



DNA Barcoding 101 Answer Page

These are suggested answers to the assignment/discussion questions in **BLM M3: DNA Barcoding 101 Assignment**.

1. What is DNA barcoding?

DNA barcoding is the process of taxonomically identifying a species based on a short sequence of mitochondrial DNA (mtDNA).

2. List some applications of DNA barcoding

- catching agricultural pests at the border (identifying invasive species)
- identifying disease-carrying mosquitos (bioremediation)
- preventing consumer fraud by accurately identifying the fish used in food
- identification of the remains of birds that have struck aircraft to better understand flight paths and help avoid bird strikes in the future
- taxonomy (the identification of organisms can be done in a much more efficient way)
- tracing unwanted plant and animal ingredients in foods

3. Why are the traditional methods of classifying species not sufficient?

Traditional methods:

- are very time-consuming
- can result in inaccurate species identification
- overlook morphologically cryptic taxa, that is, taxa that are extremely difficult to identify on morphology alone
- cannot identify some species unless they are a particular gender (e.g., male) and/or a particular stage of life (e.g., adult)

4. List some of the limitations associated with using snippets of DNA to identify certain species

- It may not work as well for other plant and animal groups, such as lichen, fungi and parasitic insects
- DNA barcoding isn't nearly as accurate as promised

5. What other limitations might this technique have?

- It may be difficult to identify species since species boundaries can be blurred by hybridization or introgression; therefore, supplemental analyses of one or more nuclear genes will be required
- It may be difficult to identify species that have arisen through polyploidization

6. What is the function of cytochrome c oxidase 1 (COX-1) and where is it found?

Cytochrome c oxidase-1 (COX-1) is one unit of a large trans-membrane protein complex found in bacteria and mitochondria. As the final step in the electron transport chain, cytochrome c oxidase-1 is vital for the energy production of the mitochondria.



7. How is the COX -1 gene related to species identification?

COX-1 is one of the subunits that is manufactured within the mitochondria, encoded by mtDNA. The gene has enough sequence diversity that it is able to distinguish between species but enough similarities that a single probe can be used making it a simple target for species identification.

8. Why is it not practical or efficient to barcode an organism's entire genome: what is used instead?

Targeting the entire genome is inefficient and would take a long time. By targeting a small area, the identification can be done much faster. The target gene COX-1 from mtDNA is used instead. Since the gene encoding COX-1 is part of the mitochondrial genome, this means that this region of DNA, while mandatory for life in all organisms, will exhibit the same variability inherent in all mtDNA. This gives the region encoding COX-1 both an ubiquitous and highly variable nature - basically, it's in every eukaryotic cell and it changes a lot from one species to another. On top of that, there are many mitochondria in a cell and many copies of the mtDNA within each mitochondrion, so there's the potential to extract a lot of COX-1 from even a tiny sample. Furthermore, COX-1 is a better target than the nuclear genome because of its lack of introns, its limited exposure to recombination and its haploid mode of inheritance; it is cheaper and takes less time.

9. How many species have been identified to date? How many are yet to be identified? How many have been identified using DNA barcoding?

Only 1.7 million species have been DNA barcoded so far - leaving over 28 million more species to be DNA barcoded. DNA barcoding has been used to identify 31,000 new species so far.

10. What are some of the future goals scientists hope to achieve in using this technique?

Scientists hope to:

- DNA barcode 500,000 species in the next 5 years
- find ways to barcode plant species as well
- identify all the biodiversity of life