CONSTRUCT A BUG

Activity overview

Age: 11 – 18 years old

Time: 30 min

Topics: Genomics, DNA, genes, genetic variation, microbes, antimicrobial resistance

Learning objectives:

- A genome is an organism's complete set of genetic instructions. Each genome contains all of the information needed to build that organism and allow it to develop and function the way it does.
- Genes are sections of DNA within the genome that act as the individual instructions giving an organism its traits.
- Bacteria are a type of microbe that are highly relevant in biomedicine and biotechnology.
- DNA sequencing can be used to characterise unknown microbes (often hard to do using traditional methods).

BACKGROUND

A bit like a recipe book, all the biological instructions for making an organism are contained in a long molecule called DNA (deoxyribonucleic acid). All living things, from humans and mice, to plants and bacteria, have a unique set of instructions written in the four chemical letters of DNA: A, C, G, and T. The whole set of instructions for an individual is called a genome.

Within the DNA code are the instructions for all the proteins (molecular machines) that our body needs to function. These instructions are called genes, with there being different genes associated with different features of an organism.

Bacteria are a hugely diverse kingdom of life. They play important roles in many natural processes, as well as, in disease and human healthcare. Over the last century, bacteria have become better understood and in some cases utilised for useful biotechnological purposes. Their role in disease has also become ever more a focus of research with the rise of antimicrobial resistance in a number of pathogenic (infection causing) bacteria adding more pressure to healthcare services worldwide.

With the advancement of DNA sequencing technology, there are now new ways to probe the microbial world and uncover new medicines, technology, and novel products hidden in microbial DNA. It has also provided new methods to identify specific bacteria in samples that would have appeared the same when analysed using traditional identification methods.

In this activity we will explore how DNA sequencing can be used to identify specific species of bacteria based on their unique genetic code. We will also discover how the presence of specific genes in an organism's genome can provide clues as to the lifestyle and survival strategy of that organism. We recommend running this activity with groups of 2-4 but larger groups or individuals can also do the activity.

Find out more

What is a genome:
www.yourgenome.org/facts/what-is-a-genome

What does DNA do:
www.yourgenome.org/facts/what-does-dna-do

What are infectious diseases:
www.yourgenome.org/facts/what-are-infectious-diseases

What is *Salmonella*:
www.yourgenome.org/facts/what-is-salmonella

ACTIVITY PREPARATION

Materials

- ☐ Sequence reads sheet
- ☐ Reference genome sheet
- ☐ Gene profile sheet
- ☐ Bacteria Information sheet
- ☐ Worksheet
- ☐ PowerPoint Slides (optional)

Set up

1. Print and cut out sequence reads from the sheet so you have enough for 5-6 per group. Shuffle and distribute so each set is randomised

2. Provide each group with a worksheet, reference genome sheet, gene profile sheet, and a bacteria information sheet if not using the provided PowerPoint slides.

ACTIVITY GUIDANCE

Warm up

1. Using the PowerPoint slides provided (optional), begin the activity by discussing with the group that DNA contains the instructions for making all living things. All the DNA instructions in an organism is called the genome. Within the DNA code are instructions for making proteins – these instructions are called genes. The genes give the organism its characteristics. Explain how different organisms have different amounts of DNA (different length instruction manuals) and different numbers of genes (often depending on how many things the creature needs to do).

2. Describe how DNA sequencing in a technique used to turn the DNA molecule into a sequence of DNA letters that can be matched with known genes to work out what the DNA is coding for. Highlight how this is often done by matching sections of DNA code with known genomic data.

3. Explain to the group that they are going to work in small teams to identify a fictional unknown bacteria from a sample by matching sequence reads (sections of DNA) from their fictional bacteria with sequences from known bacteria species.

Run the activity

1. Hand out sets of 5-6 DNA sequence reads to each group to act as their sequencing results.

2. Explain that they need to match the reads they have to the reference genome DNA codes (every read should match somewhere).

3. Show them how they can find the name of the gene(s) their read comes from by reading the gene names above the DNA sequences on the genome reference sheet. As they do this they need to tick off the genes they find on the gene profile sheet.

4. Once they have done this for all their sequence reads they should look at what genes are ticked on their gene profile sheet. These are the genes their unnamed mystery bacteria contains.

5. They should then use this knowledge to answer the questions on the worksheet. They can refer to the bacteria information sheet to help with this or the PowerPoint slide containing the same information. Note that the answers will depend on what combination of sequence reads each group got.

Reflect on it

Highlight to the group how this technique is still relatively new and is having a huge impact due to how much easier and more accurate it is compared to many traditional techniques (such as selective microscope staining of bacterial cells).

Discuss how bacteria can often share DNA and genes and ask the group to consider what this might mean for outbreaks of pathogenic bacteria.

Take it further

Want to explore how DNA codes for specific proteins? Try decoding DNA codes from a range of species in the natural world.

Function finders: www.yourgenome.org/activities/function-finders

You have explored how much DNA is in different organisms but what does all that information really look like? Try your hand at extracting DNA from fruit and see for yourself what the molecule of life looks like.

Extracting DNA from fruit: www.yourgenome.org/activities/extracting-dna-from-fruit