MUTANT BEES

Purpose - To build a model of a bee using coded instructions. To identify the different effects that mutations may have on an organism (positive, negative or neutral).

Background –

DNA is a set of coded instructions for making all the proteins in our bodies. It uses 4 bases, represented by A, T, C and G, to code all the information contained in our DNA. There are several steps to breaking the code. DNA is stuck in the nucleus, therefore it first needs to be written into a form that can be read outside the nucleus: This step is called transcription. This new form, RNA, leaves the nucleus where it is read to make proteins. This is called translation. The code is read in 3 letter segments (codons) to create amino acids, the smallest part of proteins.

Sometimes mutations occur in the DNA. These are permanent changes to the DNA sequence and may have different effects on the organism. There are three major kinds of mutations:

Substitution - Usually one base is changed in the sequence. The sequence around the change is the same.

Insertion - Extra bases are added to the sequence. The surrounding sequence is the same after the insertion ends.

Deletion - Some bases are removed. The surrounding sequence is the same after the insertion ends. An example of each kind of mutation follows. The mutation's impact on the sequence is underlined.

Original: AMY GOT HER RED HAT

Substitution: AMY GOT HER ROD HAT

Insertion: AMY GOT HIS ERR EDH AT

Deletion: AMY OTH ERR EDH AT

In this activity, you will be given codons and the instructions that correspond to each codon. Your task is to follow each set of instruction to build your own bee. Beware, your neighbour may not have the same set of instructions as you!

Materials - (for each group)

- Three pipe cleaners in three different colours (one each of yellow, black, and brown)
- Black pom-pom
- Googly eyes (or you can make your own bee's eyes)
- Glue gun
- Paper (will be used to create wings)
- Scissors

Procedure -

Use the sequence you are given to build a model of a bee. Start by breaking the correct sequence below into three letter chunks (codons). Then find the matching codons in the left column of the table and place your instructions into the order of the correct sequence. Beware, the instructions in the table are not in order, so you will need the sequence to tell you what set of instructions come next!

Correct sequence:

GTGTAATGCCCGCAATGGCG

TCTAGGG

Codon	Instructions
GGG	Cut out a pair of wings and glue them onto the bee's body.
CGA	Take the other half of the fourth piece of the brown pipe cleaner and fold it in half. Glue to the top of the black porn-porn to make another pair of antennae.
TGG	Attach a black porn-porn to the front of the body to create a head. Note: this is opposite to the stinger end of the body.
TAA	Put the red and black halved pipe cleaners side-by-side and coil them around a pen. This will become the bee's body. Tip: start coils at free ends of pipe cleaners with black on the outside.
TGC	Take one of the free ends of the black pipe cleaner and straighten it to create a stinger.
GTG	Take one red pipe cleaner and one black pipe cleaner and fold both of them in half.
CAA	Fold 3 of the 4 pieces of brown pipe cleaner in half. Feed one end of each 'V' through a black coil so that the brown legs hang down from the body. Bend the ends of the brown pipe cleaner to create feet. Do this 3 times to create 6 legs.
ATG	Take one yellow pipe cleaner and one black pipe cleaner and fold both of them in half.
CTA	Glue on the eyes.
CCG	Take brown pipe cleaner and cut into four equal pieces.
CGT	Cut the fourth piece of the brown pipe cleaner in half and then fold one piece in half. Glue to the top of the black porn-porn to make a pair of antennae. **BEE #4**

Procedure -

Use the sequence you are given to build a model of a bee. Start by breaking the correct sequence below into three letter chunks (codons). Then find the matching codons in the left column of the table and place your instructions into the order of the correct sequence. Beware, the instructions in the table are not in order, so you will need the sequence to tell you what set of instructions come next!

Correct sequence:

ATGTAATGCCCGCAATGGCGTCTA

Codon	Instructions
GGG	Cut out a pair of wings and glue them onto the bee's body.
CGA	Take the other half of the fourth piece of the brown pipe cleaner and fold it in half. Glue to the top of the black porn-porn to make another pair of antennae.
TGG	Attach a black porn-porn to the front of the body to create a head. Note: this is opposite to the stinger end of the body.
TAA	Put the yellow and black halved pipe cleaners side-by-side and coil them around your finger. This will become the bee's body. Tip: start coils at free ends of pipe cleaners with black on the outside.
TGC	Take one of the free ends of the black pipe cleaner and straighten it to create a stinger.
ATG	Take one yellow pipe cleaner and one black pipe cleaner and fold both of them in half.
CAA	Fold 3 of the 4 pieces of brown pipe cleaner in half. Feed one end of each 'V' through a black coil so that the brown legs hang down from the body. Bend the ends of the brown pipe cleaner to create feet. Do this 3 times to create 6 legs.
GTG	Take one red pipe cleaner and one black pipe cleaner and fold both of them in half.
CTA	Glue on the eyes.
CCG	Take brown pipe cleaner and cut into four equal pieces.
CGT	Cut the fourth piece of the brown pipe cleaner in half and then fold one piece in half. Glue to the top of the black porn-porn to make a pair of antennae. **BEE #3**

Procedure -

Use the sequence you are given to build a model of a bee. Start by breaking the correct sequence below into three letter chunks (codons). Then find the matching codons in the left column of the table and place your instructions into the order of the correct sequence. Beware, the instructions in the table are at in order, so you will need the sequence to tell you what set of instructions come next!

