DNA Overview Activity:
Exploring DNA Applications
Instructor Guide

Notes to Instructor

This Activity the participants with the opportunity to explore DNA applications.

This Activity is part of the *Overview of DNA Learning Module*.
- Knowledge Probe (Pre-quiz)
- Overview of DNA Primary Knowledge
- DNA Activity: Exploration of DNA Concepts
- **DNA Activity: Exploring DNA Applications**
- Overview of DNA Assessment

Description and Estimated Time to Complete

This is one of two activities in the *Overview of DNA Learning Module*. This activity provides the opportunity for you to further explore the applications of DNA and its significance as the genetic material. This will help you to better understand how microsystems are used for DNA analysis.

Estimated Time to Complete
Allow approximately 1 hour

Introduction

Deoxyribonucleic acid (DNA) is a long polymeric molecule found in most cells that functions as the carrier of genetic information. The information carried in the linear sequence of bases in DNA defines an organism. Changes in the linear sequence, sometimes called mutations or polymorphisms, explain differences between individuals and diagnose diseases such as cancer.

Past and current studies of DNA identify how DNA can be used in biomedical applications. Such applications include the following:
- Improve diagnosis of a disease
- Test the best treatment options for a disease
- Execute rational drug design
- Create custom drugs
- Utilizing DNA in gene therapy

Activity Objectives and Outcomes

Activity Objectives

- Describe microsystem applications that rely on DNA

Activity Outcomes

Upon completion of this activity, you will be able to explain ways in which DNA and DNA concepts are used in different fields.

Activity: Exploring DNA Applications

Description

In this activity you explore DNA's role in applications such as infectious and inherited diseases. You will also continue your exploration of the basic concepts of DNA.

1. Go to the Infectious Diseases tutorial at the Koshland Science Museum.
   (URL: http://bit.ly/2w4sU7D*)*
   NOTE: If for some reason the link is broken, go to the Koshland Science Museum website and do a search for "Infectious Diseases". This should bring up the tutorial.

2. Complete the tutorial.

3. Complete the tutorial "Putting DNA to Work".
   (URL: http://bit.ly/2xdqofP*)*
   a. Read through the material and complete all of the activities.
   b. Be sure to take notes and write down any questions you may have.
   c. Discuss your results with other students.

4. Complete the **Post-Activity Questions** at the end of this procedure.

Post-Activity Questions

1. What is a virus chip?

2. In what time frame was the SARS disease agent identified using the virus chip?

3. How are the dots visualized?

4. Describe how DNA sequences are used in forensics to identify a specific individual.

5. Discuss an application of DNA and DNA sequences (genes) in agriculture. You may discuss an example that was used in this tutorial OR research another example (for example, bovine genes). Just be sure to include the sources for your discussion.

6. What part(s) of these tutorials did you find the most interesting and why?

Post-Activity Questions / Answers

1. What is a virus chip?
   Answer: *The virus chip is an ordered arrangement of 11,000 specific 70-letter DNA sequences, which represent 1,000 different viruses. To make and analyze a virus chip, a sample of each 70-letter sequences is prepared and arranged as a tiny dot on a small glass slide using a specialized robotic equipment. The virus chip can now be used to identify the cause of a disease. (Another example of a diagnostic BioMEMS device)*

2. In what time frame was the SARS disease agent identified using the virus chip?
   Answer: *Within 24 hrs.*

3. How are the dots visualized?
   Answer: *The DNA samples to be applied to the chip were labeled with fluorescent dyes. Once the samples join with a probe on the chip, the chip is scanned with a laser and the dyes fluoresce.*

4. Describe how DNA sequences are used in forensics to identify a specific individual.
   Answer: (Excerpt from tutorial. Students should be able to summarize this in their own words.) *Most people share very similar gene sequences, but some regions of DNA sequence have been found to vary from person to person with high frequency. Comparing variation in these regions allows us to answer the question of whether two different DNA samples come from the same person.*

   The FBI's forensic DNA identification system probes thirteen such regions in the genome. Sequences in these special regions involve multiple repetitions of short combinations of letters, such as GATA. Easily detectable differences between people lie in the number of repeats that occur in both copies of their DNA in these regions. When two DNA samples match completely in a large number of regions, such as the 13 used in the FBI's CODIS system, the probability that they could have come from two unrelated people is virtually zero. This fact makes DNA identification extremely reliable.

5. Discuss an application of DNA and DNA sequences (genes) in agriculture. You may discuss an example that was used in this tutorial OR research another example (for example, bovine genes). Just be sure to include the sources for your discussion.
   Answers will vary

6. What part(s) of these tutorials did you find the most interesting and why?
   Answers will vary

Summary

DNA is the genetic material with the genetic information stored in the linear array of nitrogenous bases. Many fields from forensics, agricultural to biomedical are using the information found in DNA to identify specific individual, specific diseases and variations of diseases, and identify the specific gene(s) in plants and animals that contribute to specific trait.

References

1. Putting DNA to Work: Marian Koshland Science Museum. http://bit.ly/2xdqofP
2. DNA Interactive: Dolan DNA Learning Center. Cold Spring Harbor Laboratory. http://www.dnai.org
3. Overview of DNA: SCME Primary Knowledge Unit

Disclaimer

Support for this work was provided by the National Science Foundation's Advanced Technological Education (ATE) Program through Grants. For more learning modules related to microtechnology, visit the SCME website (http://scme-nm.org).

This Learning Module was developed in conjunction with Bio-Link, a National Science Foundation Advanced Technological Education (ATE) Center for Biotechnology @ www.bio-link.org.