**GENETIC DISEASE:**
Putting DNA to Work
Overview for Teachers

Introduction
This webquest developed by the Koshland Science Museum for high school and undergraduate students focuses on genetic testing and genetic diseases. Students play various roles as they try to determine why a group of children in a remote village are becoming ill. The activity was designed in conjunction with the 2006 National DNA Day Celebration, which was hosted with the National Human Genome Research Institute of the National Institutes of Health. It is designed to make use of the Koshland’s online exhibit *Putting DNA to Work*.

Overview
In just the past decade, scientists’ knowledge about genes and how they work has grown at an unprecedented rate. Recent discoveries about how genes contribute to common diseases such as cancer, diabetes, and heart disease are changing the way medicine is practiced and driving discovery of new types of drugs and treatments. These discoveries promise to continue well into the future.

Studying the human genome has led to some amazing developments in recent years. Much of the early progress in this field came from studying genetic diseases that resulted from the presence or absence of a single gene. In this activity students will gain a solid understanding of how DNA works and discover how scientists and public health officials identify, test for, and treat genetic diseases. As students play a role in a medical investigation team, they will make some of the same discoveries that a real scientist working in genetics would make.

Students
Begin the webquest adventure:
- Introduction, instructions, and initial group activity
- DNA Scientist materials
- Epidemiologist materials
- Disease Specialist materials
- Genetic Counselor materials
- Group project worksheet and instructions

Teachers
Access instructions and more information on how to use this webquest:
- Background
- Academic Standards – Relevant Next Generation Science Standards and Common Core State Standards
- Evaluation – Rubric for evaluating student achievement
- Alternate Activities – Other activities you can do in your classroom related to this webquest
This webquest, designed for high school and undergraduate students, is an ideal introduction to the concepts of bioinformatics, genetic diseases, and potential careers in science fields. The activity can be used as a stand-alone lesson, or as a precursor to exploring the Koshland Science Museum’s online exhibit *Putting DNA to Work*.

The webquest is easily adaptable to fit the needs of your classroom. It is recommended that students be divided up into groups of four, so that each student can assume the role of one of the medical investigation team members. This encourages cooperative learning in the student groups and also gives students a chance to work as a team, much the way a real-world investigative team might do. Alternatively, the webquest can be completed by students individually, investigating all four roles on their own. Either way, emphasis should be placed on students communicating their findings by creating a presentation, using multimedia tools whenever possible.

This webquest is designed to take approximately one week. However, it is also possible to shorten the activity to one class period by completing only the bioinformatics section.
Background Information for Teachers

This webquest focuses on the genetically inherited disease cystic fibrosis. It is a recessive disease that is characterized by gastrointestinal and respiratory problems such as coughing, pneumonia, and bronchitis. If untreated, many children die before their first birthday. With treatment, the median age of survival is the low 30s.

Below is the entire mRNA sequence for the CFTR gene (mutations of which cause cystic fibrosis). The mutation discussed in the webquest is in underlined bold text.

