



## Triggering Factors for Organism' Evolution

Do Sepachai<sup>1</sup>, Yuuyen Pathompul<sup>1</sup>

<sup>1</sup>Faculty of Science, Chulalongkorn University, Thailand

\*Corresponding Author: Do Sepachai



### Article Info

#### Article history:

Received 16 November 2021

Received in revised form 16

December 2021

Accepted 19 December 2021

#### Keywords:

Organism' Evolution

Adaptation Physiology

Triggering Factor

### Abstract

*The purpose of the article is to know the triggering factor for organism' Evolution. Evolution is defined as the change in the heritable features of a population of organisms from one generation to the next, or from one generation to the next. Evolution, according to the contemporary conception, is characterized by changes in the attributes of living organisms through time, with these changes being guided by the process of natural selection.*

## Introduction

An organism's heritable features vary from generation to generation as a result of evolution. There are three key mechanisms at work here: variation, reproduction, and selection, which all contribute to these changes. Only a population is capable of experiencing evolution. Since spermatozoa and egg cells mated, the genetic makeup of a person was established. Most of the changes that have occurred throughout his life have been a result of genetic alterations. Both the genetic mix and the growth capacity of a population may vary over time. There are evolutionary changes in the genetic makeup of a population.

Evolution is a process that relies heavily on diversity. In nature, there are forces at work to keep a species' integrity intact, even if the process was well-known when it was first presented by Lamarck and Darwin. If it exists on its own, the two components seem to be at odds with each other

According to contemporary evolutionary theory, living organisms' traits vary through time and are influenced by natural selection. A population's evolution is influenced by the lifestyles of its members. The population, not the individual, is the one that has experienced evolution (Schoener, 2011). When a person's genes are expressed differently, he or she experiences a difference in development potential.

## Variability

An organism's heritable features vary from generation to generation as a result of evolution. There are three key mechanisms at work here: variation, reproduction, and selection, which all contribute to these changes. Only a population is capable of experiencing evolution. Since spermatozoa and egg cells mated, the genetic makeup of a person was established. Most of the changes that have occurred throughout his life have been a result of genetic alterations. Both the genetic mix and the growth capacity of a population may vary over time. There are evolutionary changes in the genetic makeup of a population.

According to contemporary evolutionary theory, living organisms' traits vary through time and are influenced by natural selection. A population's evolution is influenced by the lifestyles of its members. The population, not the individual, is the one that has experienced evolution. When a person's genes are expressed differently, he or she experiences a difference in

development potential. Potential for growth may be expressed in both the population's makeup and the way it is expressed. Evolution is a term used to describe this shift in genetic makeup.

There are two forces at play in nature, one that promotes variety and the other that protects a species' integrity.

Genetic variation as the basic ingredient of evolution

There are many people in a population, yet no two are the same. Whether or whether this change is true, it will be noticeable. It is possible for the makeup of a population to vary over time, if there is a selection for certain variations and a favorable selection for others in the population.

### **Phenotypic Variation**

Differential reproduction (selection) may occur due to phenotypic differences in the population. Genetic variations may not be the cause of all of this variance. Natural selection is able to identify differences in the time of development induced by external factors (Horton & Rowsemitt, 2019). Natural selection may alter a population's makeup in a short period of time by acting on a variety of variances, but variations reflecting genetic differences have a longer-term impact. Phenomenological variance, on the other hand, isn't an essential ingredient in the process of evolution.

Somatic mutations are a kind of genetic variation that is not effective as a raw material for evolution (Andrews, 2017). The ectoderm cells of immature embryos from an animal may have important alterations (Murry & Keller, 2008). This mutation will be passed on to future generations in this individual's growth and development period. Because it doesn't occur in sex cells, this mutation won't be handed on to future generations and will have an effect on the neurological system. Cells in the ectoderm do not form gametes. Somatic mutations, on the other hand, cannot lead to evolutionary change in sexually reproducing species due to selection (Schoen & Schultz, 2019).

