



Class: Getting To Know You: DNA Progress versus Privacy (Biology)
Workshop 2: DNA and Human Health.

Lesson Plan

60 – 75 minutes: The Inspire Scholars Programme for Years 9, 10 & 11

Learning Objectives (skills-based)

Explain that some human diseases are impacted by mutations in more than one gene
Apply DNA sequencing techniques to decode DNA
Critique arguments for and against the routine sequencing of human DNA

Learning Points (knowledge-based)

1. Most human traits involve more than one gene (polygenic)
2. It can be medically important to look at all the genes which impact on one phenotype
3. DNA sequencing determines the order of A, C, G and T bases in the genome
4. DNA sequencing is becoming cheaper and could help us with personalised medicine
5. 'Big Data' refers to the storage of large data sets, such as genomes
6. There are ethical considerations involved in routinely sequencing people's genomes

Materials required

- A. Pencil and Worksheet (1 per student)
- B. DNA sequencing technologies kits in envelopes labelled: **1st** - a discovery sheet and a 'gel', **2nd** – a discovery sheet and a 'photo-set', or **3rd** – a discovery sheet and electricity signals with 2 small comparison signals) (3 envelopes per kit, groups of 3-5 students)
- C. DNA nucleotides cut-outs
- D. Set of Big Genomics debate characters (1 set of 4 per kit, divide students into 4 groups of 2-4 students) *This is an adapted resource offered free from 'I'm a Scientist get me out of here'*

Video resources

Videos (Vid-1 to Vid-5) are included in the resources for this workshop. These videos are designed as an example of the workshop being delivered. They are intended to be used flexibly to support the workshop as required. You may use all or none of these videos to help run the workshop, in the way you find most helpful.

- **Clarification:** refer to videos as specified when looking through this lesson plan to clarify points, demonstrate activities and see worked through answers. This is particularly the case for Vid-3, which summarises points students will discover and present in one of the class exercises.
- **In class:** play videos (or sections of videos) directly to the students. For example:
 - The start of a video where new ideas are introduced
 - The end of a video where solutions to particular activities are outlined.

Pause points are included to allow students to complete activities. In this lesson plan, pause points are referred to as (**pause -time- Vid-X**). The corresponding video will display a screen 'Pause here'. These points are designed to give students time to complete the corresponding activity or discussion in the lesson plan.



Session outline

| Time (mins) | Activity | Key skills | Materials |
|-------------|--|--|------------------|
| 5-10 | <ul style="list-style-type: none"> Introduce the idea that many human diseases are caused by more than one gene. Ask students to examine their worksheets (page 1) and read the section 'More than one gene'. Ask students to consider other human diseases which they think might be caused by mutations in more than one gene (examples are given on the answer sheet). (pause 02:57 Vid-1) Discuss why sequencing someone's entire genome (all their DNA) could be useful when treating these diseases: <ul style="list-style-type: none"> 1) it would allow us to know more information about the patients particular type 2) this may be important when considering treatments Conclude this section by commenting that testing people for one gene does not always give us the medical information we need. Therefore, since the structure of DNA was discovered (1953) we have been trying to sequence our DNA, and students will now learn how technology has helped us do this. | <ul style="list-style-type: none"> Identify relevant information from a worksheet Discuss human diseases caused by one gene | A Vid-1 |
| 15 | <ul style="list-style-type: none"> Introduce that we read the bases of DNA using DNA sequencing technologies. Divide students into three groups of 3-5 students. (pause at end of Vid-2) Assign each group either 1st 2nd or 3rd generation DNA sequencing. Each group should receive the Discovery sheet (1st, 2nd or 3rd generation sequencing), and the corresponding laminate (organised into envelopes labelled 1st, 2nd and 3rd). Ask students to read their Discovery Sheet to find how their technology works and what the key advances were during the use of this technology. They should note the type of sequencing they are looking at on their worksheet. Students should decode their laminate (which represents data from their assigned sequencing technology) and use the 3D nucleotides to build the DNA molecule they decode as a group. | <ul style="list-style-type: none"> Identify how one kind of DNA sequencing works Solve the DNA sequence from one kind of sequencing data | A, B, C Vid-2 |
| 10-15 | <ul style="list-style-type: none"> Ask each group (beginning with 1st generation sequencing) to explain their DNA sequencing technology. | <ul style="list-style-type: none"> Describe a kind of sequencing | B, C Vid-3* |



