CSI Wildlife

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Click & Learn
Educator Materials

OVERVIEW

In the *CSI Wildlife* Click & Learn, students analyze genetic evidence to solve two cases of elephant poaching based on real events. Scientists use similar methods to identify the regions where most elephant poaching occurs in order to better protect elephants in those areas.

The Click & Learn can be divided into the following sections, which can be assigned separately or in combination:

- **Introduction and Case One** introduces key principles behind DNA profiling or fingerprinting, including short tandem repeats (STRs), the polymerase chain reaction (PCR), and gel electrophoresis. Students will use this information to determine whether a sample of seized ivory came from an elephant that was illegally poached.
- **Frequency Primer** is a section at the end of Case One where students use allele frequencies to calculate the chances of two elephants sharing the same genetic profile.
- **Case Two and Ivory Trade Summary** extends the concepts in Case One from individuals to populations. Students will apply what they've learned to track a shipment of ivory seized in Taiwan back to its source population in Africa.

The Click & Learn contains several embedded questions to check understanding. It also has three associated worksheets:

- **Student Worksheet One (Analyzing Genetic Evidence)** walks students through all sections of the Click & Learn except for the Frequency Primer. This worksheet can serve as a record of completion, as well as a reference for key concepts.
- **Student Worksheet Two (Using Genetics to Hunt Elephant Poachers)** provides additional data sets that students will use to solve several new cases. This worksheet is more of an extension activity in which students apply what they learned from the Click & Learn. It requires students to think scientifically, use math appropriately, and apply claim-evidence-reasoning to support their thinking.
- The **Frequency Primer Student Supplement** scaffolds the Frequency Primer section at the end of Case One and provides additional practice with probability calculations. It may be helpful for students who are new to frequency and probability calculations.

For suggested implementation strategies, see the Teaching Tips below.

KEY CONCEPTS

- DNA variations can be used to identify individual organisms and genetic relationships between populations.
- Biological techniques such as PCR and gel electrophoresis can be used to generate genetic profiles for individuals and populations.
- Scientists use empirical data and mathematical models to estimate allele frequencies in different populations. These frequencies can be used to calculate the chances of two individuals sharing a genetic profile.
- Science contributes to society in many ways, including helping to conserve wildlife.

STUDENT LEARNING TARGETS

- Describe some of the major challenges African elephant populations face.
- Describe how the process of DNA profiling or fingerprinting works.
- Analyze and interpret gel electrophoresis results to determine relationships between individuals and populations.
- Use allele frequencies to calculate the probability of two individuals sharing the same genetic profile.
- Explain how the geographic and genetic distances between two populations are related.
- Explain how genetic data helps law enforcement officers and conservationists decide where to target their efforts.

CURRICULUM CONNECTIONS

Standards	Curriculum Connection
NGSS (2013)	HS-LS2-2, HS-LS2-7, HS-LS3-3
AP Bio (2015)	3.A.1, SP1, SP2, SP5, SP6
IB Bio (2016)	3.1, 3.5, C.3, C.4
AP Env Sci (2012)	II.A, VII.C
IB Env Systems and Societies (2017)	3.3, 3.4
Common Core (2010)	ELA.RST.9-12.7; Math.S-CP.2, S-MD.7, MP2, MP3
Vision and Change (2009)	DP2

KEY TERMS

conservation, DNA fingerprinting, DNA profiling, elephants, gel electrophoresis, genetic marker, ivory, poaching, polymerase chain reaction (PCR), short tandem repeat (STR)

TIME REQUIRED

Exploring the entire Click & Learn may take 60–90 minutes depending on the students. Recommended times for each section are as follows:

- **Introduction and Case One:** 30 minutes
- **Frequency Primer:** 20–30 minutes
- **Case Two and Ivory Trade Summary:** 15 minutes

Completing the worksheets will require additional time:

- **Worksheet One:** additional 30 minutes
- **Worksheet Two:** additional 30–45 minutes
- **Frequency Primer Guide:** additional 10–20 minutes

SUGGESTED AUDIENCE

- Middle School: Advanced Life Science (may want to skip the Frequency Primer section)
- High School: Biology, all levels
- College-level: Introductory Biology

PRIOR KNOWLEDGE

Students should:

- be familiar with basic genetics concepts, such as DNA, genes, alleles, and homozygosity/heterozygosity
- have some experience calculating frequencies and total probabilities based on multiple independent probabilities

MATERIALS

- computers and an internet connection so students can access the Click & Learn
- copies of the associated worksheets (optional; see Teaching Tips for worksheet recommendations)
- calculator (optional; recommended for the worksheets)

TEACHING TIPS

- Have students work in pairs or small groups to complete the Click & Learn and associated worksheets.
- If you have only one class period to spend on the Click & Learn, we suggest focusing on Case One and Questions 1–15 of Worksheet One. If you have additional time, add on Case Two and the remaining questions of Worksheet One; alternatively, assign these as homework.
- Worksheet Two can be used as an enrichment extension. For advanced classes, you may wish to replace Worksheet One with Worksheet Two as the Click & Learn's primary accompaniment.
- The "Frequency Primer" and accompanying guide can be used as an enrichment extension or as a math activity for a collaborative unit.
- The scenarios in the Click & Learn are based on published literature. As an additional extension, you may have students read the Wasser *et al*. paper cited in the References and explore its underlying data.
- Students may be used to thinking about alleles as variations in genes. Here, the alleles are different versions of short tandem repeats at various locations in the genome. It may be helpful to review with students at different points in the interactive that any one marker can have many alleles in a population, but any individual elephant will have either one or two alleles for that marker.

REFERENCES

Wasser, S. K., L. Brown, C. Mailand, S. Mondol, W. Clark, C. Laurie, and B. S. Weir. "Genetic assignment of large seizures of elephant ivory reveals Africa's major poaching hotspots." *Science* 349, 6243 (2015): 84–87. https://doi.org/10.1126/science.aaa2457.

The article's underlying data are available on the Dryad Digital Repository at http://dx.doi.org/10.5061/dryad.435p4.

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