Better Bananas: Transgenesis Team

As the transgenesis team, you are tasked with adding a new gene to the banana plant to delay its ripening process so it stays ripe longer before going bad. Your team will mimic the process of using a *gene gun* to add new DNA into the chromosome of the banana plant so it ripens more slowly.

**Banana Background:**

Bananas are an important agricultural product in the U.S.. In 2017, the U.S. consumed so many bananas that it is estimated each American ate an approximately 29 pounds of bananas over the course of the year. Bananas continue ripening after they are picked. Because most of the bananas that Americans consume are grown in South America or Asia, the time it takes to transport bananas from these countries to the U.S. can make it difficult to ensure the bananas in grocery stores are ripe. Ripening allows bananas to become sweeter, softer, and juicier. However, overripe bananas are usually soft or have brown spots on the peel. These characteristics discourage consumers from purchasing or consuming overripe bananas and contribute to substantial food waste. In fact, bananas are one of the most wasted produce products in grocery stores, which has environmental and social impacts for farmers and consumers. Subsequently, scientists are looking for ways to delay the ripening process for bananas.

**Step 1:** As the **transgenesis** team, you are tasked with **adding a gene** to the banana plant to delay it’s ripening process. There are many genes that contribute to how a plant ripens. Review the list of genes associated with ripening below. As a team, choose a gene from the list that you would like to try to add to the banana plant to delay its ripening. **Put an X on the line of the gene you’d like to add**.

**Genes**

\_\_\_\_***REDUCE ETHYLENE PRODUCTION*** ethylene is a natural hormone associated with plant growth, development, and ripening. One the plant is fully mature, the plant’s production of ethylene triggers a series of biological pathways that change the fruit’s color, soften the fruit, and develop distinct tastes and aromas associated with overripe fruit. Scientists may be able to delay ripening by adding a gene into the banana’s DNA that disrupts these biological pathways.

**DNA Sequence:** GCT TCA ATG GTG CTG GAC ATA CAA TTC

\_\_\_\_***REDUCE PECTIN PRODUCTION****: Reduce pectin production:* pectin is a plant substance that maintains the integrity of cell walls. During the ripening process, plants produce an enzyme that breaks down pectin. This softens the fruit because there is not as much pectin available to maintain the stability of the cell walls. Scientists may be able to delay banana ripening by adding a gene into the banana’s DNA that stops the production of the enzyme that breaks down pectin, allowing cell walls to maintain stability for a longer period of time.

**DNA Sequence:** TAG CTG AGA CAC GCA AAT TAT GTA CGT

\_\_\_\_ ***ESTABLISH RESISTANCE TO FUSARIUM WILT****: Establish resistance to fusarium wilt:* fusarium wilt is a deadly disease caused by a fungus that lives in the soil. The fungus enters the plant through the roots. It can cause discoloration of the leaves and fruit, wilting, and plant death. This can contribute to plants exhibiting signs of ripening. Scientists may be able to establish resistance to fusarium wilt by adding a gene associated with resistance into the banana’s DNA.

**DNA Sequence:** CAT ATA CAA TTC TGT CTG AGA CAC TAT

**Why did your team choose to add this gene to the banana instead of the others?**

**Step 2**: Your team of scientists needs to search the gene pool to find the genetic material that controls the ripening trait you want to add.

* Search the gene pool for the strip of paper that contains the DNA sequence of the trait that you identified in Step 1 above.
* Once you’ve found this crucial genetic material, submit it to your teacher.
* There are 10 copies of your genetic material in the gene pool. For each DNA strand your team would like to try to insert into banana cells, you must find and submit a copy of the genetic material to your teacher to randomly receive a numbered ball.

**Step 3**: Scientists need to get the genetic material into the cell. One method to do this uses Agrobacterium, which enters the cell and can insert DNA into the nucleus. The other uses a gene gun to insert tiny little pellets covered in DNA into the cell. Both of these processes have a lot of uncertainty and can be very random. Scientists do not know if the DNA will get into the cells at all or if they will get into the nucleus, the portion of the cell where the DNA is housed. For this activity, your team will act as gene guns.

* Take turns throwing the DNA at the plant cell side of the felt board until at least one sticks to the nucleus portion of the cell (light blue felt).
* Because scientists use gene guns to propel multiple copies of the genetic material at a petri dish of plant cells, you can throw as many balls as you would like at the board at each time.
* IMPORTANT: Keep track of the total number of balls you throw at the board throughout the entire activity so you can calculate your success rate at the very end.
* Once you successfully insert the DNA into the nucleus of the cell, have your teacher make a note of which numbered ball(s) successfully made it. **Only successful balls can be used in the next steps**

**Step 4:** Once at least one of your genetic material balls has landed in the nucleus of the cell, you need to determine if it was successfully incorporated into the DNA in the chromosome within the nucleus.

* Flip over the board to the side with two chromosomes.
* Continue throwing the successful ball(s) at the board until one lands on one of the chromosomes.

**Step 5**: Sometimes DNA can be inserted into a chromosome and not be taken up into the chromosome and replicated during the DNA replication process. You need to make sure that even though your new genetic material (ping pong ball) landed in the chromosome, it is being replicated into future copies of the cell.

* Call your teacher over to determine whether the ball(s) that landed on the chromosome portion of the felt board were successful.

**Step 6**: Calculate your success rate.

* How many balls did you throw at the felt board until you were successful (the DNA was successfully replicated)? \_\_\_\_\_\_\_\_\_
* Divide 1 by this number (above) to determine your success rate. \_\_\_\_\_\_\_\_\_\_\_