### **Genotypic Variation**

In evolutionary biology, qualities of a population are more important than features of a single person. Variation is constantly the source of new alleles. Recombination is a method that enables an endless amount of genetic variety in a population after a variation of distinct alleles is generated (Huang et al., 2011). In organismal fertilization, meiosis and recombination result in a wide range of variations. The next recombination is crossing over, translocation, or a chromosomal abnormality.

You have to start with a very little structure, but it is really crucial in defining heredity in order to discover variety. DNA is the molecule responsible for all life on Earth. Adenine (A), cytosine (C), guanine (G), and thymine (T) are the four nucleic acids that make up DNA (T). Uracil is used to replace the last RNA acid (U). A total of 20 essential amino acids will be formed by the four types of nucleic acids. Amino acid triplet codons or genetic codes are formed when three of the four nucleic acids are combined.

### **Factors That Cause Diversity**

Factors that influence evolution as well as affect biodiversity. Adaptation and natural selection cause changes in an individual so that variations will increase and increase the diversity of living things from time to time.

## **Adaptation**

In order to thrive in a new environment, biological organisms must have the capacity or disposition to adapt. In this paper, the distinctions between animal and plant adaptations to their environment will be discussed, as well as the similarities between the two.

### **Morphological Adaptation**

An adaptation of the organs of the body to the demands of living things. When it comes to eating meat, certain animals' teeth are pointed and sharp for this purpose; however, the teeth of animals such as cows, goats, buffaloes, and sheep are not pointed and sharp since they are used mostly for cutting grass or leaves, as well as for chewing food and drinking milk.

### **Adaptation Physiology**

An adjustment that is influenced by the surrounding environment which causes adjustments to the body's organs to maintain life properly.

### **Behavioral Adaptation**

Variation is a term that refers to genetic events that result in distinct features among individuals or groups of animals (Voelkl et al., 2020). For example, almost everyone on the planet has the same DNA. According to possible genetic variance, there may be individuals with slanted vision or red hair; those with sharp noses or small height.

Evolutionists point to the diversity of a species as evidence of their theory's validity. The fact that there is a wide range of genetic variety does not necessarily mean that evolution has occurred, since variation is just the product of different combinations of pre-existing genetic information.

Within the boundaries of known genetic information, variations will always arise. When it comes to genetics, these borders are referred to as "gene pools". There are several ways in which a species' traits might be expressed in its genetic pool, as a result of variation. Genes for both short and long legs are stored in the same gene sack, thus mutation may lead to a variety of reptiles with long or short tails, for example.

However, the addition of wings or feathers, or a change in metabolism, does not transform reptiles into birds. Because living organisms lack the ability to transfer genetic information to themselves, such modifications are impossible in variety. Species evolve as a result of natural selection. Only those people who succeed and possess unique features and talents are able to live and thrive under natural selection. Consequently, it will create descendants that are distinct from those in the natural selection population. Changes in genetic and phenotypic diversity will occur as a result of this combination of adaptation and change.

### **Diversity Due to Evolution**

The Theory of Evolution is one of the most important concepts to learn about in biology. A broader evolutionary process took place at the beginning of the Earth's formation, which eventually led to the first cell (ancestor cell).

Multicellular species were born from this initial cell after a lengthy period of time in evolutionary history. Climate change and the movement of continents have a direct effect on the development of living beings. Eventually, numerous living species arose as a consequence of the evolution process. Golden epochs for reptiles, flowers, and mammals occurred at the close of the Mesozoic and beginning of the Cenozoic eras (Cenozoic).

However, even if there are many different kinds of organisms on the planet, there is still a universal quality that can be found in them all. DNA molecules are the building blocks of all living things, according to this equation. Despite the fact that the "letters" in DNA are written in the same language, the information contained in each "letter" might be different, resulting in the variety of living beings.

Genes, species, and ecosystems all contribute to an area's overall variety of living things. Variations in shape, appearance, and other features may be evident at different levels due to the wide variety of living organisms. The variety of living things encompasses factors such as morphological, anatomical, physiological, and behavioral traits of living things, which will eventually form a distinct ecosystem. There is a great deal of variation within a single species, as well as across species. Differences between species like shallots and garlic, whilst differences between rice kinds include Javanese, Cianjur and more.

