

# What Is Mutation and Genetic Variation?

## Worksheet

A mutation is a random, heritable change in a DNA sequence; when mutations create new alleles, they increase genetic variation within a population.

## Questions

1. What best defines a mutation?

- A) A change in an organism's behavior
- B) A permanent change in a DNA sequence
- C) The mixing of alleles during reproduction
- D) The movement of individuals between populations

2. Which type of cell must a mutation occur in to be passed to offspring?

- A) Skin cells
- B) Muscle cells
- C) Germline (egg/sperm) cells
- D) Liver cells

3. A mutation that has no effect on the organism's phenotype is called

- A) A lethal mutation
- B) A silent mutation
- C) A frameshift mutation
- D) A chromosomal mutation

4. Why is mutation called the 'ultimate source' of genetic variation?

- A) It's the fastest way to change a population
- B) It's the only process affecting DNA
- C) All new alleles originate from mutation
- D) It always improves fitness

5. A human genome has about 3.2 billion base pairs. If the mutation rate is roughly 1 in  $10^8$  base pairs per generation, estimate the number of new mutations per generation.

6. In a population of 500 individuals, a beneficial mutation arises in 1 individual. What is the initial allele frequency (assuming diploid, one new allele copy)?

7. A point mutation changes a single DNA base from A to G in a gene. Does this always change the protein produced?

8. Define: What is a mutation?

9. Define: What is genetic variation?

10. Define: Are all mutations harmful?

## Answer Key

1. B) A permanent change in a DNA sequence - A mutation is a change at the DNA level, distinct from recombination or migration.
2. C) Germline (egg/sperm) cells - Only germline mutations are inherited by offspring; somatic mutations are not.
3. B) A silent mutation - Silent mutations don't change the resulting protein or trait.
4. C) All new alleles originate from mutation - Recombination reshuffles existing alleles, but mutation is what originally creates new ones.
5. New mutations = genome size mutation rate =  $3.2 \cdot 10^9 (1/10^8)$  32 new mutations per generation (order-of-magnitude estimate)
6. Total allele copies = 2 500 = 1000 New allele frequency =  $1/1000 = 0.001$  (0.1%)
7. The genetic code is degenerate - several codons can code the same amino acid If the mutation falls in the third codon position it may be 'silent' and not change the amino acid If it does change the amino acid, the protein's structure and function may change Conclusion: not every mutation alters the protein - silent mutations are common
8. A permanent, heritable change in an organism's DNA sequence.
9. The differences in DNA sequences among individuals in a population.
10. No - mutations can be harmful, neutral, or beneficial depending on their effect.

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