

## Lesson Plan — DNA Barcoding of Different Organisms

**Goal:** Students will perform an experiment where they will be testing different DNA samples of animals with the goal that this will help identify the unknown identity of the samples.

### Background:

It can be difficult to identify a species simply by analyzing its physical characteristics. The method of grouping organisms according to common physical characteristics, known as Linnaean taxonomy, has been around for 250 years and has long been the standard method of species identification. However, that does not mean this method is always easy or accurate. Confounding factors such as convergent evolution, where two species starting from quite different ancestors independently develop similar traits due to environmental pressures, make Linnaean taxonomical classification difficult. Examples include quills on both porcupines and echidnas, wings on bats and birds, or biomimicry such as nontoxic viceroy butterflies resembling poisonous monarch butterflies. Even after 250 years of collection, analysis, and categorization of species using physical characteristics, fewer than two million of Earth's estimated 10–50 million plant and animal species have been formally described and cataloged. With the increases in human population, habitat destruction, pollution, and overharvesting, the rate of species loss threatens to outpace the rate of species discovery using this traditional classification system.

The explosion of faster and cheaper technology to isolate, purify, amplify, and sequence DNA has spurred the development of new methods to help identify different species. Using DNA-based technologies, a multinational alliance of scientists is now cataloging life using what is called a DNA barcoding system in order to accelerate the discovery of species and develop powerful new tools to monitor and preserve Earth's vanishing biodiversity. In much the same way that a UPC (universal product code) barcode can differentiate a carton of milk from a bag of carrots when scanned at the grocery store, DNA sequences can be used to uniquely identify different species. DNA barcoding consists of two primary components:

- 1) a genetic sequence or barcode that is unique to a particular species, comparable to a commercial product UPC; and
- 2) a database capable of providing the identity or name of a species by reading and matching its genetic barcode to a library of reference barcodes. That library performs a function similar to that of a grocery store's cash register computer.

DNA barcoding uses a short genetic marker to identify an individual organism as belonging to a particular species. An ideal DNA barcode should be present in most organisms of interest, readily amplified without using species-specific PCR primers, and should exhibit relatively few nucleotide differences among members of the same species but larger variation between species.

**PROCEDURE:**

The DNA Barcoding Kit encompasses a laboratory workflow designed to serve eight student groups in extracting and purifying DNA from a tissue sample, amplifying a region of DNA suitable for barcoding, sequencing the amplified DNA, and using bioinformatics analysis to determine the genetic identity of the original sample.

|                                                                 |                                                     |                                       |
|-----------------------------------------------------------------|-----------------------------------------------------|---------------------------------------|
| Prepare DNA samples using extraction buffers and centrifugation | Add master mix to DNA samples and control DNA       | PCR amplification and electrophoresis |
| View results on a UV transilluminator                           | Analyze DNA via electrophoresis                     | PCR results analysis                  |
| Mail PCR products to sequencing facility<br>DNA extraction      | Analyze sequences using DNA bioinformatics platform |                                       |

**DISCUSSION:**

Have students discuss their result and propose how this helps in identifying unknown sources of DNA. Present examples of practical use in animal identification.