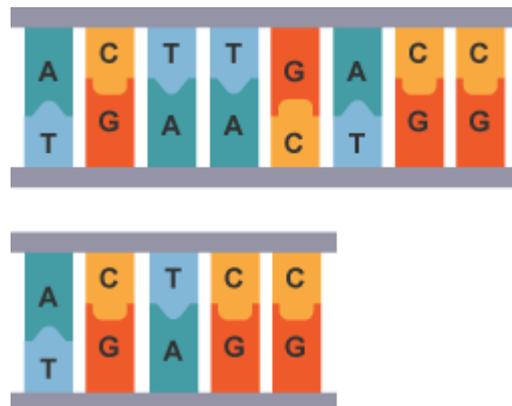


ADAPTATION, NATURAL SELECTION AND THE EVOLUTION OF SPECIES

Mutations can alter the genes of individuals in a beneficial or detrimental way and introduce variety into a species.

Mutations

A mutation is a random change to genetic material. In the mutation shown below, a section of DNA, three base pairs long, has been lost.

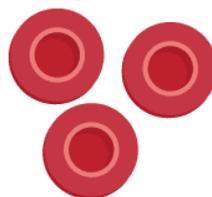


DNA contains genes that carry instructions for the manufacture of a protein. If a mutation occurs in a gene that results in a change to the sequence of DNA bases, then the structure of the protein that is made may also be altered. This could alter an individual's phenotype.

A mutation can be neutral and have no effect or can have an advantageous or disadvantageous effect on an individual that possesses it. Mutations are the only source of new alleles.

Mutation	Effect on individual's ability to survive and reproduce
Advantageous	Increased
Disadvantageous	Decreased
Neutral	No change

Some people carry a mutated version of the gene that codes for hemoglobin. The protein that is coded for by the mutant allele doesn't function correctly and can distort the shape of red blood cells.



Three circular red blood cells

If a person has two copies of the mutant allele in their body cells then they will have the genetic condition sickle cell anemia. The sickle shaped red blood cells can block blood vessels and have a much shorter life span than normal red blood cells.

Mutations happen spontaneously. The rate of mutation can be increased by environmental factors such as UV radiation, X-rays, gamma rays and certain types of chemicals such as bromine.



A red blood cell with a distorted 'sickle' shape

Evolution by natural selection

Evolution can be defined as the change in the frequency of a phenotype in a population over many generations.

Variation

Although members of a species have many features in common they are not identical to each other. Variation occurs as a result of mutations that create new alleles of genes.

Mutations can be inherited if they occur in DNA that is passed on to the next generation. In populations that produce offspring by sexual reproduction, variation also occurs as a result of individuals receiving different combinations of alleles from their parents.

Variation in a population allows a population to evolve over time, and this may occur as a result of changing environmental conditions.

Natural selection

Individuals produce more offspring than their environment can support, and some die because of factors such as predation, food shortage or disease. These factors are known as environmental selection and they determine which individuals will do best at surviving and reproducing.

Some individuals are better adapted to their environment than others as a result of characteristics they have inherited from their parents. The genes that produce these characteristics give them a selective. They may have a better ability to avoid predators, compete for food, or resist disease.

These individuals are therefore better able to survive and reproduce than less well-adapted individuals. They pass on the versions of genes that produce their adaptations. Predation, competition and disease are examples of selection pressures.

Example of natural selection in action

Industrial melanism in the peppered moth

In the peppered moth population of Great Britain there is variation in the color of the moth's bodies. Some moths have a light body; some have a dark, or melanic body. Body color is an inherited characteristic.



Three moths camouflaged against different background colors and textures

Before the industrial revolution, light moths had a selective advantage. Because they were well camouflaged against the lichen-covered trees, they were better able to avoid predation.

During the nineteenth century pollution killed off some of the lichens and soot deposits caused the tree bark to appear darker. Light colored moths were no longer camouflaged and were more likely to be eaten by birds. The dark moths were now better camouflaged.

As a result, dark moths had a greater chance of reproducing and passing on the alleles that made them dark. This led to a gradual increase in the proportion of dark moths until light moths became very rare in industrial areas. The moth populations in these areas had evolved.

