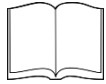


<b>SUBJECT CODE:</b>	Bio 1	<i>Fundamentals of Biology 1</i>
<b>LEARNING GUIDE CODE:</b>	2.0	<i>Evolution</i>
<b>LESSON CODE:</b>	2.4	<i>Sources of Genetic Variation</i>
<b>TIME FRAME:</b>		<i>30 minutes (1 session)</i>



## **MATERIALS NEEDED**

To complete this lesson, 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. explain the importance of mutation as the raw material for evolution; and
2. recognize variations in population sizes, including extinction, and describe mechanisms and conditions that produce these variations.



## **HOOK**



*Figure 1. A herd of cats. Reprinted from Feral Cat, In Wikipedia, n.d., Retrieved June 19, 2020, from [https://en.wikipedia.org/wiki/Feral\\_cat](https://en.wikipedia.org/wiki/Feral_cat). Reprinted with permission.*

The picture above shows a population of *Felis catus* or domesticated cats. They are the only domesticated members of the feline family and are characterized by being carnivorous and nocturnal hunters. What can you observe about the cat population shown above? Can you determine which cats belong to the same filial generation? Why are these cats considered as members of the same species despite the obvious differences in physical appearance? More importantly, what do you think contributed to the differences in the physical appearance among the members of this species?



## **IGNITE**

In the previous lesson, you have been introduced to the concept of evolution and the historical development of this revolutionary thought. You have learned that evolution pertains to the change in the allele frequencies of a population over generation and that the population is the smallest level of organization where evolution can happen.

One of the key elements needed for evolution to occur in a population is **genetic and phenotypic variation** – or simply defined as variations in the genetic composition or traits of individuals in a population; respectively. In this lesson, you will be introduced to the different sources of genetic variation.

### **CONCEPT**

**Genetic variation** pertains to the differences among individuals in the composition of their genes or other DNA sequence. Genetic variation is often reflected by **phenotypic variation**, or differences among individuals in terms of their traits or characteristics. Key term is *often* since a large phenotypic variation *does not* necessarily imply a large genotypic variation since the phenotype (trait) of an individual is a result both of genotypic variation and its *environment*.

Please refer to the link below to learn more about genotypic and phenotypic variation. Please focus on the video and not on the comment section in the website.



<https://www.youtube.com/watch?v=jUHokSPkzT8>

There are many possible sources of genetic variation. In this lesson, we will tackle four sources of genetic variation which include **mutation, alteration of gene number or position, rapid reproduction, and sexual reproduction**.

# MUTATION

defined as the change in the genetic sequence of an individual, is the raw material for evolution.

- ❖ Mutations are often random, and we do not know which part of an organism's DNA will be altered. Mutation in body cells does not contribute to evolution since these mutations are eliminated when an organism dies. Only mutations which happen in sex cells or gametes contribute to evolution since these mutations are being passed on from parents to offspring or from one generation to the next.
- ❖ A result of mutation in humans is the sickle cell disease, where the red blood cells become abnormally shaped like a sickle or a crescent moon. The mutation occurred only in a single nucleotide base in the DNA but had a great effect to the phenotype of an individual as shown in the figure below. Sickle cells may form clumps and clogs in narrow blood vessels which may be detrimental to the human bearing this disease. A human needs two copies of the sickle cell gene in order to possess this disease. If a human only possess one copy of this gene, that person will not possess a sickle cell disease. Further studies show that having only one copy of the sickle cell gene actually conferred an evolutionary advantage among African people, since this single copy of sickle cell gene "reduces the frequency and severity of malaria attacks, especially among children" (Campbell, 2015). Mutation, in this sense, can be detrimental or advantageous depending on the genetic make-up of the bearers of this mutation.

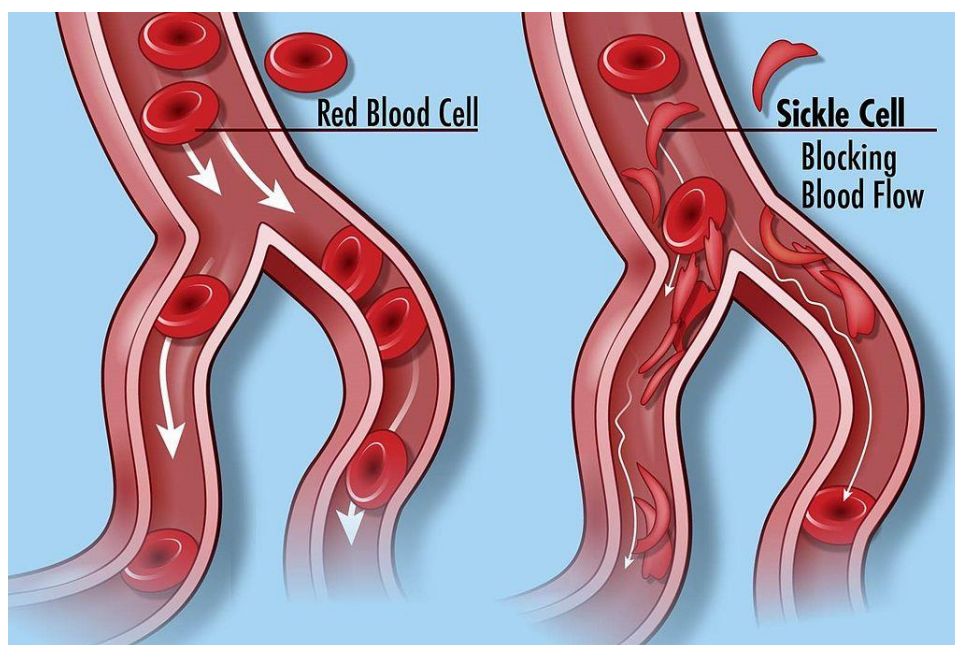


Figure 2. Sickle cell disease and its effects. Reprinted from Bethesda, MD, USA - Sickle Cell Disease, In Wikipedia, n.d., Retrieved August 15, 2020, from <https://commons.wikimedia.org/w/index.php?curid=52360077>  
Reprinted with permission: CC BY 2.0.

