DEPARTMENT OF EDUCATION
SCHOOLS DIVISION OF NEGROS ORIENTAL
REGION VII
Kagawasan Ave., Daro, Dumaguete City, Negros Oriental

EVIDENCE OF EVOLUTION

for General Biology 2 Grade11
Quarter 3 /Week 5

SELF LEARNING KIT

FOREWORD

This Self Learning Kit is made to help learners to be prepared with the necessary idea in General Biology 2. This module is created to help the learners acquire the knowledge needed in understanding the following competencies a) explain evidences of evolution (e.g. biogeography, fossil record, DNA/ protein sequences, homology and embryology) and b) infer evolutionary relationships among organisms using the evidence of evolution. This learning kit will enhance the understanding of students about the early life forms and origin of life here on Earth.

The activities in this learning kit will strengthen the knowledge in the different skills in the said competency that can help to improve their everyday life and their skills.

OBJECTIVE:

The objectives of this self-learning kit are the following:

K. describe the evidence of evolution;

S. explain the evolutionary relationships among organisms; and

A. appreciate that evidences from paleontology, embryology, morphology, anatomy and molecular biology can be used to establish evolutionary relatedness.

LEARNING COMPETENCIES

- Explain evidences of evolution (e.g., biogeography, fossil record, DNA/ protein sequences, homology, and embryology) **STEM_BIO11/12-IIIc-g-12**
- Infer evolutionary relationships among organisms using the evidence of evolution (**STEM_BIO11/12-IIIc-g-13)**

I. WHAT HAPPENED

Do you ask yourself, how everything on Earth began? Let us first define the word EVOLUTION. It is the biological change process by which descendants come to differ from their ancestors. We will learn more about evolution in this learning kit. Enjoy!

https://tinyurl.com/yyhtav2m

PRE-TEST:

Directions: Identify the word represented by the pictures. Write your answers in your notebook.

1. 

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2. 

Source: https://images.app.goo.gl/bkb974X7ru78zNQf7

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3. 

Source: https://images.app.goo.gl/4VjCPZiSNAn1WF4t9

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II. WHAT I NEED TO KNOW

DISCUSSION

What is Life?

According to Dubeck et al., 2004 all living organisms share characteristics which biologically distinguish them from non- living things. The following are the characteristics:

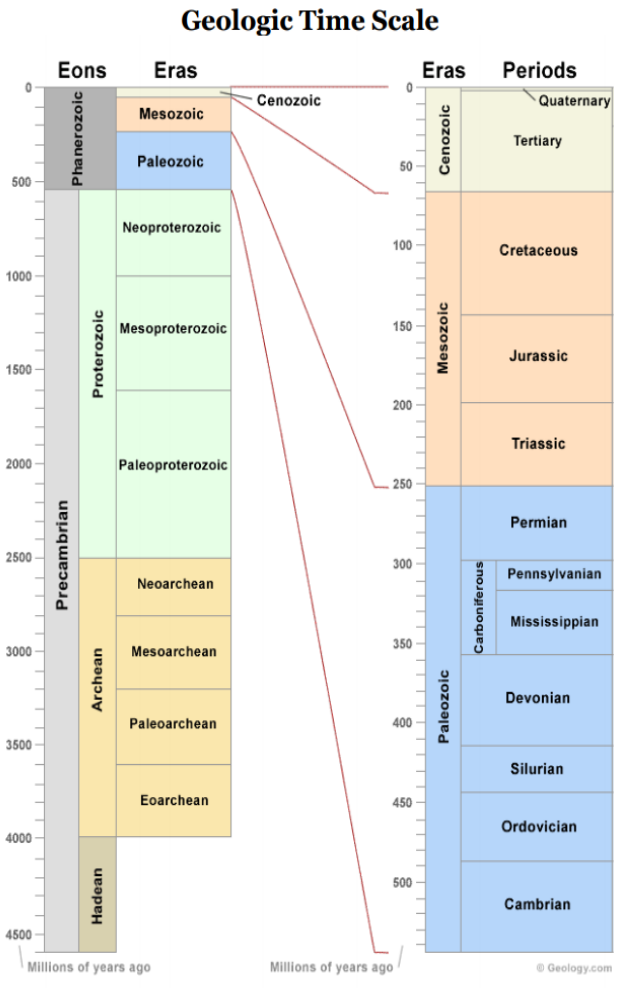
a. Cellular complexity- all living things are composed of either one or more cells
b. Growth and Development – organisms undergo different stages, which follow a systematic process from birth to maturity
c. Reproduction- to ensure continuity of life, organisms undergo reproduction that pass traits from one generation to next.
d. Irritability/ Ability to response to stimuli- all organisms are very sensitive to different stimuli. This response refers to any movement to stimuli in the organisms' own volition.
e. Homeostasis- The ability of the organism to maintain balance in different environmental condition.