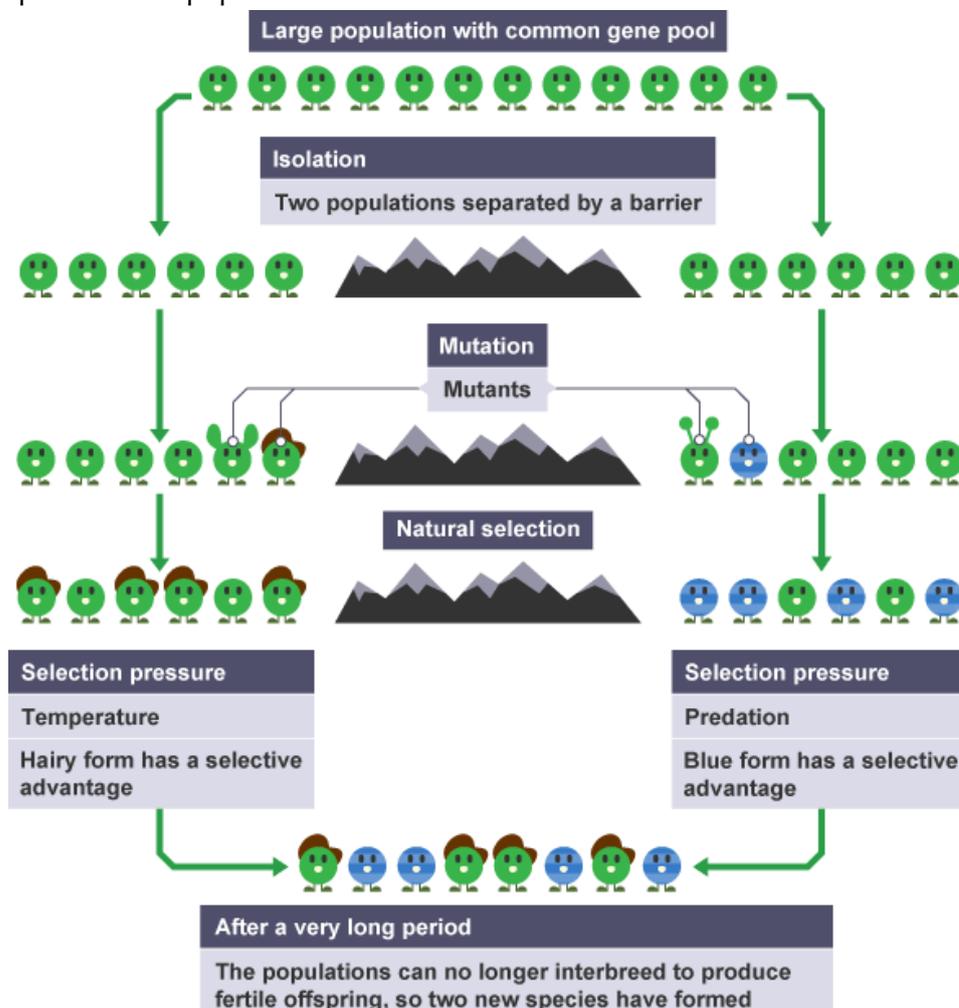
This change from predominantly light to dark forms in industrial areas is called industrial melanism.

Note that this change was not due to pollution making the moths darker. The dark variety had always existed in small numbers, but only had a selective advantage when the selection pressure changed.

Speciation

A species is a group of organisms able to interbreed and produce fertile offspring. Speciation is the formation of two or more species from the original one.

As long as the individuals in a population have the opportunity to interbreed and combine genes, they remain one species. A population of one species can only evolve into more than one species if groups within the population become isolated from each other.



The diagram illustrates what could happen to an animal population, which is separated into two isolated groups by a geographical feature. In addition to geographical separation, species can also be isolated by ecological or reproductive barriers.