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| | <ul style="list-style-type: none"> • Groups should explain the technique, then explain how they interpreted their laminated data to build their DNA molecule. • Other information groups should include: • Years this technology was mainly used • Things sequenced using this technology • Any new projects (such as the Human Genome Project) started in this time • Students should be prepared to answer questions about their technology from the rest of the group, before moving onto the 2nd group, then the 3rd group. <p><i>*Vid-3 is included in the Y9Biol01P2 resources. This 10 minute video summaries all three generations of DNA sequencing: 1st generation (00:28), 2nd generation (04:29) and 3rd generation (07:06) DNA sequencing technologies. It is not expected that Vid-3 will be played to students as they will have already found and spoken about this information in their presentations (above).</i></p> | <p>technology to a group of people</p> <ul style="list-style-type: none"> • Demonstrate how to interpret data to decode DNA • Distinguish between the three kinds of DNA sequencing | |
| 5 | <p>Having considered how to sequence human DNA, ask students to now consider whether we <i>should</i> sequence human DNA. Explain that in 2010 the UK launched a project called UK10 in order to sequence 10,000 human genomes.</p> <ul style="list-style-type: none"> • Scientists wanted to learn about small differences in DNA which add up to cause disease. • The diseases which are influenced by changes in many genes are known as polygenic traits. • Learning how different gene variants can contribute to disease helps doctors treat people in the best way for them. This is known as personalised medicine. | <ul style="list-style-type: none"> • Define polygenic traits and personalised medicine | A Vid-4 |
| 5 | <ul style="list-style-type: none"> • Divide students into four groups of 2-4 students. Hand out one debate character per group. • Ask students (using their worksheet as a prompt) to consider whether their character is for or against the UK10 project. • Ask students to consider what their characters' main reasons for this opinion are, and make notes to convey this point of view in a debate. (pause 03:41 Vid-4) | <ul style="list-style-type: none"> • Appraise an opinion on a controversial topic | A, D Vid-4 |
| 10 | <ul style="list-style-type: none"> • Run a debate between students, in their character personas. • Go around the groups, giving each 2 minutes to present: • 1) Their character's name, job and whether they are for or against the UK10 project. | <ul style="list-style-type: none"> • Construct an argument to support one point of view | D |



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| | <ul style="list-style-type: none"> • 2) Their MAIN reason for this point of view | | |
| 10-15 | <ul style="list-style-type: none"> • Read the following statements and questions to each group. Give them a minute to discuss how their character would respond before asking each group in turn to answer. (Remind groups to use the facts and information on their character sheet to help them.) • 1) Not all genetic diseases can be treated currently. Would you want to know that you had a genetic disease if it wasn't curable? (pause 04:26 Vid-4) • 2) Being at risk for a genetic disease doesn't mean you will definitely develop that disease (e.g. 10% of people with your mutation may develop cancer). Does that change your mind about getting your DNA sequenced? (pause 05:06 Vid-4) • 3) You share your DNA with other members of your family. Do you think someone should have to get their family members' permissions before having their DNA sequenced? (pause 06:21 Vid-4) | <ul style="list-style-type: none"> • Defend a particular point of view with reasoned points and/or facts | Vid-4 |
| 0-5 | <ul style="list-style-type: none"> • Depending on time, the following activities can either be introduced as extension activities or done in the session. Ask students to consider the arguments they have heard for and against human DNA sequencing. • Students should decide if they would personally like their DNA sequenced or not. Use their worksheet to write a justified response. | <ul style="list-style-type: none"> • Weigh the pros and cons of sequencing human DNA • Develop a personal opinion on DNA sequencing | A Vid-5 |



Syllabus links to national curriculum (KS4)

Syllabus correct from following source, 19th March 2019.

<https://www.gov.uk/government/publications/national-curriculum-in-england-science-programmes-of-study/national-curriculum-in-england-science-programmes-of-study#key-stage-4>

Core concepts (analysis and evaluation)

- presenting reasoned explanations, including relating data to hypotheses

Biology

Evolution, inheritance and variation

- the genome as the entire genetic material of an organism
- the potential impact of genomics on medicine
- genetic variation in populations of a species
- the uses of modern biotechnology including gene technology; some of the practical and ethical considerations of modern biotechnology

Syllabus links to national curriculum (KS5)

Although the aim is not to teach KS5 material, introducing students considering science A-levels to KS5 material, where relevant, will help them when they come to learn these topics.

Syllabus correct from following source, 19th March 2019.

https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/593849/Science_AS_and_level_formatted.pdf

Biology

19. Genetics and evolution

- sequencing projects have read the genomes of organisms ranging from microbes and plants to humans. This allows the sequences of the proteins that derive from the genetic code to be predicted genetic variation in populations of a species
- gene technologies allow study and alteration of gene function in order to better understand organism function and to design new industrial and medical processes