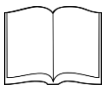
SUBJECT CODE:	Bio 1	*Fundamentals of Biology 1*
LEARNING GUIDE CODE:	2.0	*Evolution*
LESSON CODE:	2.5	*Mechanisms for Evolutionary Change*
TIME FRAME:		*30 minutes (1 session)*



MATERIALS NEEDED

To complete this module, you need the following:

1. pen;
2. paper;
3. phone/tablet/laptop;
4. Moodle app;
5. Moodle account;
6. stable internet connection and;
7. Biology: A global Approach by Campbell et al. (2015).

TARGET

After completing this lesson, you are expected to:

1. Describe how populations have changed, and continue to change, over time showing patterns of descent with modification from common ancestors to produce the organismal diversity observed today;
2. Describe mechanisms that produce change in populations from generation to generation (artificial and natural selection, genetic drift, mutation, recombination);
3. Differentiate the three mechanisms for evolutionary change to occur.

HOOK

To start our lesson, kindly proceed to the link below and take your time to maneuver through the online simulation below entitled, “Who Wants to Live a Million Year?”

https://coolsciencelab.com/who_wants_to_live_a_million_years.htm

Did you enjoy the simulation? Which mechanism for evolutionary change is highlighted in the simulation? Do you know that there are other mechanisms which can cause evolutionary change to a population?

IGNITE

In the previous lesson, you have learned the different sources of genetic variation which will make it possible for evolution to occur. In this lesson, you will be learning the three mechanisms of evolutionary change and how each mechanism differs from one another.

In the previous lessons, we have defined evolution as the change in the genetic frequency of a population from one generation to the next. There are three ways or mechanisms of altering genetic frequency of a population. These mechanisms are **genetic drift, gene flow, and natural selection.**

GENETIC DRIFT is a process by which genetic frequencies **fluctuate unpredictably** from one generation to the next in a **small population**.

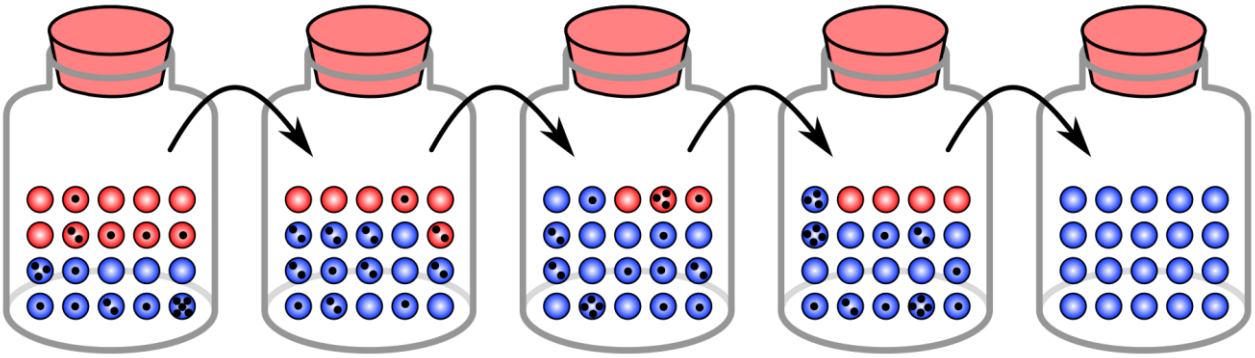


Figure 1. Genetic drift. Reprinted from Genetic drift, In *Wikipedia*, n.d., Retrieved June 19, 2020, from https://en.wikipedia.org/wiki/Genetic_drift. Reprinted with permission.