Geologists have divided Earth's history into a series of time intervals. These time intervals are not equal in length like the hours in a day. Instead, the time intervals are variable in length. This is because geologic time is divided using significant events in the history of the Earth.

Two ways to relate time in geology:

Relative time ("chronostratic") -- subdivisions of the Earth's geology in a specific order based upon relative age relationships (most commonly, vertical/stratigraphic position). These subdivisions are given names, most of which can be recognized globally, usually on the basis of fossils.

Absolute time ("chronometric") - numerical ages in "millions of years" or some other measurement. These are most commonly obtained via radiometric dating methods performed on appropriate rock types.



Geological Time Scale copyright 2010 - geology.com

TWO TYPES OF EVIDENCE:

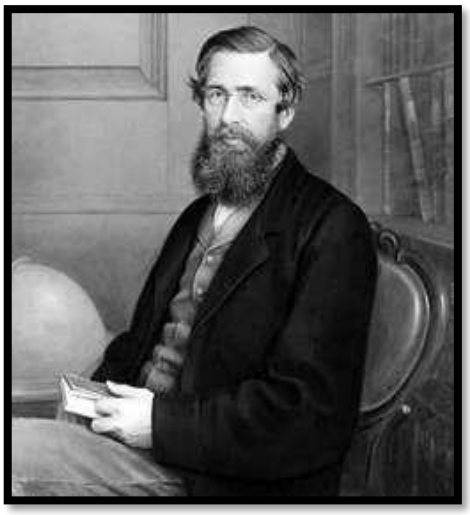
- DIRECT EVIDENCE -can be directly observed or seen
- INDIRECT EVIDENCE- does not involve actual observation of evolution but from which evolution may be inferred

EVIDENCE OF EVOLUTION

Biogeography is the study of the distribution of species on Earth in the past and present, and how the distribution is affected by abiotic factors such as habitat, climate and terrain. The field is divided into three disciplines of biogeography: historical, ecological and conservation.

Historical biogeography is also called paleobiogeography and studies species distribution now as it relates to distribution in the past. Ecological biogeography examines the distribution of species in relation to biotic and abiotic factors in the environment. Finally, conservation biogeography is a relatively new field of biogeography which combines the study of conservation with biogeography to try and anticipate future conditions so that planning can be done to protect the biodiversity on Earth.

The great diversification of the marsupials in Australia and the absence of other mammals reflects that island continent's long isolation. Australia has an abundance of endemic species—species found nowhere else—which is typical of islands whose isolation by expanses of water prevents migration of species to other regions. Over time, these species diverge evolutionarily into new species that look very different from their ancestors that may exist on the mainland. The marsupials of Australia, the finches on the Galápagos, and many species on the Hawaiian Islands are all found nowhere else but, on their island, yet display distant relationships to ancestral species on mainland.



Alfred Russel Wallace: The Father of Biogeography. He was born January 8, 1823 in Usk, Monmouthshire, Wales. Wallace started an expedition of his own in 1848 through the Amazon and South Asian region. Wallace spent eight years in the Malay Archipelago, from 1854 to 1862, traveling among the islands, collecting biological specimens for his own research and for sale, and writing scores of scientific articles on mostly zoological subjects. He devised what became known as the Wallace Line, the boundary separating Australian fauna from Asian fauna.

Source: https://www.britannica.com/biography/Alfred-Russel-Wallace

The **fossil record** helps paleontologists, archaeologists, and geologists place important events and species in the appropriate geologic era. It is based on the Law of Superposition which states that in undisturbed rock sequences the bottom layers are older than the top layers. Therefore, some discovered fossils can be dated according to the strata, a distinct layer of rock, that they are found in. Another common way that fossils are dated, is through radiocarbon dating. The development of this type of dating, in the 1950s, transformed paleontology and enhanced the accuracy of the fossil record. With every new fossil discovery, our understanding of the environment in a particular time becomes richer.