There are an estimated 10 million to more than 100 million species of living creatures in the planet, according to estimates. One million species have been recognized thus far, but hundreds are found each year. Classifying living things into taxa based on similarities between species is done by professionals in order to make it simpler to research.

## Mutation

Normally, the sequence of any DNA molecule does not alter throughout replication. However, there are a variety of factors that might cause the DNA sequence to alter. This kind of transformation is referred to as a mutation. According to Widodo (2003), a mutation is a mistake in replication or repair that might result in the formation of a new sequence. a mutation is a change in the genetic material of a cell or a virus that occurs (Sanjuán & Domingo-Calap, 2016). In each cell, whether somatic or germline, mutations have the potential to arise. Mutations in somatic cells are not passed down through the generations. As a result, it is not taken into consideration in the context of evolution.

Mutations are a source of variety in the course of evolutionary development. There are four components of mutation to consider: the molecular process that causes mutations to occur, the impact of each kind of mutation on genetic material and its products, transitory properties or mutation space, and the randomness with which mutations occur (Pooraouiouby & Slusarenko, 2008).

## Type of Mutation

There are various types of mutations known to date. The following are the types of mutations based on certain basic classifications

### Point Mutation

Point mutations are mutations that occur in a single nucleotide (Henikoff & Comai, 2003).

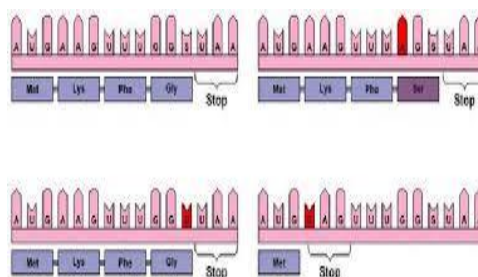


Figure 1. Point mutation(a) silent mutation(b) misrepresentation (c) meaningless mutation

## **Segmental Mutations**

This mutation occurs in a number of different nucleotides. Substitution is a form of mutation that occurs when one nucleotide is replaced with another nucleotide in a DNA molecule (Sanjuán et al., 2004). Substitution is a kind of mutation that is less likely to interfere with protein synthesis than other types of mutation. Substitution is the process of replacing one base with another. One amino acid is substituted for another as a consequence of a codon change of this kind. As long as the replacement amino acid is structurally and functionally comparable to the old amino acid, no harm will occur.

Transitions and transversions are the two types of substitution mutations that exist. Transitions are mutations that occur as a result of the replacement of purine bases with other purines or of pyrimidine bases with other pyrimidine bases. In other words, transitions are mutations that occur as a result of the replacement of purine bases with other purines or as a result of the replacement of pyrimidine bases with other pyrimidine bases.

Mutations that arise in protein coding may also be classified into various categories based on the consequences that they have on the protein. A synonymous mutation occurs when there is no change in the amino acid that has been designated. Nonsynonymous mutations may also occur when an amino acid is changed in the prescribed amino acid sequence.

Aside from that, nonsynonymous mutations are subdivided into two categories: missense mutations and nonsense mutations. A missense mutation changes the codon that is impacted into an amino acid codon that has been previously established. While nonsense mutations will convert a sense codon into a terminal codon, resulting in the termination of translation and the production of an incomplete protein, frameshift mutations will not.

## **Recombination**

Recombination is another method that may result in genetic diversity, in addition to mutation, in a population. Living creatures that are inherited from a parent may not always have the same genetic features as their parents since, in most cases, the offspring have experienced a change in genetic makeup as a result of this change. It is the process of transferring genetic components across separate DNA strands (interstrand) or between sections of a gene situated within one DNA strand that is known as Genetic Recombination. Genetic Recombination is also known as genetic intermixture (intrastrand).

