**Point Mutations Activity**

**Background:** There are two types of mutations, small-scale gene mutations and large-scale chromosomal mutations.  In this activity you will be learning about gene mutations.  There are two basic types of gene mutations: **base substitution** and **frameshift (insertions and** **deletions)**.

**Part 1: *Frameshift Mutations***

Example 1: Insertion Frameshift

DNA Sequence Sentence:       THE FAT PIG ATE THE BIG BUN AND HOT DOG

    **↘**

Effect of Insertion:                  THE FAT **X**PI GAT ETH EBI GBU NAN DHO TDO

       **↑**

**Insert a nitrogen base**

Example 2: Deletion Frameshift

                                                                                    **Delete a nitrogen base**

**↓**

DNA Sequence Sentence:      THE FAT PIG ATE T**H**E BIG BUN AND HOT DOG

**↙**

Effect of Deletion:                 THE FAT PIG ATE TEB IGB UNA NDH OTD

The insertion shifts the reading frame to the right.  The deletion shifts the reading frame to the left.  Complete the following lines for frameshift mutations.

1. Why did I only use 3 letter words? What do they represent?\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. What is the mutation’s effect on the resulting protein? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. Why are most frameshift mutations fatal? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Part II:**  Now use a real DNA sequence and transcribe and translate it into the correct amino acids.  In the original DNA code put the insertion frameshift mutation in the **FOURTH CODON by inserting a G after the C in TCT**. Please use the mRNA codon chart below to find the corresponding amino acids.



Write each codon per line and **highlight** the mutated nitrogen base where the mutation took place and the amino acid(s) that are effected.

Original DNA                 TAC   GGA    CGA   TCT  CAG   GAG   CCT   ATA   ATC

Insertion Mutation          \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Mutated mRNA              \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Mutated Amino Acids     \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Original Amino Acid

            Sequence              Met     Pro       Ala      Arg     Val      Leu    Gly     Try     STOP

In the original DNA code put the deletion frameshift mutation in the **THIRD CODON by deleting the C of CGA**. Please use the mRNA codon chart provided to find the corresponding amino acids.  Write each codon per line and **circle** the mutated nitrogen base where the mutation took place and the amino acid(s) affected.

Original DNA                  TAC     GGA   CGA   TCT   CAG   GAG   CCT   ATA   ATC

Deletion Mutation           \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_    \_\_\_\_

Mutated mRNA              \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_    \_\_\_\_

Mutated Amino Acids     \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_     \_\_\_\_

Original Amino Acid

            Sequence              Met     Pro       Ala        Arg    Val      Leu       Gly   Try    STOP

**Part III: *Base Substitution Mutations***

Example 1:  ***Missense Point Mutation***

A missense mutation occurs when one nitrogen base is substituted for another nitrogen base causing a different amino acid than previously to occur in the protein sequence.

A. Use the DNA code below to demonstrate a *missense mutation*.  All you have to do is change the DNA base in the **SEVENTH CODON from CTC to CAC.** Write each codon per line and **circle** the mutated nitrogen base and affected amino acids. **\*This is the mutation that occurs in sickle cell anemia\*.**

Original DNA               CAC     GTG   GAC   TGA   GGA   GGA   CTC   CTC   ATC

Mutation   \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Mutated mRNA             \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Mutated Amino Acids   \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_   \_\_\_\_

Original Amino Acid

            Sequence            Val      His      Leu      Thr   Pro   Pro     Glu A   GluA     STOP



B. Use the DNA code below to demonstrate another *missense mutation*.  All you have to do is change the DNA base in the **SECOND CODON from GCC to GAC.** Write each codon per line and **circle** the mutated nitrogen base and affected amino acids**. \*This is the “boy in the bubble” syndrome (severe combined immunodeficiency)\***

Original DNA                  AAT     GCC      AGT     GGT    TCG    CAC    CTG    ACC     ACT

Mutation       \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_    \_\_\_\_     \_\_\_\_     \_\_\_\_

