Hands-On Lab

Extracting DNA

While scientists use DNA extraction kits available from biotechnology companies, you can actually extract DNA using common ingredients found in your own home. During a DNA extraction, a detergent is used to burst open cells so that the DNA is released into solution. Then alcohol is added to the solution to cause the DNA to precipitate out. In this activity, you will extract DNA from a strawberry. Unlike human cells, which contain two copies of each chromosome, a strawberry has eight copies of each chromosome in its cells.

Predict What will DNA extracted from a strawberry look like?

FIGURE 18: Strawberries have eight copies of each chromosome in their cells.

PROCEDURE

1. Place the alcohol in a freezer 24 hours before beginning the lab.
2. Place the strawberry in a plastic zipper bag. Zip the bag closed.
3. Gently crush the strawberry by squeezing it inside the closed bag for 2 minutes.
4. Carefully open the bag and add 1 teaspoon water, 1 teaspoon liquid dish soap, and a pinch of salt. Zip the bag closed. Knead for 1 minute.
5. Pour the strawberry mixture into a cheesecloth-lined funnel that is set into a test tube to filter out the solids.
6. Remove the alcohol from the freezer. Open the test tube lid and tilt it in your hand. Very slowly, pour a small amount of alcohol down the inside of the test tube just until there is a thin layer floating on top of the solution.
7. Observe the test tube. You should see a band of white, gooey material forming just beneath the layer of alcohol. Gently put the skewer into the test tube and twirl it in the white material in one direction only. Wind the material around the skewer, then carefully draw it up and out of the test tube.
8. Record your observations.

MATERIALS

- cheesecloth
- funnel
- isopropyl alcohol (91%)
- dish soap, liquid
- salt
- strawberry (1 per student)
- teaspoon
- test tube with stopper
- water
- wood skewer
- zipper bag, plastic, quart size

ANALYZE

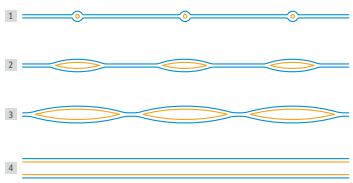
Explain Use your results from this activity to answer the following questions.

1. Describe the appearance of your DNA sample.
2. How is your DNA sample similar to and different from Watson and Crick's model?
3. The sample of DNA came from many strawberry cells. Do you think you would have been able to get the same result from your experiment if you had extracted DNA from a single cell?

EVIDENCE FOR DNA STRUCTURE AND FUNCTION | TELOMERES AND AGING | Go online to choose one of these other paths.

Fast and Accurate Replication

FIGURE 16: Replication Origins



In every living thing, DNA replication happens repeatedly, and it happens remarkably fast. In human cells, about 50 nucleotides are added every second to a new strand of DNA at an origin of replication. But even at this rate, it would take many days to replicate a molecule of DNA if the molecule were like a jacket zipper, unzipping one tooth at a time. To speed the process along, replication takes place at hundreds of origins of replication along the DNA molecule. This allows replication to be completed in only a few hours rather than days.

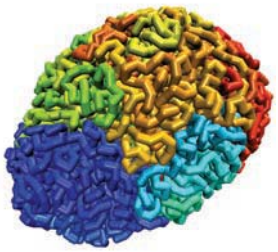
For the most part, replication proceeds smoothly. Occasionally, though, the wrong nucleotide is added to the new strand of DNA. This is called a *base substitution*, which is a type of point mutation—a mutation that occurs at a single location in the sequence of nucleotides. However, DNA polymerase can detect the error, remove the incorrect nucleotide, and replace it with the correct one. In this way, errors in DNA replication are limited to about 1 error per 1 billion nucleotides. If the substitution is not repaired, it may permanently change the organism's DNA. Sickle-cell anemia is an example of a genetic disorder that results from a base-substitution point mutation.

Predict Why is it important for DNA polymerase I to proofread the new strands of DNA before the cell divides?

Engineering

The Art of DNA Folding

FIGURE 17: Folded DNA Model



The human body has a knack for packing. It fits about eight meters of large and small intestines into the abdomen and jams about 100,000 kilometers of blood vessels, large and small, into the body. It should come as no surprise that the tiniest unit of the human body, the cell, has the same astonishing capability.

There are about 3 billion DNA base pairs in the human genome. If stretched out, the strand would be about 180 meters. This must fit into an area the size of a pinpoint. To make that happen, DNA must be tightly folded over and again, without becoming a tangled mess. The problem is solved by the formation of about 10,000 precise, non-overlapping loops like the ones in a bow. Instead of knots, the loops are held together by special proteins. The loops are crumpled to conserve space and are coated with chemical tags. The loops are then organized into groups by tag.

Explain How does the structure of DNA aid in its replication?