



DNA Highway Repair

Originally developed for the National Aviary in Pittsburgh, PA

GRADE LEVEL: 7-10

TIME: 20 minutes

SUBJECT: Biology/ Genetics

CONCEPTS: DNA, DNA replication, mutation, repair, environmental agents

LEARNING OBJECTIVES

- DNA exists in every cell, it contains all instructions for the cell to live and reproduce.
- Our DNA can be altered by elements in nature; therefore we need to protect ourselves against them (use sunscreen).
- DNA can be mutated by the sun, forming thymine dimers.
- Damage to the DNA, if left unrepaired, can be harmful to the organism.

MATERIALS

- 1 object that will serve as a road block
- 1 dump truck
- 1 smaller truck
- Labels “Paul E. Merase Copy Co.,” “D.N.A. Highway Repair,” and “Thymine Dimer Road Block”
- Poster or information showing the parts of a DNA molecule, especially the bases (A, G, C, T)

SET-UP

- Label the dump truck with “Paul E. Merase Copy Co.” – this truck will represent DNA polymerase.
- Label the smaller truck “D.N.A. Highway Repair” – this truck will represent the DNA repair mechanism.
- Mount one of the roads on a surface; leave the pieces of the other two roads scattered around the road.
- Label the road block object “Thymine Dimer Road Block”

ACTIVITY DESCRIPTION

1. What is DNA?

- a. Ask your students if they know what DNA is.
 - i. *DNA is a molecule that exists in every cell. All living things have cells, from bacteria that are only one cell to humans who are made of trillions of cells. Inside every cell of each organism is a copy of the same DNA. The cells in our body cannot live forever, so they need to be able to make copies of themselves so that we can live. To do this, each cell has a list of everything it needs to survive and how to make it. This list is our DNA!*
 - ii. *Each cell in our bodies has a full copy of our DNA. The road represents our DNA – “DNA Highway”, and each different colored piece of the “road” helps the cell make a different protein that it needs to work properly. Proteins are used for lots of things, such as helping our cells keep their shape, or helping us digest the food that we eat.*
- b. Ask your students what they think needs to happen when you need new cells?
Duplicate the DNA!
- c. When our body makes new cells it has to copy the DNA so that the new cell can survive and function properly.
 - i. This is done by a special molecule called a polymerase that reads the DNA, and makes a new copy – represented *by the dump truck* (Paul. E. Merase Copy Co.)

2. Normal DNA replication – Trial 1

- a. Move the truck along the road, and as it passes by a puzzle piece, pick a similar piece up from around the road – at the end there should be one of every piece in the back of the truck.
- b. Have participants assemble the new road so it looks exactly like the first one. Explain how this new DNA road will then be copied whenever new cells need to be made again.

3. UV light damages DNA

- a. Explain that each segment of the road is actually two long sequences of big molecules called adenine, guanosine, thymine and cytosine (point to the poster).
- b. Explain that rays from the sun can damage our DNA by causing some pieces to stick together, usually molecules called thymine. When 2 thymine molecules stick together, we call it a **thymine dimer**.

4. Replication with thymine dimer – Trial 1

- a. Tell your students to imagine that a particular spot has two thymines in a row. Place your finger there.

- b. Ask your students: what are ways that people sometimes get too much sun? *By sun bathing without sunscreen, doing sports outside, basically any activity that involved being in the ways of sun rays without protection.*
- c. Say that one of the suggested activities is going on, and that the sunrays shining down make the two thymines stick together creating a kink in the road. Place the road block where your finger was onto the middle puzzle piece of the main road.
- d. Ask your students: now what will happen when this cell needs to replicate? *There will be a problem in the piece that has a road block.* Repeat trial 1, however when the truck gets to the Thymine Dimer Road Block it cannot pick up that puzzle piece. The truck must go around it and continue to pick up the other puzzle pieces leaving us with one less puzzle piece in the end.
- e. Have the participants arrange the collected puzzle pieces in the same order as the main road (however, one in the middle will be missing – instead connect the second and fourth pieces together)
- f. Ask your students: what happened? What will happen to the new cell? Explain that this new cell is missing some of its DNA that it needs to survive. If it doesn't have all of its DNA, then it can't make all of the proteins that it needs.

5. DNA Repair

- a. Ask your students: what can the cell do to repair the DNA?
- b. Luckily the cell can recognize when the polymerase makes a mistake, and the new copy of DNA is incorrect, and can fix the mistake. Here comes the DNA Highway Repair truck (point to new truck). This truck represents special DNA repair molecules. Have the second truck come in with the missing piece and let the students repair the DNA.
- c. Now the DNA is back to normal, and the new cell can work properly!

