SN IN HIGH SCHOOLS
May 27, 2017

The Difference Makers

Article-Based Observation

Directions: Read the article "The difference makers" and then answer these questions.

1. **What are transposons and what do they have to do with evolution?**

2. **Based on the section titled "Propagating parasites," what does propagation mean and why does the author refer to transposons as parasites? What is the microbiome and what role does it play in the body?**

3. **Using the diagram on Page 23, titled "Copy or cut," what are the two types of transposons and how does each type move?**

4. **What is the transposon that scientists know is still "hopping" around the human genome? What are some potentially negative and positive effects of this activity?**

5. **What happens to make a live transposon a “transposon fossil”? What are a few positive outcomes that have come from “transposon fossils”?**

6. **What is the benefit of having hundreds of copies of the now-extinct retrovirus MER41 in our human genome? Explain.**

7. **The graphic on Page 26, titled “Colorful effects,” shows some examples of genetic variations caused by transposons. Summarize your favorite example.**

8. **Developmental biologist Joanna Wysocka and her colleagues are interested in the effect of transposons on human development. What connection between chimps and humans did the researchers simulate, and what did they learn from their research?**

9. **Suggest another possible title for the article.**

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Responses to Article-Based Observation

1. **What are transposons and what do they have to do with evolution?** Possible student response: Transposons, also known as jumping genes or transposable elements, are mobile segments of DNA that can insert themselves into different parts of an organism's genome. A transposition event can disrupt a gene or regulatory region of the DNA. Since transposons can alter the genetic code, they can contribute to the changes seen during evolution.

2. **Based on the section titled "Propagating parasites," what does propagation mean and why does the author refer to transposons as parasites?** Possible student response: Propagation means multiplication or reproduction of something. Propagating transposons means increasing the number of transposons spread throughout the genome. The author refers to transposons as parasites because they insert themselves into their hosts' DNA and their sole purpose is to make more of themselves.

3. **Using the diagram on Page 23, titled "Copy or cut," what are the two types of transposons and how does each type move?** Possible student response: There are retrotransposons and DNA transposons. Retrotransposons use the "copy-and-paste" technique and DNA transposons use the "cut-and-paste" technique. Retrotransposons in an organism's DNA are first transcribed into many RNA copies, and then an enzyme called reverse transcriptase converts the RNA copies to DNA. The DNA copy inserts back into the genome at random. DNA transposons don't actively copy themselves—they are cut out of DNA by the enzyme transposase and are reinserted in a new location.

4. **What is the transposon that scientists know is still "hopping" around the human genome? What are some potentially negative and positive effects of this activity?** Possible student response: A retrotransposon called Long Interspersed Element-1, or LINE-1, is still "hopping" around the human genome and accounts for about 18 percent of it. Though most jumps are inconsequential, when LINE-1 jumps into a gene called APC, it can lead to colon cancer. If LINE-1 jumps into a gene coding for a blood clotting protein, it can cause hemophilia. According to pathologist Kathleen Burns and her colleagues, pancreatic tumors collect LINE-1 insertions as they grow. Scientists suggest that the frequency of LINE-1's hopping in brain cells could allow new capabilities that were not previously encoded in the genome, such as differences in the brain that make genetically identical twins different from one another.

5. **What happens to make a live transposon a "transposon fossil"? What are a few positive outcomes that have come from "transposon fossils"?** Possible student response: If the mobile elements of a transposon are not fully copied, either because of partial copying or a mutation, the transposon will no longer be able to move or jump on its own. Small and large RNAs and some proteins from recycled transposons can boost or dampen protein production and gene activity in cells and can generate antibodies and other immune proteins.

6. **What is the benefit of having hundreds of copies of the now-extinct retrovirus MER41 in our human genome? Explain.** Possible student response: Retrovirus MER41 invaded the primate genome about 45 million to 60 million years ago. Today humans have hundreds of copies of the now-extinct retrovirus spread throughout their genome. This is important because the sites of these insertions include transcription factors that call the immune system into action.

7. **The graphic on Page 26, titled "Colorful effects," shows some examples of genetic variations caused by transposons. Summarize your favorite example.** Possible student response: A transposon jumped into the *Ruby* gene in oranges. This insertion created a red color inside the blood orange. Different types of blood oranges are the results of different jumps.

8. **Developmental biologist Joanna Wysocka and her colleagues are interested in the effect of transposons on human development. What connection between chimps and humans did the researchers simulate, and what did they learn from their research?** Possible student response: The researchers used cells from humans and chimpanzees and reprogrammed them to act like stem cells, and eventually, cranial neural crest cells, which help form the face. The process allowed the researchers to watch how facial development differs between humans and chimps. The team found that hundreds of gene regulatory switches are used differently by the two species. Recycled, mutated transposons were frequently found around the regulatory switches, leading to different activity.

9. **Suggest another possible title for the article.** Possible student response: "Transposons: Rolling the evolutionary dice with each jump." Responses might include the idea of "jumping genes," explaining genetic differences between species or individuals, human evolution or cut-and-paste and copy-and-paste.