## **A** LTERATION

**OF GENE NUMBER OR POSITION** often results from errors in cell division, and mistakes when DNA is replicated.

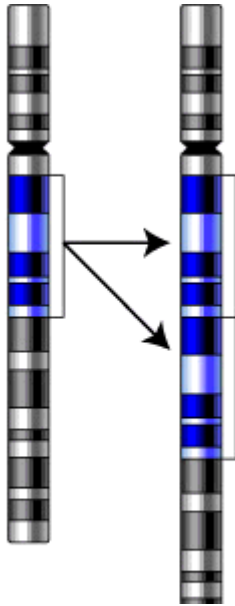


Figure 3. Gene Duplication. Reprinted from Gene Duplication, In Wikipedia, n.d., Retrieved August 15, 2020, from <https://commons.wikimedia.org/wiki/File:Gene-duplication-notext.png>, Reprinted with permission.

- ❖ Large scale gene duplication often has a harmful effect, but small duplication of smaller strands of DNA often has a neutral effect on an organism and may be carried over from one generation to the next. These small duplications may accumulate through generations and will result to an expanded genetic sequence which may give rise to new traits or phenotypes.
- ❖ One case of gene duplication in mammals resulted to multiple genes for detecting odors. According to studies, the ancestor of mammals has only one gene for detecting odors. This gene was duplicated more than a thousand times. This resulted to multiple genes for detecting odors among mammals, which played an evolutionary advantage especially for hunting preys, and attracting mates through pheromones. For instance, mice have around 1,300 genes for odor perception while humans have approximately 1000 genes for this purpose. Duplication of genes also resulted to different variants of agricultural crops such as wheat and corn.

## **R** APID

**REPRODUCTION**, especially in prokaryotes, often increases the probability of mutation in the population.

- ❖ Prokaryotes have short generation span which means that it takes only a short period of time for every individual in the population to reproduce. Mutation can easily accumulate in a population with shorter generation span.
- ❖ An example of organisms with short generation span are the viruses. For instance, HIV or Human Immunodeficiency Virus has a generation span of two days and has RNA as their genetic material. These two characteristics of HIV increase the probability of mutation to occur in the members of their population making it hard to develop a single-drug treatment which will eradicate their population as mutant forms often develop antibiotic resistance and can proliferate in a shorter period of time.

## SEXUAL

**REPRODUCTION** induces variation in populations undergoing this

type of reproduction since genes of the parents are being shuffled and being distributed at random to produce the genetic composition of every individual.

- ❖ Events which occur in the lifetime of a sexually reproducing organism contribute to the shuffling of genes which rearranges the genetic composition of every individual in each generation. For instance, a human gets one set of chromosomes from the mother and one set from the father. The combination of these genes will form variation among the resulting offspring. This rearrangement results to genetic variation, which will make evolution possible to occur.
- ❖ Sexual reproduction in Viennese banded snails resulted to different patterns in their shells as shown in the figure below.



*Figure 4. Variation of Shells in Viennese Banded Snails.*

Retrieved August 15, 2020, from <https://commons.wikimedia.org/w/index.php?curid=34155167>

Reprinted with permission: CC BY-SA 3.0 by H. Zell.

Now that you have learned the different possible sources of genetic variation among the population, in the next lesson, we will be discussing the three possible mechanisms for evolutionary change to occur.

Please refer to the link below to learn more about the sources of genetic variation. Please focus on the content of the video and not on the comment section of the said website.



<https://www.youtube.com/watch?v=VjIE5Qz1IS0>  
<https://www.youtube.com/watch?v=bLP8udGGfH>

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





Plants vs. Zombies 2 is one of the most popular games which has graced the mobile application world in the past years. In this game, diverse plant forms are being used to fight off zombies and to prevent them from reaching the house of the player. In this game's latest installment, the player can wander around different "worlds" or "timelines" – each with their own breed of plants as well as zombies.

You will be graded using the rubrics below.

## RUBRICS

### TOTAL NUMBER OF POINTS: 5 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.
Application of Concepts Learned	3	2	1
	<b>All</b> 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.	<b>Most</b> of the explanations are accurately anchored to the concepts presented in the lesson. There is <b>at most one part</b> of the explanation which is inaccurate and not founded on the scientific principles learned.	<b>Some</b> of the explanations are accurately anchored to the concepts presented in the lesson. There are <b>more than one part</b> of the explanation which is inaccurate and not founded on the scientific principles learned.
Grammar	1	0.5	0.25
	There are <b>at most three</b> grammatical errors in the output.	There are <b>four to six</b> grammatical errors in the output.	There are <b>at least seven</b> grammatical errors in the output.

*Take a picture or scan the activity sheet provided and submit your output through your Moodle classroom on or before the deadline set by your teacher.*



## **KNOT**

In summary, genetic variation - the differences in the genetic composition of every organism in a population - is a key prerequisite for evolution to occur. Mutation is one of the mechanisms which induces genetic variation to a population, and is known to be the raw material for evolution. Other sources of genetic variation include gene duplication, rapid reproduction, and sexual reproduction.



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