ACTIVITY TWO - BIOINFORMATICS

Definitions - Look for definitions of bolded words in these boxes!

Background

Biology is the study of life and living organisms. Life is really complex, and in order to study it, scientists collect a lot of data. In fact, we've collected so much data that we've even had to create a new science called bioinformatics just to understand it all. Bioinformatics uses biology and computer science to turn **bio**logical data into **information** that you and I can understand. In our case, we use bioinformatics to turn data created by DNA sequencing technology into information about the organisms that survive in specific environments.

Today we'd like your help figuring out what organisms the DNA in your sample belong to. Unfortunately, our computers aren't working, so we hope you'll be able help!

The Goal

Put together all of the ***fragments*** of DNA and determine which organisms there are.

Fragment - a small part broken or separated off something bigger.

Get Started!

1. Open your Market Science Kit and take out all the supplies. Put a checkmark next to each item you find in the kit. Items with a * are not in the kit and would be helpful for the activity but not necessary.

- ❏ "Environmental Sample" - envelope w/ 14 paper slips
- ❏ "Confidence Tracker" - die
- ❏ "DNA Connectors" - tape*

2. Open the envelope to extract the DNA. Lay out all the strands of DNA on the table. These DNA have already been ***sequenced***, and are now specific and unique patterns of ***bases***.

Sequenced - put in a specific order.

TACGTCGCAT

DNA strand from the "environment" (envelope)

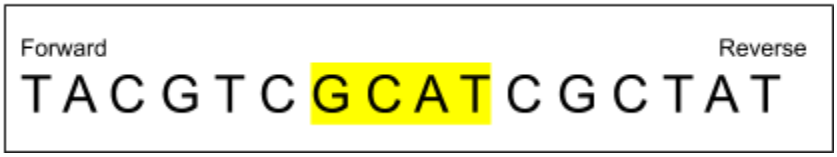
Bases - a building block of DNA. There are four bases that build, DNA and each base has a partner base that it matches with making a base pair. The four bases are A, T, G, C and and the pairs are A-T and G-C.

Task One - Combine the DNA ***fragments*** to make a full strand of DNA

Unfortunately, sequencing machines cannot sequence a complete strand of DNA in one round because the full strand is too long. In fact, if you unraveled all your DNA it would stretch to the sun and back roughly 600 times! The first thing you need to do is find the matching DNA strands and make them ***contiguous***, or one long DNA strand.

> ***Contiguous***- having the same border, or being next to each other in sequence.

1. Look at the yellow highlighted areas on the DNA fragments.
2. Find the two strips of paper that have the same letter pattern highlighted.
3. Tape the slips of paper together so that there is only one highlighted area.



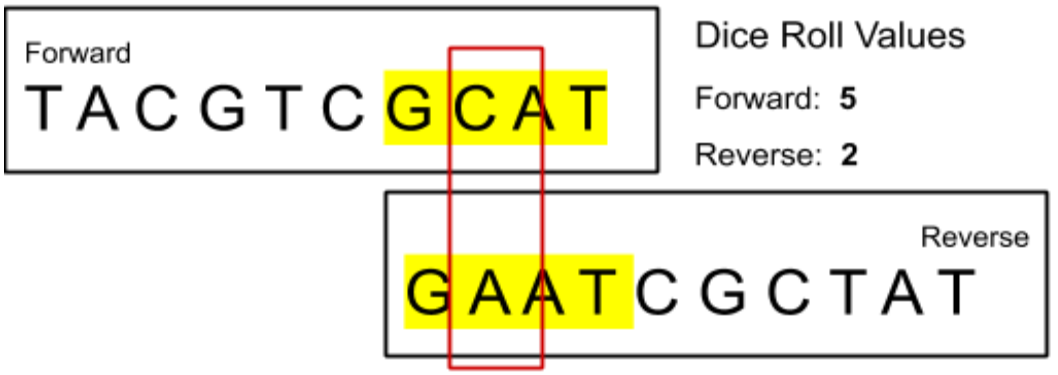
4. Keep looking for matching patterns until all the DNA fragments have a match.
5. If you have any leftover DNA that does not match exactly, move to TASK TWO!

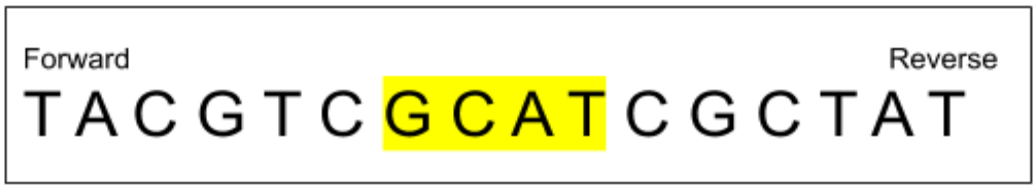
Task Two - Determine the confidence of ***bases*** to correct ***fragments*** that do not match.

Sequencing technology does a pretty good job of determining the bases in a strand of DNA. However, sometimes there are different results. When this happens the computer uses a confidence score or number to determine which base (letter) to use.

1. Find the fragments that don't match exactly in the middle. These should be left over from task one.
2. Roll a dice for each strand, forward and reverse, to determine which strand is correct.

Here is an example on how to determine the winning strand.





Since the forward read got a score of 5, it wins!
Tape, or place the winning strand on top.

3. Choose five of your complete strands and record their sequences on the DNA inventory sheet.
4. With all your DNA cleaned and connected, you can determine what each DNA belongs to. Go to Task Three!

<u>Task Three</u>: Determine what organism the DNA in your sample belongs to.

Once the sequences are put together, the computer uses a ***database*** of known DNA sequences to determine what the organisms are. We've given you a database with sequences and organisms names. Use this to decode what organisms were in your sample. Record the name of each on the DNA inventory list.

