a. Evolution of the restaurant scene in Vancouver → there are many ways you could have interpreted this, but for the purposes of this answer key, I will focus on what happened to restaurants during the pandemic. Some historical details have been fudged to better serve the analogy.
        i. Variation. Many restaurants exist. They vary greatly in a number of important ways, e.g. type of cuisine, price point, accessibility, quality of food, etc. In particular, some types of cuisine are more conducive to take-out than others (e.g. pizza and sushi are great for take-out, but fine dining would not).
        ii. Natural Selection.
        For some businesses located in busy downtown areas, the bulk of their customers were office workers on lunch break. However, when the pandemic caused many office workers to have to work from home, restaurants that had relied upon those office workers now had very little revenue. Their 'fitness' and ability to make enough revenue to turn a profit became greatly reduced.
        At the same time, since indoor dining was not permitted, the restaurants that did well tended to be those that already had good take-out options or could easily switch over to take-out. Fine dining options would have been at a disadvantage since people who go to fine dining establishments tend to go for the food ***and the ambiance***, the latter of which is impossible to include in a take-out container.
        iii. Evolution. Over time, we saw a reduction in the number of restaurants that had previously offered a quick meal to customers during lunch break. We saw a shift in the restaurant scene to favour restaurants that had a very strong customer base (that did not depend on office workers), and restaurants that were able to easily transition to offer good take-out options.
    b. Evolution of culture (e.g. what causes some memes to persist or certain tiktok videos to become popular but not others?)
        i. Answers may vary.
        Note that 'number of shares' and 'number of likes' is very similar to reproduction in the biological sense…the greater the number of shares, the more likely a meme is to be popular because the faster it will spread. So success in terms of a meme is largely dependent on how many times it is shared (the ***reproduction*** part of survival and reproduction).