6. Mutations

- a. Ask your students: but what if the DNA Highway Repair is too busy?
- b. Sometimes the DNA Highway Repair truck is really busy and can't always fix DNA (at this point, take the piece that was brought in by the repair truck out). If this is never repaired, then the DNA is permanently mutated. This cell might never work properly.
- c. Ask your students: what happens when the body needs new cells? Eventually, another new cell will be needed, and Paul E. Merase Copy Co. will have to make a copy of the mutated DNA, further spreading the mutation, and so more cells will be created that cannot work properly. Mutations can also cause cells to behave improperly, not be able to make necessary proteins causing them to disrupt other healthy cells. Sometimes these mutations make the cells live forever.
- d. How can we prevent this from happening to our DNA? By wearing sunscreen and not standing in the sun too long.
- e. **Conclusion:** Always wear your sunscreen!

OPTIONAL DISCUSSION

- Why is DNA important? DNA holds all information for every cell to live. Every living organism is made of cells, from bacteria to humans.
- What caused this mutation to occur in the first place? The sun!
- How can a mutation be reversed? Special DNA repair molecules can sometimes reverse the mutation.
- What happens if mutations are not repaired? The cell might not be able to function properly, and it might not be able to reproduce.
- How can we prevent this from happening to our DNA? By wearing sunscreen! Sunscreen helps to keep the sun's harmful UV rays from penetrating our skin, and our skin cells, like all of the cells in our body, contain DNA which we need to protect.