Fossils provide solid evidence that organisms from the past are not the same as those found today; fossils show a progression of evolution. Scientists determine the age of fossils and categorize them all over the world to determine when the organisms lived relative to each other. The resulting fossil record tells the story of the past, and shows the evolution of form over millions of years.

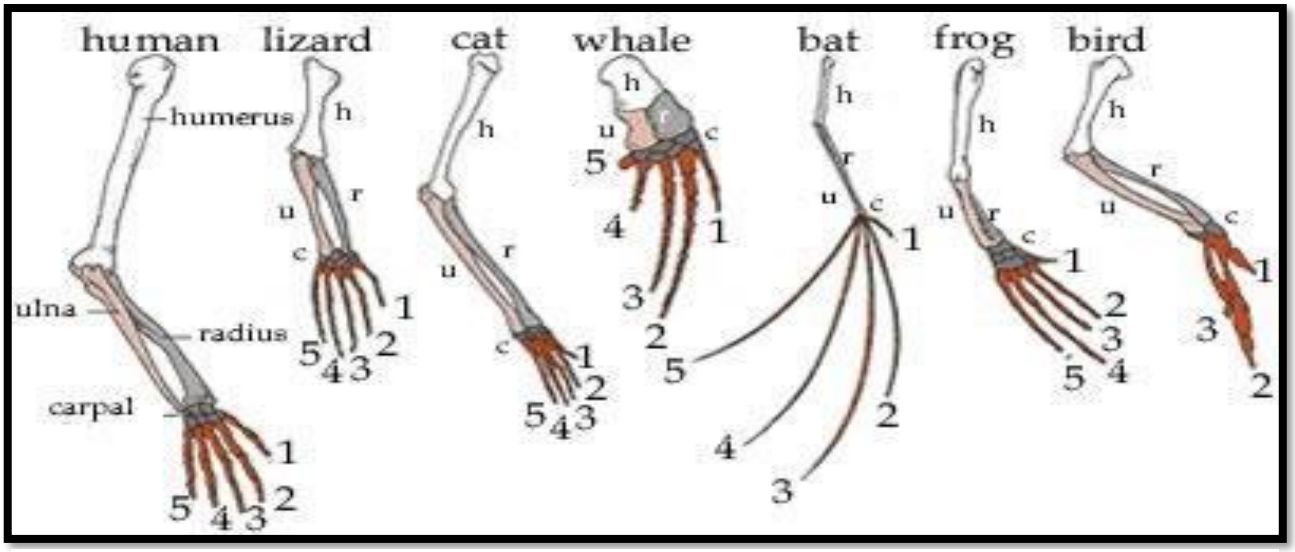
However, the information obtained from fossil is relatively incomplete for several reasons.

1. Only a small number of fossils are found;
2. Soft tissues are rarely preserved;
3. Most fossils have been destroyed by erosion, and or/ movement of the earth's crust may have caused some fossils to be buries deeply; and
4. Fossilization takes place only in places where conditions are favorable.

DNA and protein structure. All living cells have the same basic DNA structure and use the same genetic code. Proteins produced from genes all come from the same set of amino acids. Comparing sections of DNA in difference species has shown that even organisms that seem to be different, actually have large sections of identical DNA.

Organisms that seem fairly similar on the basis of comparative anatomy, show more genes in common than organisms that aren't much alike. For example, 96% of the genes in humans and chimpanzees are identical. That two species and their common ancestor have similar DNA is strong evidence supporting evolution. Protein amino acid sequences can also be used to compare similarities between species. Proteins are made from amino acids and the sequence of these amino acids is controlled by genes. Comparing how many of the amino acids are in the same positions on the protein chain can provide some idea of how closely related two species are. For example, humans and chimpanzees only have one position where they are different on the amino chain, while humans and moths have 31 different positions.

Homology. Homology is defined as similar biological structures or sequences in different taxa, thus implies divergent evolution. Homologous structures evolved from a common ancestor. Examples of homologous structures include the forelimbs of a variety of mammals. For example, human, cat, whale, and bat. These species show the same skeletal elements in the humerus, radius and ulna as share a common origin. Similarly, the forelimbs of ancestral vertebrates have evolved into the front flippers of whales, the wings of birds, the running forelegs of dogs, deer, and horses, the short forelegs of frogs and lizards, and the grasping hands of primates including humans. The same major forearm bones (humerus, radius, and ulna) are found in fossils of lobe-finned fish such as *Eusthenopteron.*