Mutated mRNA               \_\_\_\_    \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_    \_\_\_\_     \_\_\_\_     \_\_\_\_

Mutated Amino Acids     \_\_\_\_     \_\_\_\_     \_\_\_\_    \_\_\_\_      \_\_\_\_     \_\_\_\_   \_\_\_\_      \_\_\_\_     \_\_\_\_

Original Amino Acid

            Sequence              Leu      Arg       Ser      Pro     Ser     Val     Asp A   Trp     STOP

 

Example 2: ***Silent Point Mutation* – 40% of all mutations are this type.**

A *silent mutation* happens when one base in a codon is changed but both code for the same amino acid.

Use the DNA code below to demonstrate a *silent mutation*.  All you have to do is change one DNA base in the **THIRD CODON from TCT to TCC.** Write each codon per line and **circle** the mutated nitrogen base and amino acid.

Original DNA                             TAC     CAT      TCT     CGG    TGT     AAA     AGG     GCG    ATT

Silent  Mutation               \_\_\_\_     \_\_\_\_    \_\_\_\_    \_\_\_\_      \_\_\_\_     \_\_\_\_     \_\_\_\_      \_\_\_\_     \_\_\_\_

Mutated mRNA                \_\_\_\_    \_\_\_\_    \_\_\_\_    \_\_\_\_      \_\_\_\_     \_\_\_\_     \_\_\_\_      \_\_\_\_     \_\_\_\_

Mutated Amino Acids     \_\_\_\_     \_\_\_\_    \_\_\_\_     \_\_\_\_     \_\_\_\_     \_\_\_\_      \_\_\_\_      \_\_\_\_     \_\_\_\_

Original Amino Acid

            Sequence              Met     Val      Arg       Ala     Thr      Phe      Ser     Arg     STOP

Example 3: ***Nonsense Point Mutation***

A base mutation that creates a new stop codon in place of an amino acid causing a premature stopping of translation is called a *nonsense mutation*.

Use the DNA code below to demonstrate a nonsense mutation.  All you have to do is change one DNA base to create a new amino acid sequence with a premature stop codon in the **FIFTH CODON by changing ATA to ATT**. Write each codon per line and **circle** the mutated nitrogen base and amino acid. **\*This is the type of mutation that occurs in Duchenne muscular dystrophy, cystic fibrosis, hemophilia and thalassemia.\***

Original DNA                             TAC     GGT   AAT   CAA    ATA   GAA    CCT    GAG    ACT

Nonsense  Mutation         \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_     \_\_\_\_    \_\_\_\_   \_\_\_\_     \_\_\_\_

Mutated mRNA               \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_     \_\_\_\_    \_\_\_\_   \_\_\_\_     \_\_\_\_

Mutated Amino Acids     \_\_\_\_   \_\_\_\_    \_\_\_\_    \_\_\_\_   \_\_\_\_      \_\_\_\_   \_\_\_\_    \_\_\_\_     \_\_\_\_

Original Amino Acid

            Sequence              Met     Pro      Leu       Val     Tyr      Leu      Gly      Leu     STOP

**Analysis Questions. Put the answers to these in complete sentences in your notebook.**

1.       How many amino acids were affected in the point mutations compared to the frameshift mutations?

2.      Describe the difference between a frameshift mutation and a point mutation.

 3.      Which type of mutation, a frameshift or a point mutation, has more effect on the organism?  Why?

4.      Usually a frameshift mutation results in the synthesis of a nonfunctional protein.  Why do you think mutated proteins might not be functional?

5.      Which type of point mutation would be insignificant to the organism?  Why?

6.      Which type of point mutation would most likely cause major changes to physical structures of the organism?

7. In your notebooks, draw a diagram to shows the relationships between: transcription, translation, DNA, tRNA, mRNA, amino acids, and polypeptide (protein).