Genetic recombination may be described as the insertion of genes from one or more cells into the genome of a target cell in a more straightforward manner. Recombinant cultures are cells that have had genes from outside or from other cells inserted or inserted genes from outside or from other cells. Genetic recombination has a variety of functions that vary depending on the technique used. Some of the roles of genetic recombination include the preservation of genetic distinctions, the formation of specialized DNA repair mechanisms, the control of the expression of certain genes, and the programming of genomic rearrangements throughout development. The three kinds of genetic recombination that are widely recognized are, in general, homologous/general recombination, site-specific recombination, and transposition/replicative recombination.

There are two forms of homologous recombination crossover (reciprocal recombination) and gene conversion: reciprocal recombination and gene conversion (nonreciprocal recombination). Mutual recombination occurs when homologous sequences are swapped across homologous chromosomes, creating a novel combination of neighboring sequences. Reciprocal recombination occurs when both forms of the same gene are participating in the

same recombination event at the same time. Non-reciprocal recombination, on the other hand, is the uneven replacement of one sequence by another in a chromosome. This is a process that leads in the deletion of one of the variant sequences that was engaged in this particular occurrence. According to current theories, both kinds of homologous recombination include the formation of an intermediary molecule known as a Holliday structure or junction. This structure has an effect on the production of paired mistakes in double-stranded DNA, which is referred to as heteroduplex formation in the scientific community. Cellular enzymes are capable of detecting and correcting pairing faults in heteroduplexes. The gap is then filled up by DNA polymerase, which uses the complementary chain as a template. For the likelihood of resolving a Holliday junction as well as the likelihood of disproportionate repair and removal of the heteroduplex.

Molecular crossing over and gene conversion are both accomplished by the recombination of homologous sequences. Site specific recombination, on the other hand, entails swapping one sequence, which is often extremely short (made of no more than a few nucleotides), with another sequence, which is frequently much longer (usually no sequence similarity to the original). The integration of the phage genome into the bacterial chromosome is accomplished by site specific recombination. If we look at it from the perspective of mutation, site specific recombination is a sort of insertion.

### **Delesi and Inertia**

There are a variety of methods via which deletions and insertions may occur. The first mechanism is referred to as uneven cross-over. Unequal crossing over between two chromosomes results in the deletion of a segment of DNA on one chromosome and the insertion of a segment of DNA on the other chromosome as a consequence of unequal crossing over. When a DNA segment is replicated in tandem, the likelihood of uneven crossing over occurs is considerably enhanced, and as a result, the likelihood of an incorrect sequence developing is raised. In the following process, deletion in the chain happens, which is a kind of site-specific recombination that occurs when a repetitive sequence is coupled with another sequence that has the same orientation on the same chromatid, resulting in an intrachromosomal crossover.

According to one study, in the bacteria *Escherichia coli*, spontaneous deletion of the *lac* gene is often connected with inter-chain recombination that occurs in a narrow region of similarity. The elimination of transposable elements is often accomplished by direct recombination along 5-9 base pairs, which are referred to as flanking elements. As with deletions in chains, deletions in tandems, such as simple repeating DNA (microsatellite) and satellite DNA, are responsible for the decrease in the number of tandems present.

Replication slippage, also known as slipped-strand mispairing, is the third mechanism. This sort of occurrence happens in DNA repeat regions that are close to one another. Slippage can occur during DNA replication as a result of mispairing between adjacent repeating regions, and the slippage can result in the deletion or duplication of DNA segments depending on whether the slippage occurs in the 5' to 3' direction or vice versa. Slippage can also occur during DNA replication as a result of mispairing between adjacent repeating regions. Mispairing of the strands of DNA that has not been duplicated may also occur. DNA transposition is the fourth mechanism that is responsible for the insertion and deletion of DNA sequences in the genome.

Due to the difficulty in distinguishing between an insertion and a deletion when two sequences are compared, insertions and deletions are generally referred to as indels. Indels is an acronym for either insertions or deletions, and it is used when two sequences are compared.

## **Consequences of Mutations for Organisms**

If we look at it from the perspective of human interests, artificial mutations may be carried out in order to develop mutants that are more helpful or more lucrative than the individual's prior circumstances, such as in the process of producing better seeds of a plant. It will aid in the advancement of genetic engineering in the field of biotechnology.

