a place of mind

FACULTY OF EDUCATION

Department of
Curriculum and Pedagogy

Biology
Evolution:
Mutation I

Science and Mathematics Education Research Group

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Mutation

Retrieved from http://photosbybobby.blogspot.ca

Question I

Mutation is one of the four forces of evolutionary change: mutation, genetic drift, gene flow, and natural selection. Mutation is mainly involved with DNA changes. Which of the following is not a type of DNA mutation?

A. Substitution
B. Insertion
C. Deletion
D. Frameshift
E. Random mating

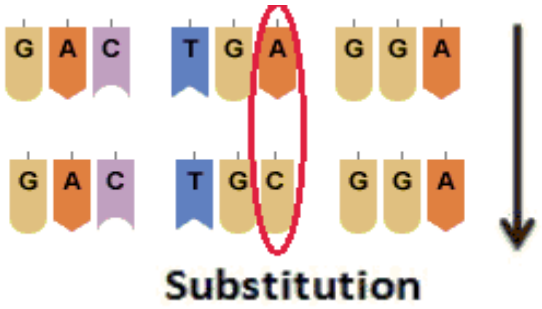
Solution I

Answer: E

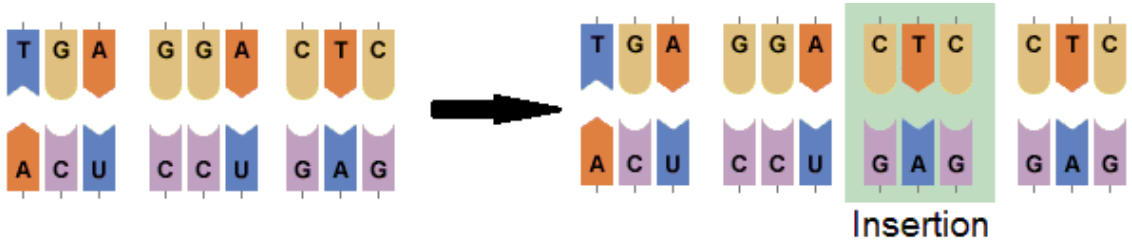
Justification:

There are 4 types of mutation that can change DNA structure. The types are substitution, insertion, deletion, and frameshift.

A substitution is a type of mutation that can exchange a single base nucleotide for another nucleotide of the genetic material (DNA or RNA).

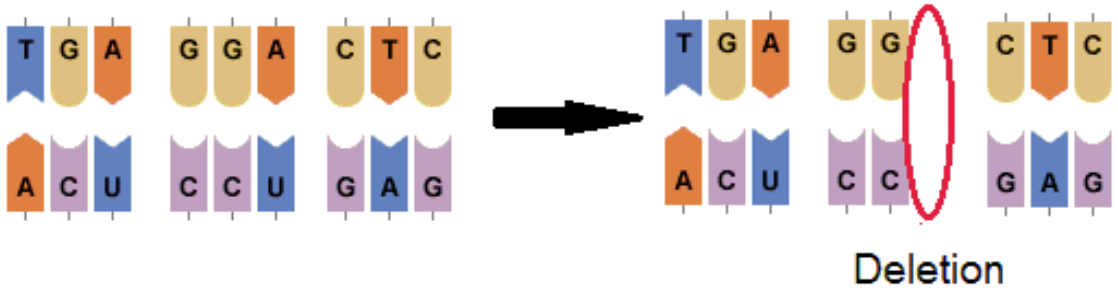


An insertion is the addition of extra nucleotide base pairs into a DNA sequence.

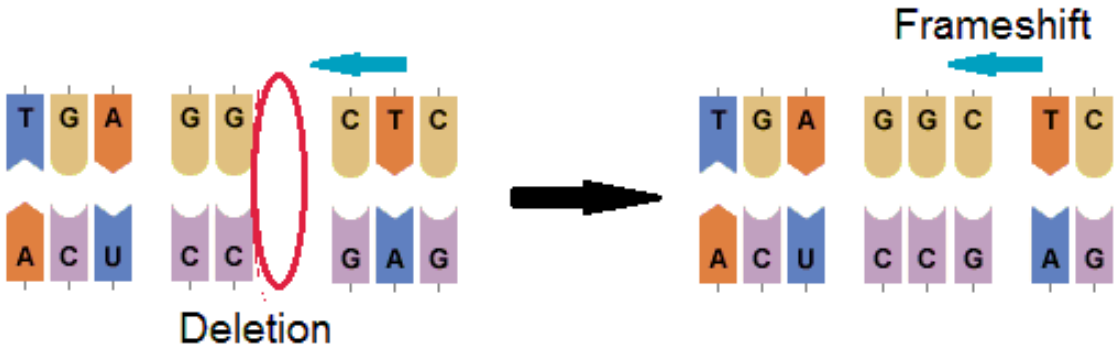


Solution I continued

A deletion is a mutation in which a section of DNA is lost, or deleted during DNA replication.



Frameshift is a genetic mutation initiated by a deletion or insertion which then causes a shift in the DNA sequence to make different groups of three nucleotides.