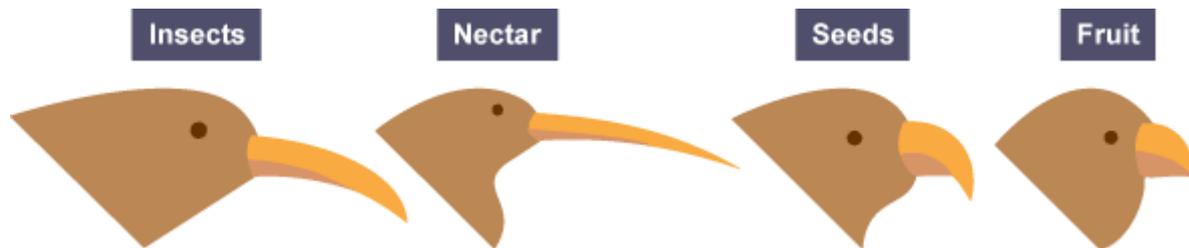
Different mutations will occur in the isolated groups (because mutations occur at random). If the environmental conditions differ in the two locations then the individuals in the two isolated groups will experience different selection pressures. Different phenotypes will be selected for in the two groups.

Over many generations the isolated groups will evolve to be different from each other. Eventually the groups may become so different that if they come together again they are no longer able to interbreed and produce fertile offspring and so are now separate species.

Speciation in honeycreepers

The islands of Hawaii were colonized by a single species of finch-like birds. Eventually populations were isolated from each other on separate islands.

The diagram shows how they evolved into the modern honeycreeper species with beak shapes which adapt them for different feeding methods.



Reading comprehension

Tick the right answer.

1. *What is a mutation?*
 - a. A change to an organism's appearance
 - b. A change to an organism's behavior
 - c. A change to an organism's genetic material
2. *How can you increase the rate of mutation?*
 - a. By natural selection
 - b. By radiation
 - c. By variation
3. *What can cause variation?*
 - a. Changes in the environment
 - b. Isolation
 - c. Mutation
4. *What can cause variation to be passed on to offspring?*
 - a. Less well-adapted individuals cannot reproduce
 - b. Most well-adapted individuals can reproduce
 - c. Reproduction involves passing on genes

5. *What are the only types of characteristics that can be passed on by inheritance?*
 - a. Those that make an organism more likely to survive and reproduce
 - b. Those that are present in all the organisms in a population
 - c. Those that are the result of the genes an organism possesses

6. *What is meant when an organism is described as having a 'selective advantage'?*
 - a. The organism can change to help it survive and reproduce in its environment
 - b. The organism has characteristics that help it to survive and reproduce in its environment
 - c. The organism is unable to survive and reproduce in its environment

7. *Which of the following is an example of evolution by natural selection?*
 - a. A giraffe increasing its neck length by stretching to reach the top of a tree
 - b. A human increasing the size of their muscles as a result of training
 - c. An increase in the number of drug resistant bacteria in a population

8. *What is the correct order for the events of speciation?*
 - a. Isolation → mutation → selection
 - b. mutation → isolation → selection
 - c. mutation → selection → isolation

9. *During speciation when do two groups of organisms become separate species?*
 - a. When they become isolated from each other
 - b. When they cannot interbreed to produce fertile offspring
 - c. When they look different

10. *Which of the following is an example of a selection pressure?*
 - a. Competition for food
 - b. Mutation
 - c. Variation

Vocabulary

Match the terms in A with their definitions in B

1. Adaptation	a. A feature of an organism's body which helps it to survive.	1. +...
2. Mutation	b. A favorable characteristic which gives an organism an increased chance of survival.	2. +...
3. Radiation	c. Used in the classification of living organisms, referring to related organisms capable of interbreeding.	3. +...
4. Selection pressure	d. A factor such as predation or disease that affect a population resulting in the death of some individuals and the survival of others.	4. +...
5. Selective advantage	e. A random and spontaneous change in the structure of a gene, chromosome or number of chromosomes.	5. +...
6. Speciation	f. Energy carried by particles from a radioactive substance, or spreading out from a source.	6. +...
7. Species	g. The formation of new and distinct species in the course of evolution.	7. +...

Writing

Transition words are used in a sentence to connect two ideas. They join clauses or sentences together to show a difference or a connection.

Example 1: We arrived late at the movie, so we didn't understand the ending.

In Example 1, the word **so** connects two clauses to show **a result**. It was because we were late that we didn't understand the ending. The meaning of the two clauses is clearer than if each stood alone.

Example 2: We arrived late at the movie. We didn't understand the ending.

In Example 2, the two ideas are separate. There is no connection with arriving late and not understanding the movie. Instead, it appears that not understanding the ending has nothing to do with arriving late.