X-rays have been demonstrated to be effective in increasing the frequency of mutants in a variety of investigations. Additional mutations may be caused by high-energy particles such as the alpha, beta, and neutron radiation. The use of radioactive materials by humans for diagnostic purposes, treatment, disease detection, sterilization, and food preservation is likewise mutagenic, as is the exposure to radioactive elements.

Artificial mutations aren't necessarily a terrible thing, though. There are a plethora of benefits that radioactive elements may provide to human wellbeing. Especially important is the development of novel plant breeds. Changing manmade mutations in crops like wheat, beans, and tomatoes may really increase the quality of the crop as well as its resistance to a particular pest.

Polyploidy mutant plants were created with the use of digitonin and colchicine to induce polyploidy. Colchicine may prevent the creation of the cleavage spindle, which prevents the pair of chromatids in the metaphase phase of the cell division process from separating and resulting in the production of polyploid people. Colchicine is used to treat a variety of medical conditions. Polyploid individuals are distinguished by the presence of enormous fruit, the absence of seeds, and high yields. The creation of a seedless watermelon is one example of this kind of occurrence. Another method of obtaining polyploidy plants is by the application of high heat to maize and the decapitation of tomato plants. Decapitation is the process of removing plant branches from their roots. New shoots that are  $4n$  (tetraploid) will arise as a consequence of cutting the tip of this shoot, which will have the ability to be propagated by generative reproduction.

The use of radiation mutations with gamma rays can result in superior seeds. For example, Pelita I and II rice can produce Atomita I and II types, where these superior seeds are more resistant to brown planthoppers and *Xanthomonas oryzae* bacteria, which can tolerate salt water, than the parent varieties.

Mutations have a variety of implications. Mutations in soma cells (vegetative cells) may result in cancer if they are not corrected. In the meanwhile, if it happens in generative cells, it has the potential to produce mutations. If the mutation occurs in the soma cells of the fetus, it may result in teratogens (birth abnormalities), and certain mutations can be deadly if they occur in the fetal brain (death). It is via mutations that cause mortality that a community attempts to preserve its genetic equilibrium. In the case that mutations continue unabated from generation to generation, eventually a new generation will develop with a nature distinct from that of its predecessors, resulting in the occurrence of evolutionary events.

### **Adverse Impact**

In humans, the presence of gene mutations is responsible for a wide range of illnesses, such as Turner Syndrome and Down Syndrome as well as albino and sickle cell anemia, among others. It is possible that the discovery of seedless fruit will make it more difficult for plants to produce their next generation. Insecticides that are not administered in the proper dosages might promote mutations in pests, resulting in the pest becoming resistant to the same kind of pesticide that was administered. A significant increase in the number of resistant pests will

occur, resulting in significant harm to farmed plants. Radiation exposure during the mutation process may result in the creation of cancer cells in the laboratory and the development of congenital abnormalities in the embryo in the womb.

The cause is deadly, which means that the mutation has the potential to cause death in the creature that is exposed to it. Because the organism's organs and metabolic processes would be disrupted, this mutation is considered destructive in nature. Mutations are responsible for a wide range of serious illnesses.

### **Beneficial Impact**

Watermelon, for example, is a seedless fruit. If we are going to grow watermelon, we must pay close attention to the process of production. In order to increase the selling value of a watermelon, it must be big and free of seeds. It is required to provide colchicine as a result of this. Colchicine is available for purchase at plant-based pharmacy shops. The directions for using colchicine on plants may be found on the label of the medication.

With the use of this mutation, it may be possible to create profitable business prospects by raising the yield of the plants that we sow, therefore boosting our revenue. Aglonema decorative plants, for example, are very popular in today's society and may be gained via the mutation event. Aglonema ornamental plants have a high economic value and can be obtained through the mutation event. The price of this plant may exceed tens of millions of rupiahs (about \$1 million). This has the potential to be a lucrative business opportunity. Colchicine is administered to plants in order to develop this new kind.