Solution I continued

Random mating is a population mating system in which each individual, regardless of their phenotype, has an equal chance of mating with the opposite sex and the choice of mating is not affected by any other forces.

Question II

Which of the following could be a complementary strand to the section of DNA – TATGATGGC, if a single substitution mutation occurs?

A. ATACTACCC
B. ATACTACCG
C. AUACUACCG
D. AUACUGCCG
E. ATACCAGGC

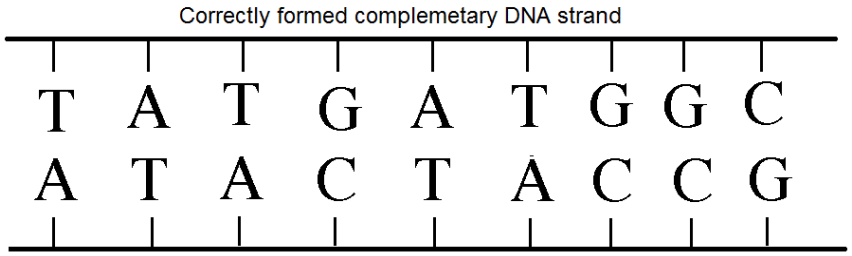
Retrieved from https://startanevolution.ubc.ca

Solution II

Answer: A

Justification:

The correctly formed complementary DNA strand to the part of DNA – TATGATGGC is ATACTACCG, therefore B is NOT the correct answer.



If we make one substitution to this complementary DNA strand we can get the strand ATACTACCC, therefore A is the correct answer.

ATACCAGGC (answer E) is also a complementary DNA strand, but contains 4 substitutions. In addition, both AUACUACCG and AUACUGCCG are RNA strands because they contain U instead of T (answers C and D).

Question III

Each human cell contains total 46 chromosomes. Consider the situation in which a chromosome is accidently broken into several pieces and rejoined without one of the pieces. What type of mutation occured in this chromosome?

A. Duplication
B. Deletion
C. Inversion
D. Translocation
E. Substitution

Retrieved from http://hms.harvard.edu

Solution III

Answer: B

Justification:

The mutation which occurs during the removal of chromosomal DNA is called a deletion of genes.

An inversion happens when a section of a chromosome rotates, but the genes are still present.

A translocation occurs when a section of chromosome breaks and relocates itself to a different chromosome.

A substitution happens when a part of a chromosome rotates, and another section of the chromosome is inserted into that place.

A duplication happens when a part of a chromosome regenerates itself during molecular evolution.

Question IV

Mutations can be caused by various reasons. Which of the following could be responsible for mutation in human DNA?

A. Radiation in the form of x-rays and γ-rays
B. Viruses causing mutation of cells
C. Naturally-occurring changes in the DNA sequence
D. A, B, and C are all correct
E. None of the above

Solution IV

Answer: D

Justification:

DNA mutation can be caused by various factors.

However, the most common factors that cause mutation in human DNA are radiation, viruses (mutagens), and naturally-occurring changes in the DNA sequence.

In fact most of the mutations that cause the ‘change’ in DNA are “naturally-occurring”. For example, if DNA fails to copy accurately, then the newly-created DNA sequence is a mutation.

Likewise, if a cell fails to repair the damaged DNA (if the DNA is damaged by chemicals, viruses, or radiation), the slightly different DNA could possibly result in a mutation.

Question V

What type of mutation happens when a portion of one chromosome is transferred to another chromosome?

A. Duplication
B. Deletion
C. Inversion
D. Translocation
E. Substitution

Retrieved from http://www.scq.ubc.ca

Solution V

Answer: D

Justification:

A mutation which results in the transfer and relocation of parts of chromosomes is called a translocation of genes.

An inversion happens when a section of a chromosome rotates, but the genes are still present.

A deletion occurs when a section of chromosome is lost or deleted.

A substitution happens when a part of a chromosome rotates, and another section of the chromosome is inserted into that place.

A duplication happens when a part of a chromosome regenerates itself during molecular evolution.

Question VI

Look at the following sequence: THE BOY ATE THE GUM. Delete the first E and re-group the letters in groups of three. If we consider this sequence as one made up of nucleotides, which type of mutation occurred?

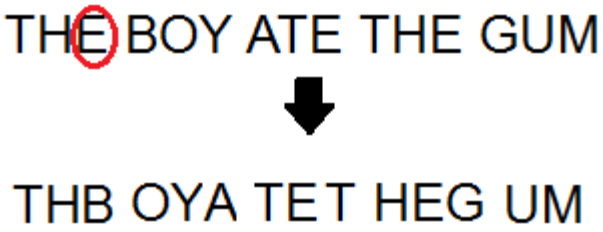
A. Substitution
B. Insertion
C. Deletion
D. Frameshift
E. Translocation

Solution VI

Answer: D

Justification:

A frameshift happened in this sequence.



Frameshift is a genetic mutation initiated by a deletion or insertion which then causes a shift in the DNA sequence to make different groups of three nucleotides.

In this sequence, the letter (or nucleotide) ‘E’ was deleted and the next letter shifted to make a group of three letters.