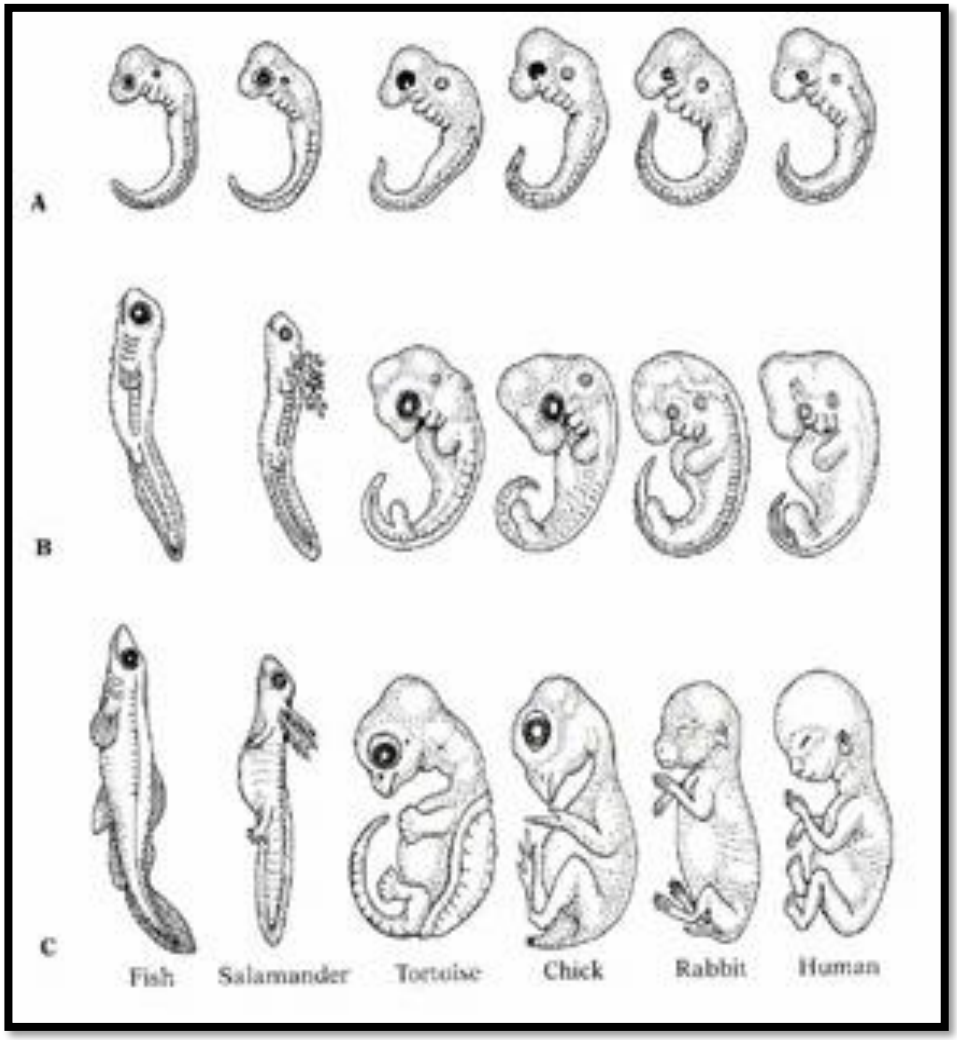


Source: https://images.app.goo.gl/h1e2yvtQSuuprsAz9

However, these skeletal elements have been modified over time to suit the different functions suitable for the type of mammal. Homologous structures result from divergent evolution.

Embryology. Embryology is the study of the development, structure, and function of embryos. When comparing vertebrate embryos in the early stages of development, you will see striking similarities. Even species that bear little resemblance in their adult form may have strikingly similar embryonic stages. For example, when looking at humans we see that the embryo passes through a stage in which it has gill structures like those of the fish from which all terrestrial animals evolved. For a large portion of its development the human embryo also has a tail, much like those of our close primate relatives. This tail is usually reabsorbed before birth. Gills could be considered homologous traits between humans and fish: in humans the parathyroid glands (endocrine glands in your neck) develop from the branchial arches. In fish, a gene called Gcm-2 controls the development of branchial arches into gills. If the gene mutates (or if scientists prevent it from working) then the gills fail to develop. The development of mammals, fish, reptiles,

and birds are linked to the branchial arteries. Biologists long ago proposed that fish evolved into amphibians, which evolved into reptiles, which evolved into birds. More recent studies of embryonic development support this idea.