Mutations may boost agricultural productivity in a variety of crops, including wheat, tomatoes, polyploidy coconut, and other crops, among other crops. The output of antibiotics, such as Penicillium mutants, will be much higher as a result of this development. Mutation is a highly beneficial mechanism for the evolution of species and the variety of genetic variation. It is possible to investigate biological processes. It is possible to introduce variety. Creatures that have undergone mutations have traits that distinguish them from other organisms.

### **Conclusion**

Evolution is defined as the change in the heritable features of a population of organisms from one generation to the next, or from one generation to the next. A mixture of three key mechanisms, including variation, reproduction, and selection, is responsible for these shifts in composition. Evolution is not something that can be experienced by an individual; it can only be experienced by a group. Because of fertilization, which is the union of spermatozoa with egg cells, the genetic content of a person has been known from the beginning of time. The majority of the changes he experiences during his life are variations in the manifestation of the capacity for development encoded within his DNA. Both the genetic makeup and the growth capacity of a population may alter over time within a single population. Evolutionary changes in the genetic makeup of a population are a fact of life. The presence of diversity is a significant component in evolution. Despite the fact that the process was recognized at the time it was presented by Lamarck and Darwin, and that evolution would not have happened without variation (diversity), there are processes at play in nature that seek to protect the integrity of a species. If it exists separately, the two components seem to be at odds with each other, as opposed to the two forces operating in harmony. Evolution, according to the contemporary conception, is characterized by changes in the attributes of living organisms through time, with these changes being guided by the process of natural selection. Individual changes during the course of their life have an impact on a population that spans multiple generations. Individuals cannot be considered to have gone through evolution; rather, it is the population as a whole

that has gone through it. Individuals experience alterations in the expression of the growth potential encoded in the genes that they carry as a result of these mutations.

## References

- Andrews, J. H. (2017). Genetic Variation. In *Comparative Ecology of Microorganisms and Macroorganisms* (pp. 25-68). Springer, New York, NY.
- Henikoff, S., & Comai, L. (2003). Single-nucleotide mutations for plant functional genomics. *Annual Review of Plant Biology*, 54(1), 375-401.
- Horton, T. H., & Rowsemitt, C. N. (2019). 8. Natural Selection and Variation in Reproductive Physiology. In *Mammalian Energetics* (pp. 160-185). Cornell University Press.
- Huang, X., Paulo, M. J., Boer, M., Effgen, S., Keizer, P., Koornneef, M., & van Eeuwijk, F. A. (2011). Analysis of natural allelic variation in Arabidopsis using a multiparent recombinant inbred line population. *Proceedings of the National Academy of Sciences*, 108(11), 4488-4493.
- Murry, C. E., & Keller, G. (2008). Differentiation of embryonic stem cells to clinically relevant populations: lessons from embryonic development. *Cell*, 132(4), 661-680.
- Pooraiouby, R., & Slusarenko, A. (2008). *Physiological, genetic and molecular analysis of two Arabidopsis mutants with defects in normal development* (No. RWTH-CONV-112731). Fachgruppe Biologie.
- Sanjuán, R., & Domingo-Calap, P. (2016). Mechanisms of viral mutation. *Cellular and molecular life sciences*, 73(23), 4433-4448.
- Sanjuán, R., Moya, A., & Elena, S. F. (2004). The distribution of fitness effects caused by single-nucleotide substitutions in an RNA virus. *Proceedings of the National Academy of Sciences*, 101(22), 8396-8401.
- Schoen, D. J., & Schultz, S. T. (2019). Somatic mutation and evolution in plants. *Annual Review of Ecology, Evolution, and Systematics*, 50, 49-73.
- Schoener, T. W. (2011). The newest synthesis: understanding the interplay of evolutionary and ecological dynamics. *science*, 331(6016), 426-429.
- Voelkl, B., Altman, N. S., Forsman, A., Forstmeier, W., Gurevitch, J., Jaric, I., ... & Würbel, H. (2020). Reproducibility of animal research in light of biological variation. *Nature Reviews Neuroscience*, 21(7), 384-393