- In the figure shown above, each bottle represents one generation of a population of bacteria. The dots represent the number of times each bacterium will reproduce and these are randomly determined. Genetic drift postulates that in a small population, chance events such as random reproduction (let us say some bacteria will not receive enough nutrients and resources), can alter the genetic frequencies of a population per generation. After five generations, the genetic composition of the population has changed, and all bacteria are now blue species.
- There are many circumstances which may result in genetic drift. Two of these circumstances are **founder effect** and **bottleneck effect**.
- **Founder effect** happens when few individuals are separated from a large population. The individuals may be separated at random as in the case when some birds are blown away by a typhoon towards an island; thereby, separating them from the original population. This phenomenon also happens when a group from a large population migrates and populates a distant area where they will establish a new genetic pool.
- **Bottleneck effect** happens when an environmental event drastically decreases the number of individuals in a population. The event is referred to as a **bottleneck event.** This phenomenon is similar when marbles have passed through a "bottleneck" which drastically reduces its size as reflected in the figure below. Some genes might be overrepresented while some genes might be absent.

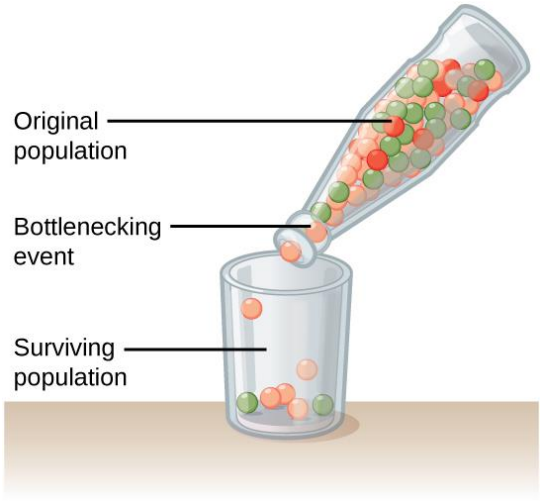


Figure 2. Bottleneck event. Reprinted from Population bottleneck, In *Wikipedia*, n.d., Retrieved June 19, 2020, from https://commons.wikimedia.org/wiki/File: Bottleneck_effect_Figure_19_02_03.jpg. Reprinted with permission.

KEY POINTS

1. Genetic drift is significant in small population.
2. Genetic drift can cause allele frequency change at random.
3. Genetic drift can cause a loss of variation in a population.
4. Genetic drift can cause harmful alleles to be fixed.

GENE FLOW is the change in the genetic frequency due to the movement of fertile individuals and their gametes in and out of the population.

- Gene flow has a large contribution to the evolution of the human population through the years. Humans today are capable of moving freely across the globe; thus, increasing the probability of random mating and spread of genes across the whole planet.

NATURAL SELECTION, a mechanism where organisms whose traits are well-suited to the environment tend to survive and produce more offspring than other organisms whose traits are not suited to the environment, is the only mechanism which results in adaptation.

- Natural selection is the only mechanism which results to adaptation since there is a selecting factor. The selecting factor which determines the survivability and reproducibility of certain members of a population is often the environment where the organism lives and mates.

- The outcome of natural selection is not random, since the outcome is determined by the environment, and natural selection increases the reproductive and survivability advantage of certain members of a population which will soon result to adaptation.
- Depending on which traits in a population is favored, there are three modes of natural selection; namely, **directional**, **stabilizing**, and **disruptive** selection.
- In directional selection, one of the phenotypic extremes is being favored by natural selection. This type of selection happens when an environment changes or when an organism migrates to a new environment.
- In disruptive selection, both extreme phenotypes are being favored by natural selection. Organisms with intermediate phenotype tend to underperform and will soon become extinct.
- In stabilizing selection, none of the phenotypic extremes is being favored in an environment. This type of selection only favors intermediate variants, reduces variation in a population, and maintains the status quo in a population.

Please refer to the link below to learn more about the different mechanisms of evolutionary change. Please focus on the content of the videos and not on the comment section in the website.

https://www.youtube.com/watch?v=W0TM4LQmoZY
https://www.youtube.com/watch?v=7VM9YxmULuo
https://www.youtube.com/watch?v=aTftyFboC_M

You may also refer to your textbook (Campbell et al., 2015) for other illustrative examples and more detailed explanations.