> ***Database***- information stored in one computer file.

1. Match your DNA sequences with the database sequences. Compare your ***bases*** (letters) to the ***bases*** in the database and find the exact match.

<u>Task Four</u>: Determine where might you discover the organisms you had in your sample?

In our lab, we are interested in learning more about how these organisms impact their environment or how the environment impacts these organisms. Using the information about each organism on the decoder sheet, where do you think we might find all these organisms living together?

Draw a picture of a place you might find all your organisms.

I think my organisms live _____ because

_____

_____.

We'd love to see where your organisms live! Share them with us @TheFringeLab and @MarketScience. You can also see some of our drawings on our website.

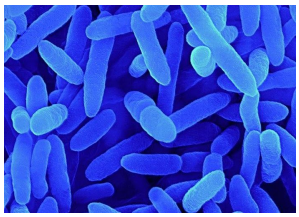
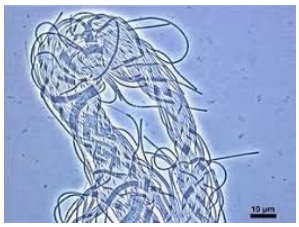
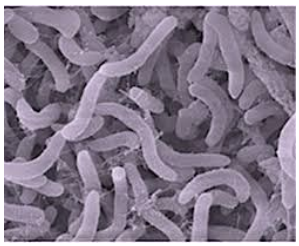
DNA Inventory

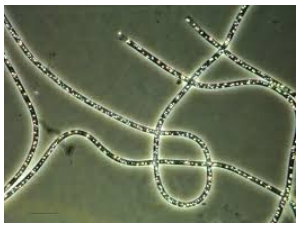
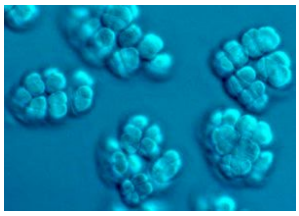
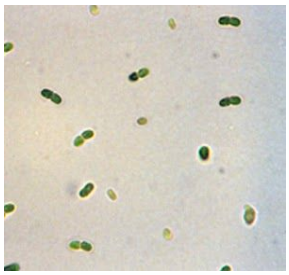
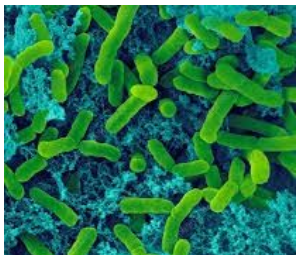
Working through all the data can be tough! We thought you might like a place to record all your progress. Keep up the good work.

Example DNA **Sequence:** TACGTCGCATCGCTAT **Organism Name:** Pseudomonas fluorescens
DNA #1 **Sequence:** _____ **Organism Name:** _____
DNA #2 **Sequence:** _____ **Organism Name:** _____
DNA #3 **Sequence:** _____ **Organism Name:** _____
DNA #4 **Sequence:** _____ **Organism Name:** _____
DNA #5 **Sequence:** _____ **Organism Name:** _____

DNA Decoder Database

Here is a collection of 10 possible bacteria. Use this to match your DNA sequences to the sequences here. Don't forget to record the name of your organism on the inventory sheet

DNA Sequence: T A C G T C G C A T C G C T A T **Organism Name**: ***Pseudomonas fluorescens*** **Characteristics:** Lives in soil or water, can eat a variety of things for energy, needs oxygen, likes to live in temperatures ranging from 75-85F.	**Illustration:** 
DNA Sequence: G A T C T A T A C C G A T T G A **Organism Name**: ***Nostoc commune*** **Characteristics:** Grows on a solid surface in all environments, even extreme environments like deserts and the arctic. Uses sunlight for energy and can breathe Nitrogen.	**Illustration:** 
DNA Sequence: A G C T T A G A C C T A G T C T **Organism Name**: ***Roseiflexus castenholzi*** **Characteristics:** Grows into red colored mats in environments that are HOT, 120F. They can use sunlight for energy and do not like to live in environments that are too acidic or basic.	**Illustration:** 
DNA Sequence: T G C G A C T A A G T C T T C G **Organism Name**: ***Pelagibacter ubique*** **Characteristics:** Lives in freshwater and saltwater environments. These are extremely small bacteria, but there are a lot of them in the world. Some people think there are more of them than any other bacteria!	**Illustration:** 

DNA Sequence: C G T A G G T G C A T C C G A C **Organism Name**: ***Beggiatoa species*** **Characteristics:** One of the first bacteria discovered. Forms white mats in polluted oceanic sediment environments that are sulfur rich or hydrothermal vents.	**Illustration:** 
DNA Sequence: C G T A G G T G C T T C C G A C **Organism Name**: ***Methanosarcina barkeri*** **Characteristics:** These archaea produce methane & are found in sediments, cow stomachs, & sewage. These locations are ideal because this bacteria doesn't live in the presence of oxygen.	**Illustration:** 
DNA Sequence: A A T C G C G A A G A C C G A T **Organism Name**: ***Synechococcus lividus*** **Characteristics:** These are very small bacteria that get energy from the sun. They are found in lakes and oceans and prefer environments that have high nutrients.	**Illustration:** 
DNA Sequence: A C C T G T G A T T G G T A C C **Organism Name**: ***Chlorobium tepidum*** **Characteristics:** These bacteria use sunlight for energy but do not live in environments with oxygen. They prefer to live in temperatures that are quite warm over 100F.	**Illustration:** 
DNA Sequence: A C C T G T C A T T G G T A C C **Organism Name**: ***Spirillum winogradskyi*** **Characteristics:** This bacteria was originally found in sludge that was rich in sulfur. It can live in the presence of some oxygen and can move rapidly.	**Illustration:**