Bioinformatics:

Food Detective

Lesson Plan

|  |
| --- |
| Stevie A Bain, Daniel Barker and Richard Fitzpatrick |
| 4273pi Bioinformatics Education Project, <https://4273pi.org> |
|  |
| Copyright and related rights waived via CC0 1.0 Public Domain Dedication |
| (<https://creativecommons.org/publicdomain/zero/1.0>). |
|  |
| **Version 2.1 (long)** |

Timings are approximate and assume a total of **90 mins** (comfortably fitting within a double period).

# BEFORE THE WORKSHOP

# 10 minutes

Check the NCBI Web site is working: perform steps 1–10 of the worksheet and check you get a result.

# INTRODUCTION

# 20 minutes – 0:00 to 0:20

Slide 1: **What is DNA** – give a brief overview of the structure of DNA with particular focus on the 4 bases: Adenine, Thymine, Guanine and Cytosine.

Slide 2: **How do we read DNA** – we need to extract DNA from the cells and use a machine called a sequencer that identifies the different bases based on their structure. DNA sequencing generates huge volumes of information so we need computers to help us store and analyse it.

Slide 3: **What DNA can tell us**

Slide 4: **DNA barcoding** – introduce the technique of DNA barcoding (details on slide) and make analogy to barcodes on products in the supermarket. Take home message is that these are regions of DNA that are present in all species but that have distinct differences between species that we use for identification.

Slide 5: **Uses of DNA barcoding** – this is a widely used techniques across many areas of science. It is used to identify species that may look very similar in ecological analyses (particularly some larvae that cannot be identified in any other way). Also used widely to test product authenticity e.g. timber, fish, leather and crops.

Slide 6: **Horsemeat scandal** – ask students if they know what this slide is all about (they usually remember the horsemeat scandal very well). Explain that DNA barcoding was used by Government scientists during this time to test food products – reinforce that horse DNA is different to sheep/cattle/pig etc DNA and so we can look at these DNA barcodes and identify species. Still very topical today.

Slide 7: **Introduce the task** – explain to pupils that these are genuine DNA sequences.

Slide 8: Explain that this is what DNA sequences look like after sequencing.

Slide 9-12: **NCBI/BLAST introduction** – use these slides to introduce pupils to the webpages they will be using. Keep this brief, but mention key points such as where to paste the sequences and where they will find their results (the parts of the table highlighted with the red arrows).

Slide 13: **Species names** – these will be in Latin throughout the workshop so inform pupils that there is a table for reference in their worksheet.

Slide 14: Ask pupils to begin Task One, working in pairs but each pupil completing their own worksheet.

# TASK 1

# 20 minutes – 0:20 to 0:40

# DISCUSSION OF RESULTS AND INTRO TO TASK 2

# 15 minutes – 0:40 to 0:55

Slide 15: **Results** – ask pupils what species they found in the sausage DNA samples. Did they find anything unusual? Don’t discuss E-values at this point.

Slide 16: **Discuss how ‘unexpected’ results may occur.** Ask pupils what they think. Other animals – traces from other meats on butcher countertops and machines. Human – sausages are handmade so likely some human DNA traces from that process. **Any** food is likely to have some human DNA on it, not just sausages. (Although they cannot tell this from their work, the amount of human DNA in the sausage was very low, certainly nothing to worry about.) Also, DNA sample could have been contaminated in the lab during extraction and sequencing processes.

Slide 17: **Recap**

Slide 18: **Explanation of E-values.** Key take home messages are the bullet points at the bottom of this slide.

Slide 19: **Further e-value information.** Reinforce that reliability of results is very important and e-values are one of the ways in which we get an indication of a BLAST results reliability.

Slide 20: **No match in database**. Briefly discuss the reasons why we may find no match to our sequence in the database.

# TASK 2

# 15 minutes – 0:55 to 1:10

# DISCUSSION OF RESULTS AND WRAP UP

# 15 to 20 minutes – 1:10 to 1:25 or 1:30

Slide 21: **Discuss Task 2 results.** Compare e-values in this task to the previous task and discuss reliability. There is a difference between (perhaps) unexpected results with **high** reliability (Task 1), and unexpected results with **low** reliability (Task 2). In Task 1, we believe these various animals – cow, human, etc – **do** have some DNA in the sausage. In Task 2, we **do not** believe these various organisms have DNA in the sausage. In Task 2, the E-values are unreliable. One likely explanation is, errors in the DNA sequences in Task 2. DNA sequencing machines are not perfect.

## EXTENSION TASKS – if time permits

There are many aspects of the topic students can explore themselves through Web searches, for example:

Find and report on an example of DNA barcoding in conservation.

Find examples and report on an example of DNA barcoding used to detect mislabelled food.