Activities:

A. Use the words in the bank to connect the clauses below. You should only use a transition word or phrase once.

Word Bank

in addition
otherwise
although
therefore
in fact
furthermore
similarly
consequently
actually
so
however
nevertheless
yet
instead
moreover
particularly

1. The girls wanted an ice cream cone, _____ they left the park early.
2. Mother didn't have time to go to the store; _____, there was no milk in the refrigerator.
3. There is no homework tonight; _____, there has been no homework this week.
4. James and his team didn't finish the project; _____, they did work hard.
5. You can come with us if you are ready; _____, you will have to ride the bus.
6. It is important to complete your homework; _____, it should be turned in on time.
7. Mrs. Simpson can be grumpy some times; _____, we should help her whenever we can.
8. Students should be quiet during the play; _____, applause at the end is allowed.
9. The Johnson children get an allowance every week; _____, they earn money for completing chores.
10. The rhino in Africa is threatened with extinction; _____, many species of gorilla are also endangered.

B. Below are sentences with misused transition words. Cross out the incorrect transition words and write a better one in the space below the sentence.

1. Tim earned an A on the test; **even so**, Justin also received an A.

2. The book was interesting; **as a result**, it was hard to read.

3. Gordon finished his chores early; **meanwhile**, he had time to play football.

4. Sarah's horse is beautiful; **instead**, it is well-bred.

5. The sailors prepared the ship to sail; **otherwise**, the dock workers loaded the cargo.

6. Her sister had a cold; **however**, Julie's family canceled the trip.

7. Oranges are good for you; **nevertheless**, they are full of vitamin C.

8. Two seats were left on the bus; **similarly**, most of the group had to wait for the next one.

C. Read each sentence below and choose the correct transition word.

1. _____ I met my former boyfriend, I never really understood the meaning of the word unreliable.

transition word	Where	Before	First of all
The transition indicates:	time	contrast	addition

2. One reason people have dogs is for companionship; _____ is for protection.

transition word	once	frequently	another
The transition indicates:	illustration	addition	conclusion

3. _____ Angry Birds is a new game; it has quickly become very popular.

transition word	Although	When	In the same way
The transition indicates:	time	cause and effect	contrast

4. There's no room in your mouth for your wisdom teeth, _____ they will have to be removed.

transition word	for example	so	but
The transition indicates:	cause and effect	contrast	illustration

5. Once the referee's back was turned, the manager of "The Demented Shadow" placed a foreign object _____ his boxer's glove.

Transition word	such as	just like	inside
The transition indicates:	comparison	location	cause and effect

6. Turtles stay in their shells when they are frightened. _____ dogs put their tails between their legs in frightening situations.

transition word	After	Similarly	Therefore
The transition indicates:	cause and effect	time	comparison

D. Answer the following questions and underline the transition words that helped you make your decision.

1. If you can't get rid of a cold, the flu, or a nagging sore throat, the reason may be your toothbrush. 2. Studies at the University of Oklahoma Dental School have shown that your old toothbrush may carry the germs that are causing your illness. 3. The studies have found that people who change their toothbrushes about every two weeks recover from common winter ills faster than people who use their toothbrushes for a month or more. 4. Old toothbrushes can culture the germs that can cause colds, influenza, pneumonia, strep throat, diarrhea, and sinus disease. 5. Another study found that disease germs can live in an unused toothbrush for as long as a week. 6. They can start to thrive again every time you brush your teeth.

- 1) The relationship between the two parts of sentence 1 is one of
- a. time.
 - b. addition.
 - c. cause and effect.
 - d. contrast.

- 2) The relationship of sentence 5 to the previous sentence is one of
- a. addition.
 - b. comparison.
 - c. time.
 - d. contrast.

1. Vietnamese and American cultures are sharply different. 2. In Vietnam, two men or two women often show affection in public, but open affection between the sexes is not considered acceptable. 3. Also, Vietnamese are often surprised by American family relations. 4. Americans may live far from their parents and grandparents. 5. Even if they're in the same city, they rarely live in the same house. 6. However, three or four generations generally live together in one Vietnamese household, with elderly people cared for by their children and grandchildren.

- 1) The relationship between the two parts of sentence 3 is one of
- a. time.
 - b. addition.
 - c. contrast.
 - d. cause and effect.

- 2) The relationship of sentence 6 to sentence 5 is one of
- a. contrast.
 - b. addition
 - c. cause and effect
 - d. comparison