Correct sequence:

ATGTAATGCCCGCAATGGCGTCGACTAGGG

Codon	Instructions
GGG	Cut out a pair of wings and glue them onto the bee's body.
CGA	Take the other half of the fourth piece of the brown pipe cleaner and fold it in half. Glue to the top of the black porn-porn to make another pair of antennae.
TGG	Attach a black porn-porn to the front of the body to create a head. Note: this is opposite to the stinger end of the body.
TAA	Put the yellow and black halved pipe cleaners side-by-side and coil them around your finger. This will become the bee's body. Tip: start coils at free ends of pipe cleaners with black on the outside.
TGC	Take one of the free ends of the black pipe cleaner and straighten it to create a stinger.
ATG	Take one yellow pipe cleaner and one black pipe cleaner and fold both of them in half.
CAA	Fold 3 of the 4 pieces of brown pipe cleaner in half. Feed one end of each 'V' through a black coil so that the brown legs hang down from the body. Bend the ends of the brown pipe cleaner to create feet. Do this 3 times to create 6 legs.
GTG	Take one red pipe cleaner and one black pipe cleaner and fold both of them in half.
CTA	Glue on the eyes.
CCG	Take brown pipe cleaner and cut into four equal pieces.
CGT	Cut the fourth piece of the brown pipe cleaner in half and then fold one piece in half. Glue to the top of the black porn-porn to make a pair of antennae. **BEE #2**

Procedure -

Use the sequence you are given to build a model of a bee. Start by breaking the correct sequence below into three letter chunks (codons). Then find the matching codons in the left column of the table and place your instructions into the order of the correct sequence. Beware, the instructions in the table are not in order, so you will need the sequence to tell you what set of instructions come next!

Correct sequence:

ATGTAATGCCCGCAATGGCGTCTAGGG

Codon	Instructions
GGG	Cut out a pair of wings and glue them onto the bee's body.
CGA	Take the other half of the fourth piece of the brown pipe cleaner and fold it in half. Glue to the top of the black porn-porn to make another pair of antennae.
TGG	Attach a black porn-porn to the front of the body to create a head. Note: this is opposite to the stinger end of the body.
TAA	Put the yellow and black halved pipe cleaners side-by-side and coil them around your finger. This will become the bee's body. Tip: start coils at free ends of pipe cleaners with black on the outside. .
TGC	Take one of the free ends of the black pipe cleaner and straighten it to create a stinger.
ATG	Take one yellow pipe cleaner and one black pipe cleaner and fold both of them in half.
CAA	Fold 3 of the 4 pieces of brown pipe cleaner in half. Feed one end of each 'V' through a black coil so that the brown legs hang down from the body. Bend the ends of the brown pipe cleaner to create feet. Do this 3 times to create 6 legs.
GTG	Take one red pipe cleaner and one black pipe cleaner and fold both of them in half.
CTA	Glue on the eyes.
CCG	Take brown pipe cleaner and cut into four equal pieces.
CGT	Cut the fourth piece of the brown pipe cleaner in half and then fold one piece in half. Glue to the top of the black porn-porn to make a pair of antennae. **BEE #1**

Answer Key!!!!

B	Bee Product
1	Healthy (wild type) bee
2	An extra codon has been inserted and this produces a bee mutant with two pairs of antennae (steps # 8 and 9 have been changed to
3	There is a deletion that produces a bee with no wings (step # 9 is missing. There is no
4	There is a DNA base substitution that results in a red and black bee (in step # 14TC is

Note: The bee # is located on the student worksheet, below the instruction chart, on the right side.

Post Activity Discussion

- After the activity, students can compare their bee products. To help them do this, write the DNA sequences from the procedural steps on the board.
- Then, the students can compare the healthy (wild type) DNA sequences to the sequences from the sick bees containing the DNA mutations.
- Ask students to compare the DNA sequences. Is their bee healthy or does it have a DNA mutation? If it has a mutation, what type is it?
- Ask students to predict the outcomes of the mutation their bee has. Is the mutation positive, negative, or neutral? Will the mutation have an effect on the bee's health? Have them explain their answers.
- Students can also discuss the relationship between DNA, genes, and proteins.
- Ask students to then extrapolate this activity and what they learned to human DNA. Do all mutations cause disease in humans?
- This wrap-up activity can be done as a discussion, or it can be handed in as a "ticket out of the door" activity.

OPTIONAL: Glue a piece of pipe cleaner onto your bee's back so that you can use it as a hook to hang on your Christmas tree next year.

Tips & Tricks

- Before you introduce the bee building activity, you may want to review bee morphology with the class. You can do this with a model or with an image of a bee.
- It may also be helpful to briefly review:

  How the information in genes relates to proteins (DNA -> RNA -> proteins).

  The different types of mutations (substitutions vs. additions vs. deletions).
- For this activity, students can work on building their own bee mutants or they can work in pairs.
- Tell students that their classmates will have different instructions and that there is more than one type of bee mutant to be made.
- Let the students know that each step corresponds to a DNA codon. Some worksheets will have all of the instructions, while others may have a modified step or they may even be missing a step. The students with these modified instructions will end up building bee mutants.
- Do the first bee-building step as a class.
- Let the students know that they will have to make their own wings. They can cut these out from paper and glue them onto the bee's thorax.
- Let the students know that they will have to glue the eyes onto the bee's head.
- Note: real honeybees have two sets of wings – front wings and hind wings. In flight, these two sets of wings hook together and work together. For simplicity, we will give our bees one set of .wings, representing two sets hooked together for flight.