NAVIGATE

FINCHES, FINCHES, FINCHES

In the past lesson about the development of evolutionary theory, you have learned the different sets of evidence Darwin has presented in support of his Theory of Natural Selection. These sets of evidence include the diversity of finches in Galapagos, particularly the variation in the beak structure of these birds.

You have also learned that Charles Darwin proposed natural selection as the main mechanism on how evolution happened in the population of finches in the Galapagos Islands.

A. Now that you have learned about the two other mechanisms on how evolution can happen, how do you think would **genetic drift** and **gene flow** operate in these populations of finches which will give rise to the observed variations among finch populations? Using the knowledge you have learned, propose a possible scenario on how **genetic drift** and **gene flow** have altered the genetic frequencies in the original finch population which resulted in the variation observed by Charles Darwin in his travel across Galapagos. Write your answer on the space provided below.

B. Looking back at the discussion about the Galapagos finches, which of the three modes of natural selection do you think has occurred in the population of finches as proposed by Charles Darwin?

You will be graded based on the following rubrics:

RUBRICS

TOTAL NUMBER OF POINTS: 6 POINTS

Submission/ Compliance	**1**	**0.5**	**0**
	The student submitted the output on or before the deadline.	The student submitted the output beyond the given deadline.	The student did not submit any output.
Completeness of Output	**1**	**0.5**	**0.25**
	The student answered **all three** parts of the assessment.	The student answered **only two** parts of the assessment	The student answered **only one** part of the assessment.
Application of Concepts Learned	**3**	**2**	**1**
	All of the explanations are accurately anchored to the concepts presented in the lesson. The students demonstrate accurate and complete understanding of the lesson which was applied in his/her explanation.	**Most** of the explanations are accurately anchored to the concepts presented in the lesson. There is **at most one part** of the explanations which is inaccurate and not founded on the scientific principles learned.	**Some** of the explanations are accurately anchored to the concepts presented in the lesson. There are **more than one part** of the explanations which is inaccurate and not founded on the scientific principles learned.
Grammar	**1**	**0.5**	**0.25**
	There are **at most three** grammatical errors in the output.	There are **four to six** grammatical errors in the output.	There are **at least seven** grammatical errors in the output.

KNOT

In summary, there are three mechanisms which result in evolutionary change in a population. Genetic drift is a process where genetic frequencies fluctuate unpredictably from one generation to the next in a small population. Gene flow, on the other hand, results from the movement of fertile individuals from one population to another population. Natural selection, often referred to as survival of the fittest, is the only mechanism which results in adaptive evolution. Natural selection has three modes, depending on which of the phenotypes are being favored by the environment in a population.

REFERENCES

Photos:

Gringer (2013) - Genetic drift. [Photograph] Retrieved from https://en.wikipedia.org/wiki/Genetic_drift, June 19, 2020.

Open Stax, Rice University (2006) - Bottleneck event. [Photograph] Retrieved from https://commons.wikimedia.org/wiki/File: Bottleneck_effect_Figure_19_02_03.jpg, June 19, 2020.

Text Book:

Reece, J., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R. B. (2011). Campbell Biology 10th edition. San Francisco: Pearson Education Inc.

Video Links:

[Amoeba Sisters]. (2017, June 9). *Genetic Drift.* [Video file]. Retrieved from: https://www.youtube.com/watch?v=W0TM4LQmoZY&t=6s

[Amoeba Sisters]. (2016, Jan 29). *Natural Selection.* [Video file]. Retrieved from: https://www.youtube.com/watch?v=7VM9YxmULuo&t=4s

[CrashCourse]. (2012, May 1). *Natural Selection – Crash Course Biology #14* [Video file]. Retrieved from: https://www.youtube.com/watch?v=aTftyFboC_M

Prepared by:

JOHN JOSHUA A. AZUCENA
Special Science Teacher I
Philippine Science High School – CALABARZON Region Campus

Reviewed by:

ELEAZAR B. GUIA
Special Science Teacher V
Philippine Science High School – Central Visayas Campus

MICHELLE B. DUCUSIN
Special Science Teacher V/Team Lead (Biology)
Philippine Science High School – Ilocos Region Campus