Homo sapiens cystic fibrosis transmembrane conductance regulator, ATP-binding cassette (sub-family C, member 7) (CFTR), mRNA

```mRNA
AATTGGAAGCAAATGACATCACAGCAGGTCAGAGAAAAAGGGTTGAGCGCGAGGCCAGCCACCCAGAGTAGT
AGTCTTGGCAATTTAGGAGCTTGGAGCCACAGGCCTTGGCAAGACCCAGACGGGCCCCAGACCTGACG
CAGAGGTCGCCCTGGAAAAAGGCCAGCTTGGCTCCAAAACACTTTTTTTTCTAGCTGGACCAGACCAAATTCT
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TTAGTTTTATATGCTTTCTGTTTTATAATTGGAAGCAAAATTTTTTCTCTAGGAATATTATTTTTAATAA
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GACTGCATTATTTATTTACTGTAAGAAAAATATCACCTGGTCAATAAAAAATCCATACATTTTGCTG
## Evaluation Rubric

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<th></th>
<th>Beginning</th>
<th>Developing</th>
<th>Accomplished</th>
<th>Exemplary</th>
<th>Total Possible Score</th>
<th>Score</th>
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<tr>
<td><strong>Initial Group Worksheet</strong></td>
<td>Short answers are incomplete or incorrect. Identification of disease is incorrect.</td>
<td>Short answers are mostly complete and mostly correct. Correct identification of disease.</td>
<td>Short answers are correct and mostly complete. Correct identification of disease.</td>
<td>Short answers are thorough and thoughtful. Correct identification of disease.</td>
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<td></td>
<td>1 Point</td>
<td>2 Points</td>
<td>4 Points</td>
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<tr>
<td><strong>Individual Worksheet</strong></td>
<td>Worksheet is incomplete. Answers show minimal understanding of material.</td>
<td>Worksheet is complete. Answers show moderate understanding of material.</td>
<td>Worksheet is complete. Answers show mastery of material.</td>
<td>Worksheet is complete. Answers show the highest level of understanding.</td>
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<td>5 Points</td>
<td>12 Points</td>
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<tr>
<td><strong>Group Report and/or Presentation</strong></td>
<td>Grammar, organization, formatting, logical arguments, and adequacy of elements considered are minimally acceptable.</td>
<td>Grammar, organization, formatting, logical arguments, and adequacy of elements considered are acceptable.</td>
<td>Grammar, organization, formatting, logical arguments, and adequacy of elements considered show mastery of subject.</td>
<td>Grammar, organization, formatting, logical arguments, and adequacy of elements considered are at the highest level of performance</td>
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<td>9 Points</td>
<td>15 Points</td>
<td>24 Points</td>
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This webquest addresses the following Next Generation Science Standards and Common Core State Standards for high school students.

**Next Generation Science Standards**

**Standards**
- **HS-LS1 From Molecules to Organisms: Structures and Processes**: HS-LS1-1
- **HS-LS2 Ecosystems: Interactions, Energy, and Dynamics**: HS-LS2-2
- **HS-LS3 Heredity: Inheritance and Variation of Traits**: HS-LS3-1, HS-LS3-2, HS-LS3-3

**Science and Engineering Practices**
- Asking questions (for science) and defining problems (for engineering)
- Analyzing and interpreting data
- Using mathematics and computational thinking
- Constructing explanations (for science) and designing solutions (for engineering)
- Engaging in argument from evidence

**Crosscutting Concepts**
- Cause and effect: Mechanism and explanation
- Scale, proportion, and quantity
- Structure and function

**Common Core State Standards**

**ELA/Literacy**
- **Literacy in Science and Technical Subjects (Grades 11 and 12)**: RST.11-12.1, RST.11-12.9
- **Writing (History/Social Studies, Science, and Technical Subjects)**: WHST.9-12.1, WHST.9-12.2, WHST.9-12.9

**Mathematics**
- **Standards for Mathematical Practice**: MP.2, MP.4
- **Number and Quantity – Quantities**: HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3
Alternative Activities

There are several activities that can be used to extend the webquest:

1. **Perform your own DNA extractions.** Students can collect cells by scraping the inside of their cheeks with a tongue depressor or swishing water in their mouths. DNA will be precipitated by treating with a soap and salt solution and isopropyl alcohol.


2. **Create your family tree.** Several web sites provide instructions for producing a family tree that shows genetic traits. This could be a springboard to discuss other kinds of genetic diseases, as well as how certain genes may make individuals susceptible to diseases. This could lead to a discussion about how environment and personal choices affect health.

   http://www.hhs.gov/familyhistory/start/startenglish.pdf
   https://familyhistory.hhs.gov/fhh-web/home.action

3. **Take an inventory of genetic traits.** Students can observe and record various physical characteristics (tongue rolling, widow’s peak, etc.) and compare with classmates.

   https://www.koshland-science-museum.org/sites/default/files/uploaded-files/Traits_Inventor_KEY.pdf

4. **Research another genetic disease.** Choose another inheritable disease, such as one from http://ygyh.org. Students can work in groups to complete the individual role activity and a final group report or presentation.