b. Did this change in the DNA sequence cause any significant change to the protein produced? Explain.

Now transcribe this new DNA strand into mRNA and then translate it into its amino acid sequence.

a. Let's simulate a point mutation at the 24th base. It was accidentally changed during replication from a G to an A.

6. POINT MUTATION: One mutation is called a point mutation where only one base in the DNA is copied incorrectly during DNA replication. Here is your original DNA sequence from this lab and the amino acid sequence that was transcribed from it:

G ALA THR HEB GLY HIS ILE STOP

Sometimes when DNA is copied (replicated), errors occur. We call these mutations. When these mutations occur in genes, they...
c. What is the name of this type of point mutation and why is it referred to by this terminology?

7. **POINT MUTATION 2**: Here is your original DNA sequence from this lab and the amino acid sequence that was translated from it:

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3' | CTGAGCTA | CTGAGCTG | CTGAGCTG | CTGACAGC | CGAGCTC | CTCTGTG | TAAACTTG |
| 5' | METTHRARGLEUASPVALSERALARGARGLYHISILESTOP |

a. Now, let's simulate a point mutation at the 13th base. It was accidentally changed during replication from a G to an A. Now transcribe this new DNA strand into **mRNA**, and then translate it into its **amino acid sequence**.

|   | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
| 3' | CTGAGCTA | CTGAGCTG | CTGAGCTG | CTGACAGC | CGAGCTC | CTCTGTG | TAAACTTG |
| 5' | CTGAGCTA | CTGAGCTG | CTGAGCTG | CTGACAGC | CGAGCTC | CTCTGTG | TAAACTTG |

b. Did this change in the DNA sequence cause any significant change to the protein produced? Explain.
c. Explain why the sickle cell mutation is selected for in certain areas of the world.

b. Explain the structural effect that this point mutation has on the hemoglobin protein.

9. Sickle cell anemia is an example of a genetic disease caused by a point mutation.

8. Describe the specific DNA changes that produce the abnormal sickle cell hemoglobin.

d. Why could a mutation in a gamete have more profound biological consequences than a mutation in a somatic cell?

c. What is the name of this type of point mutation and why is it referred to by this term?
10. **FRAMESHIFT MUTATION 1**: Another group of mutations is called **frameshift mutations** where at least one base is either added to or deleted from the DNA as it is copied during **DNA replication**. Let's investigate the effects of these.

a. Here is your original DNA sequence from this lab and the amino acid sequence that was translated from it:

```
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
CTGAGCTACTGAGCTGTGAGCTGCTGACTGAGCCAGACTCCTGCTGTGTAATACCTTG
MET THR ARG LEU ASP VAL SER ALA ARG GLY HIS ILE STOP
```

b. Let's simulate a frameshift mutation by adding an additional base between the 36th & 37th bases. The base A was accidentally added to the sequence of the gene. Now transcribe this new DNA strand into **mRNA**, and then also translate it into its **amino acid sequence**.

```
1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7 8 9 0 1 2 3 4 5 6 7
CTGAGCTACTGAGCTGTGAGCTGCTGACTGAGCCAGACTCCTGCTGTGTAATACCTTG

```

c. Did this change in the DNA sequence cause any significant change to the protein produced? Explain.

___________________________________________________________________________________________________________

___________________________________________________________________________________________________________

d. Why are insertions and deletions called "frameshift" mutations, and what is meant by the "reading frame" of a gene?

___________________________________________________________________________________________________________

___________________________________________________________________________________________________________
b. Did this change in the DNA sequence cause any significant change to the protein produced? Explain.

c. Which do you think would cause a more profound biological impact: (1) a deletion/insertion near the beginning of a gene, or (2) a deletion/insertion towards the end of a gene? Explain.

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Also translate it into its amino acid sequence.

a. Now let's simulate a frameshift mutation by deleting the 10th base. Now transcribe this new DNA strand into mRNA, and then from it: Frameshift Mutation 2: Here is your original DNA sequence from this lab and the amino acid sequence that was translated.
12. Cystic fibrosis is an example of a genetic disease caused by a frameshift mutation.
   a. Describe the specific DNA changes that produce the abnormal cystic fibrosis protein (the delta F508 mutation).

b. Explain the structural and functional effects that this frameshift mutation has on lung cells.

c. Explain why cystic fibrosis shortens life span.

13. Are mutations **always** deleterious? What is the evolutionary value of mutations? Explain.