DNA Highway

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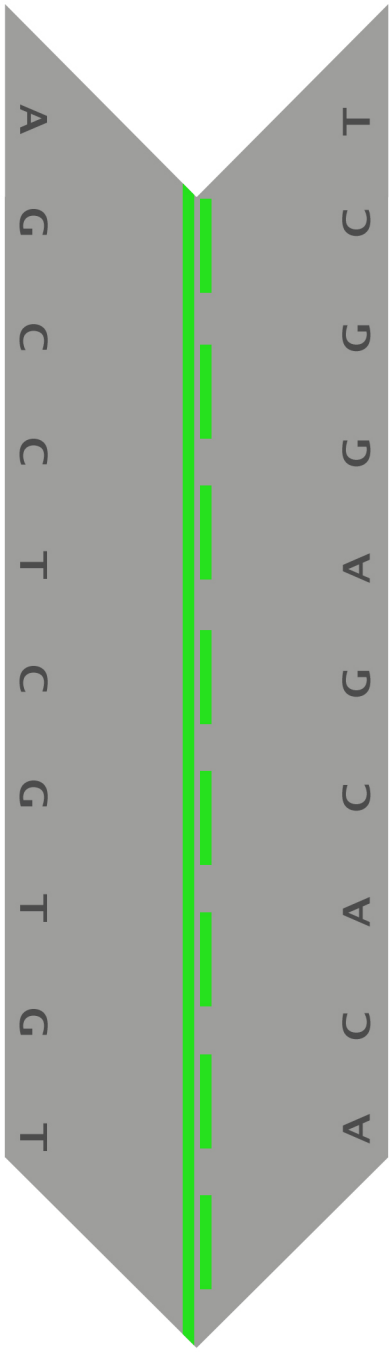
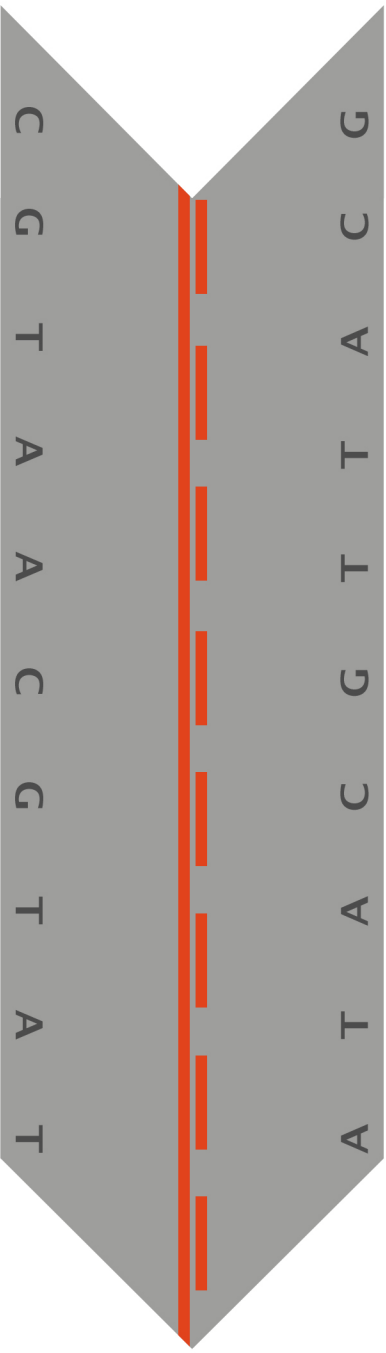
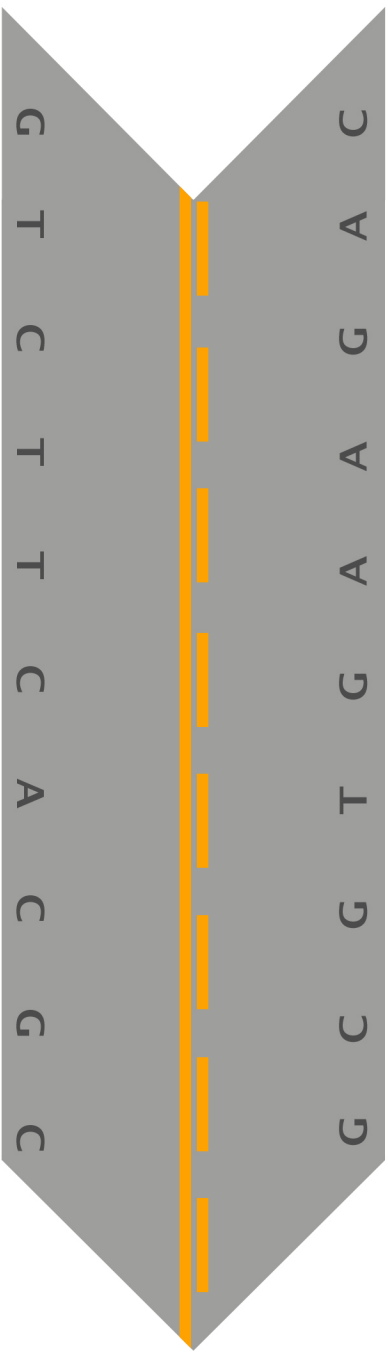
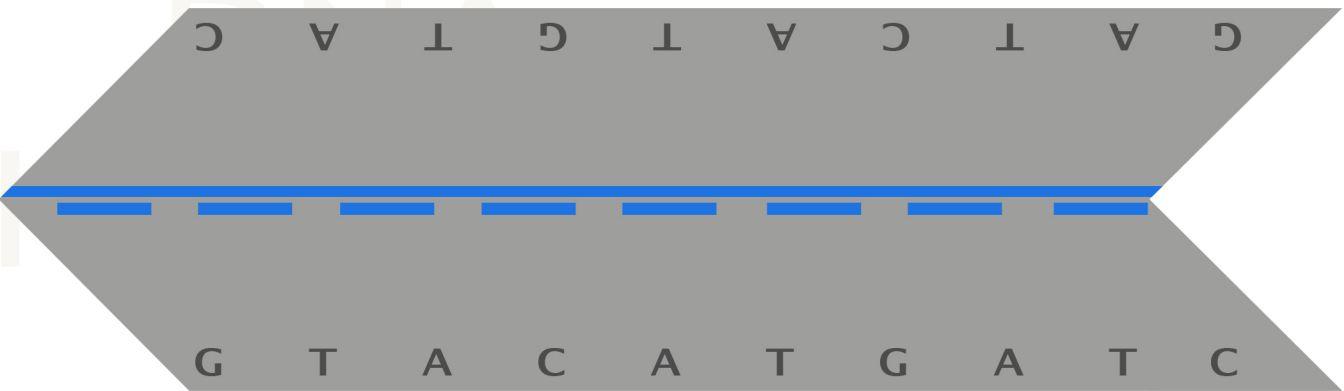
PAUL E. MERASE
COPY CO.

PAUL E. MERASE
COPY CO.

Thymine
Dimer

Thymine
Dimer

DNA
Highway
Repair



G A T C A T C T A C

C T A G A T C A T G

G A T C A T C T A C

C T A G A T C A T G

G A T C A T C T A C

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