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KEYPOINTS!

- Comparing sections of DNA in difference species has shown that even organisms that seem to be different actually have large sections of identical DNA
- The layers of fossils in sedimentary rock shows the progression of organisms through time.
- Distribution - isolation islands have unusually high proportions of unusual species.

CONTRIVANCES. Some characters that are passed on through generation will not be "perfectly" adapted based on evolutionary theory. Since natural selection occurs on the genetic variation that is presently available in a population, the

"best" alternatives cannot constantly be found. Most of the time, existing traits are modified (contrived) to serve a new function.

EVIDENCE FROM PHYSIOLOGY AND BIOCHEMISTRY

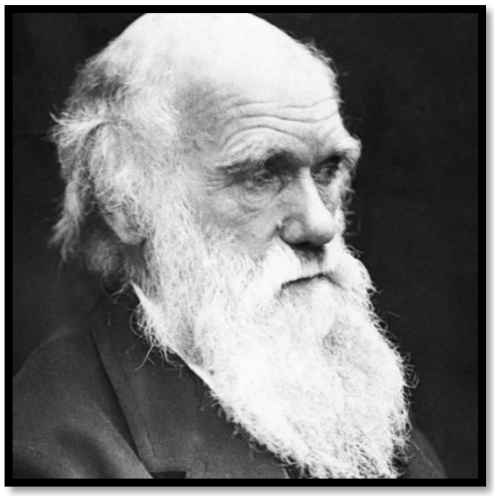
All living things evolved from a single common ancestor. There are certain key molecules and biochemical mechanisms shared by incredibly different organisms. For example, all organisms use DNA and/or RNA for their genetic code.

Photosynthesis, cellular respiration, transcription, and translation are all identical or very similar in various types of organisms. When we look closer, we can see that there are many biochemical molecules which are identical in nearly all life forms.

A classic example is cytochrome c, which is found in all life forms. Although the genetic coding of this molecule differs among species, it performs all the same functions everywhere. This highly conserved protein is a key component of the electron transport chain, which is a part of cellular respiration. Cytochrome c also has a function in many other reactions, including initiating programmed cell death.

Two somewhat related molecules are hemoglobin and myoglobin. Hemoglobin is a molecule used to transport oxygen, and myoglobin is used to store oxygen. Another very common molecule is trypsin, a protease involved in the absorption of protein during digestion.

All these molecules perform essential functions in cells, which is why it would make sense that most organisms have them. However, it would not make sense if each of these molecules appeared independently in each species. That would be impossible. These shared biochemical molecules and pathways provide strong evidence for common descent and evolution.



Charles Darwin was born in 1809 in Shrewsbury, England. His father, a doctor, had high hopes that his son would earn a medical degree at Edinburgh University in Scotland, where he enrolled at the age of sixteen. In 1859, Darwin published his thoughts about evolution and natural selection in *On the Origin of Species*. It was as popular as it was controversial. The book convinced many people that species change over time—a lot of time—suggesting that the planet was much older than what was commonly believed at the time: six thousand years.

https://images.app.goo.gl/yFenteWxiDWyTNJp7

Species distribution

All the places where species live is known as species distribution. When looking closely at distributions, it is clear that many unique species occur in isolated pockets or islands. When looking at these unique species through the lens of evolution, we would expect unusual species in isolated areas because isolation is necessary before speciation can occur. The theory of the movement of the Earth's tectonic plates was supported by the distribution of the fossils of a particular species. Moving continents also explains why Australia has most of the world's marsupials and the only two monotremes; the platypus and the echidna.

FOUR IMPORTANT MECHANISMS OF HOW SPECIES EVOLVED

- **Mutation** - Mutation is a source of new alleles in a population. Mutation is a change in the DNA sequence of the gene. A mutation can change one allele into another, but the net effect is a change in frequency. The change in frequency resulting from mutation is small, so its effect on evolution is small unless it interacts with one of the other factors, such as selection. A mutation may produce an allele that is selected against, selected for, or selectively neutral. Harmful mutations are removed from the population by selection and will generally only be found in very low frequencies equal to the mutation rate. Beneficial mutations will spread through the population through selection, although that initial spread is slow. Whether or not a mutation is beneficial or harmful is determined by whether it helps an organism survive to sexual maturity and reproduce. It should be noted that mutation is the ultimate source of genetic variation in all populations—new alleles, and, therefore, new genetic variations arise through mutation.

