BIOLOGY

Human DNA Extraction

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NGSS

MS-LS1-1

Objective

The student will understand that cells contain DNA and that this DNA contains base pairs.

The student will be able to isolate DNA from their own cheek cells.

Vocabulary

DNA/Deoxyribonucleic acid: The genetic instructions for an organism.

Genome: The whole collection of an organism's genetic material, composed of DNA.

Double Helix: The twisting shape of DNA composed of nucleotides in two long chains that twist around each other.

Genes: Carry the information that determines the features or characteristics that are inherited by offspring from parents.

Background

DNA is a record of instructions telling the cell what its job is going to be. A good analogy for DNA is a set of blueprints for the cell, or computer code telling a PC what to do. A genetic code is written in a special alphabet that is only four letters long! Unlike a book or computer screen, DNA isn't flat and boring - it is a beautiful, curved ladder. We call this shape a double helix. The letters of the DNA alphabet (called bases) make up the rungs, and special sugars and other atoms make up the handrail.

The rungs are very special. Each one has a name, but they prefer to be called by their initials: A, T, C and G. They don't like to be by themselves, so always pair up with a friend. However, they are very choosy about their friends:

A and T are best friends and always hang out together.

G and C are best friends and always hang out together.

Another way of looking at it is that A, T, G and C are like jigsaw pieces. A and T fit together, C and G fit together - you cannot force a jigsaw piece to fit in the wrong place.

Think of all the words you can spell. I bet there are loads of them, but each word is made using the same selection of letters. Yes, sometimes we leave letters out, sometimes we repeat letters, but we always have the same selection of letters. Depending on how we arrange the letters of the alphabet, we can make new words. The same is true in the four-letter alphabet of DNA.

Materials

Pens or Pencils

Human DNA Extraction Demonstration

- Clear cups (2 per student)
- Large cup (Used to pre-mix salt and water)
- Coffee stirrers (1 per student)
- Isopropyl alcohol (keep chilled)
- Distilled water
- Dish soap
- Salt
- Food coloring
- Spoons (1 per student)
- Plastic pipettes (1 per student)
- Micro centrifuge tubes and string (1 per student)

Origami DNA Model Demonstration

- DNA Origami Template (1 per student)
- DNA Origami Instructions (1 per group)

Procedure

1. **Introduce topic**
2. **Safety Precautions**

a. Do not let students handle alcohol.

3. **Human DNA Extraction Demonstration**
    a. Each student should begin with two clear cups.
    b. Fill one large cup with water and add salt until the solution is saturated (until no more salt dissolves).
    c. Transfer approximately 3 tablespoons of salt solution into each student's first clear cup.
    d. Gargle the second cup of salt water for 1 minute.
    e. Spit the water back into the first cup. This salt solution will contain suspended cheek cells.
    f. Dip a coffee stirrer into the dish soap, add a medium-sized drop of soap to the second cup, and gently stir while avoiding bubbles as much as possible.
    g. Fill each student's second clear cup ¼ full of isopropyl alcohol and add 3 drops of food coloring.
    h. Tilt the first cup containing the student's DNA and slowly add the contents of the second cup to the first cup. A layer will form on top.
    i. In approximately 3 minutes, the students will start to see a white mucousy substance. This is the DNA that has been extracted.

4. **Origami DNA Model Demonstration**
    a. Fold paper in half lengthwise. Make all creases as firm as possible.
    b. Hold the paper so that the thick lines are diagonal and the thin lines are horizontal. Fold the top segment down and then unfold.
    c. Fold the top two segments down along the next horizontal line. Unfold.
    d. Repeat for all segments.
    e. Turn paper over.
    f. Fold along the first diagonal line. Unfold and fold along the second diagonal line. Repeat for all diagonal lines.
    g. Fold the white edge without letters up.
    h. Fold the other edge away from you. Partly unfold both edges.
    i. You can now see how the model is starting to twist.
    j. Twist and turn the paper while pushing the ends towards each other.
    k. Now let go.

5. **Clean up!**

Guiding Questions

- What types of living organisms contain DNA?
- Does every cell within an organism contain the exact same DNA sequences?
- Which pair of organisms share the same DNA?
    a. Banana and a strawberry
    b. Identical twins
    c. Mother and child
    d. Snake and cat
- What is the name of an organism's complete set of genes or genetic material encoded by DNA?
- What is a nucleotide? Give an example.

Career/Future Application

DNA can help to identify people, even better than a fingerprint! Crazy, right? Being able to extract DNA helps a lot of professionals. Biomedical researchers use DNA all the time as a tool for discovering new things about diseases – their discoveries help develop new and better treatments and cures for diseases. Forensic scientists use DNA analysis to determine whether samples from crime scenes match suspects' DNA. Doctors use DNA to help diagnose genetic illnesses. Genetic engineers study the mechanisms of DNA replication. There are even scientists who conduct genetic research on our food!

Sources

Scan QR Code for Website

PBS DNA Video - https://www.youtube.com/watch?v=DaaRrR-ZHP4

Scan QR Code for Website

Origami DNA - http://www.yourgenome.org/activities/origami-dna

http://www.chem4kids.com/files/bio_dna.html

https://learn.genetics.utah.edu/content/labs/extraction/howto/

http://ftp.sanger.ac.uk/pub/yourgenome/downloads/activities/origami-dna/dnaorigamitempcoloured.pdf

https://www.teachengineering.org/view_activity.php?url=collection/cub_/activities/cub_biomed/cub_biomed_lesson09_activity2.xml