- **Gene Flow**- Another important evolutionary force is gene flow, or the flow of alleles in and out of a population resulting from the migration of individuals or gametes. While some populations are fairly stable, others experience more flux. Many plants, for example, send their seeds far and wide, by wind or in the guts of animals; these seeds may introduce alleles common in the source population to a new population in which they are rare.

- **Natural Selection** - Alleles are expressed in a phenotype. Depending on the environmental conditions, the phenotype confers an advantage or disadvantage to the individual with the phenotype relative to the other phenotypes in the population. If it is an advantage, then that individual will likely have more offspring than individuals with the other phenotypes, and this will mean that the allele behind the phenotype will have greater representation in the next generation. If conditions remain the same, those offspring, which are carrying the same allele, will also benefit. Over time, the allele will increase in frequency in the population.

- **Genetic Drift** - Another way a population's allele frequencies can change is genetic drift, which is simply the effect of chance. Genetic drift is most important in small populations. Drift would be completely absent in a population with infinite individuals, but, of course, no population is this large. Genetic drift occurs because the alleles in an offspring generation are a random sample of the alleles in the parent generation. Alleles may or may not make it into the next generation due to chance events including mortality of an individual, events affecting finding a mate, and even the events affecting which gametes end up in fertilizations. If one individual in a population of ten individuals happens to die before it leaves any offspring to the next generation, all of its genes—a tenth of the population's gene pool—will be suddenly lost. In a population of 100, that 1 individual represents only 1 percent of the overall gene pool; therefore, it has much less impact on the population's genetic structure and is unlikely to remove all copies of even a relatively rare allele.

REMEMBER!

There are four factors that can change the allele frequencies of a population. Natural selection works by selecting for alleles that confer beneficial traits or behaviors, while selecting against those for deleterious qualities. Mutations introduce new alleles into a population. Genetic drift stems from the chance occurrence that some individuals have more offspring than others and results in changes in allele frequencies that are random in direction. When individuals leave or join the population, allele frequencies can change as a result of gene flow.

ACTIVITY TIME:

ACTIVITY 1: IT'S CREATION TIME!

In a short bond paper, draw an imaginary organism that can survive both in the water and land. Make your creative instinct work!

RUBRICS

Organization ---------- 10 points
Content ---------- 10 points
Visual presentation ---5 points

_____

Total 25 points

ACTIVITY 2: "KNOW YOUR FAMILY TREE"

Can you describe your family members? What makes you similar to them and what makes you unique?"

In this activity, you list the characters or features that served as evidence that indeed you belong to the same family (e.g. texture and color of the hair, shape of the nose, blood type, etc.) List as many as you can think of. Write this in your notebook.

Example: brown colored eyes like those of my mother

III. WHAT I HAVE LEARNED

EVALUATION

PART I. DIRECTIONS: Choose the letter of the best answer. Write your answers in your notebook

1. It is a change in the DNA sequence of the gene.
   a. Gene b. Natural Selection c. Mutation d. Genetic Drift
2. _____ occurs because the alleles in an offspring generation are a random sample of the alleles in the parent generation.
   a. Gene b. Natural Selection c. Mutation d. Genetic Drift
3. _____ is the study of the development, structure, and function of embryos.
   a. Embryology b. Fossil Record c. DNA d. Homology
4. He is known as the father of biogeography.
   a. Charles Darwin b. Alfred Wallace c. Lamarck d. Gregor Mendel
5. Do you think genetic drift would happen more quickly on an island or on the mainland?
   a. Mainland b. Island c. Both d. None of the above

PART II. TRUE/ FALSE. Write T if the statement is correct, F if the statement is incorrect. Write your answers in your notebook.

1. All living cells have the same basic DNA structure and use the same genetic code.
2. Homologous structures result from divergent evolution.
3. Fossils provide solid evidence that organisms from the past are the same as those found today.
4. Absolute dating has to do with determining the temporal ordering of events in Earth's past.
5. Genetic drift is most important in small populations.

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SYNOPSIS

This self-learning kit is intended to aid the students in understanding the different evidence of evolution. This SLK will explain views from varied areas of biology that can provide information on the evolution of life.

ANSWERS KEY

Pre-Test

1. Evolution
2. Fossil
3. Life

Activity 1

Answers may vary

Activity 2

Answers may vary

Post- Test

PART I

1. C
2. D
3. A
4. B
5. B

PART II.

1. T
2. T
3. F
4. F
5. T

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