Video: Breeding a sustainable future

Student video resource worksheet

Level

10

Curriculum Area

Science

Print Resource

Resource description

This is a video unit developed with a supplementary learning experience to look at two connected streams of science. The ‘Breeding a sustainable future’ video reports on the technological advancements in the Cotton industry and how reproductive technologies such as Biotechnology are being used to improve yields. The video has a focus on Biotechnologies.

The video is supported by a **learning experience** to provide you with content to cover after viewing the video.

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Curriculum focus

In this unit, students:

- Explore past and present methods/practices in modern farming
- Investigate technological developments that have been applied to modern farming to improve yield and sustainability
- Develop an understanding of how science can connect through disciplines
- Develop an understanding of the variety of reproductive technologies and how these are applied in science and the field of primary industries.
- Investigate and present findings on types of technological developments in reproduction and where they are use

Explore and evaluate knowledge regarding GMO and consider different claims and explanations from a range of difference perspectives.

Based on Australian Curriculum, Assessment and Reporting Authority (ACARA) materials downloaded from the Australian Curriculum website in February 2015. ACARA does not endorse any changes that have been made to the Australian Curriculum.

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Australian Curriculum content descriptors

Year 10 science:

Transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)

The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)

People use scientific knowledge to evaluate whether they accept claims, explanations or predictions, and advances in science can affect people's lives, including generating new career opportunities (ACSHE194)

Formulate questions or hypotheses that can be investigated scientifically (ACSIS198)

Note: Before completing this unit of work it is recommended that students have completed the curriculum content related to reproduction: Multi-cellular organisms contain systems of organs carrying out specialised functions that enable them to survive and reproduce (ACSSU150)

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Cross Curriculum Priorities

Learning Experience

Lesson overview

The lesson will provide students an opportunity to examine the primary industries pathway to innovative developments to improve yields.

Students will:

- view content on the technological developments in the primary industry field of cotton
- conduct investigations developing skills in DNA extraction and analysis.

Lesson outcomes

Students will be able to:

- prepare a sample of DNA from plant material and animal.
- Review material to understand how this DNA material can be used in advancements in Biotechnology

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Teacher Background information

All living organisms contain Deoxyribonucleic acid (DNA). Some fruits are especially suited for DNA extractions due to their multiple sets of chromosomes. For example, strawberries are octoploid, which means they have 8 copies of each chromosome. Because of the large yield, strawberries are often used to extract DNA (see lesson plan for strawberry DNA extraction on this site; http://www.imb.uq.edu.au/download/large/strawberryDNAextraction.pdf (http://www.imb.uq.edu.au/download/large/strawberryDNAextraction.pdf)). Human body cells are diploid; they contain two copies of each chromosome. Extracting DNA from cheek cells yield just a very small amount of DNA. But students still enjoy the activity and are excited about seeing their own DNA.

Individual strands of DNA are too small to be visible to the eye.

DNA is the genetic material of all organisms, except some viruses. Located within cells, DNA cannot be seen with the naked eye – or can it? Students will extract DNA conducting an experiment on plant material, and then on themselves.

The reason it can be seen in this activity is because students are releasing DNA from a number of cells. This happens when the detergent or dishwashing liquid breaks, or lyses, the membranes around the cell and around the nucleus. Once released, the DNA from the broken open cells intertwines with DNA released from other cells. Eventually, enough DNA intertwines to become visible to the eye as whitish strands. Tell students that one strand of DNA is so thin (.0000002mm) they would never be able to see it without using a microscope.
Detergents break open cells by destroying the fatty membrane that encloses them. This releases the cell contents, including DNA, into the solution. Detergents also help strip away proteins that may be associated with the DNA.
DNA is not soluble at high ethanol concentrations, so it precipitates out as long strands. Salts, such as sodium chloride, also greatly aid in precipitating DNA. The ethanol also causes gases dissolved in the water to be released, which may be observed as small bubbles. This procedure may not work well if the researcher has eaten corn flakes for breakfast. Presumably this is because the corn flakes have scoured too many buccal cells from the inside of the mouth. Repeating may give low yields if most of the loose buccal cells have already been harvested.
Reference 1 (http://www.seplessons.org/node/222)

Electrophoresis
Once extracted what can you do with the DNA? How is this technology used in life?

Gel electrophoresis is used to separate macromolecules like DNA, RNA and proteins. DNA fragments are separated according to their size. Proteins can be separated according to their size and their charge (different proteins have different charges).

A solution of DNA molecules is placed in a gel. Because each DNA molecule is negatively charged, it can be pulled through the gel by an electric field. Small DNA molecules move more quickly through the gel than larger DNA molecules.
The result is a series of ‘bands’, with each band containing DNA molecules of a particular size. The bands furthest from the start of the gel contain the smallest fragments of DNA. The bands closest to the start of the gel contain the largest DNA fragments.

When is gel electrophoresis used to separate DNA fragments?
Gel electrophoresis can be used for a range of purposes, for example:

- To get a DNA fingerprint for forensic purposes
- To get a DNA fingerprint for paternity testing

- To get a DNA fingerprint so that you can look for evolutionary relationships among organisms
- To test for genes associated with a particular disease.
- Plant breeding

Reference 2 (http://biotechlearn.org.nz/themes/dna_lab/gel_electrophoresis)

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Equipment

Provide **worksheet 1** for each student

Download Worksheet 1 (pdf/biotech-video-ws1.pdf)

Equipment listed in the following website to conduct the experiment
http://www.pbs.org/wgbh/nova/education/activities/2809_genome.html (http://www.pbs.org/wgbh/nova/education/activities/2809_genome.html)

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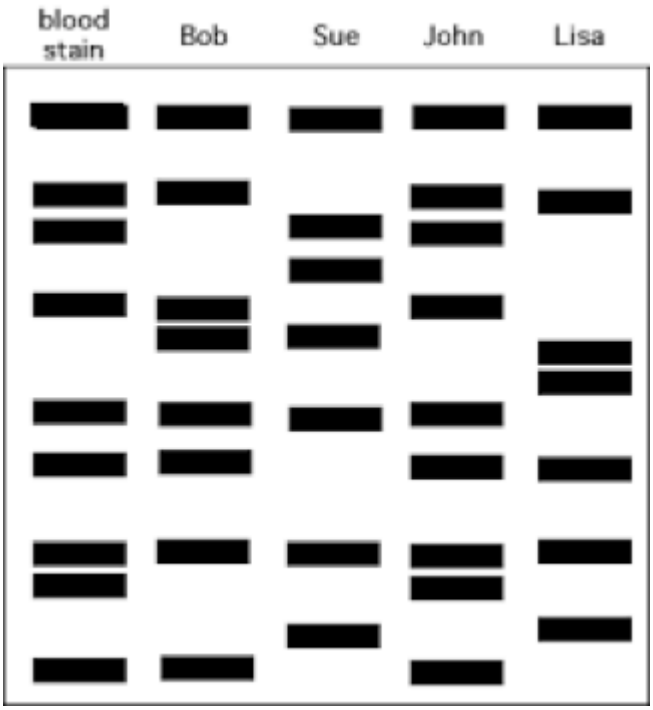
Lesson steps

1. Watch the PIEFA video on 'Breeding a sustainable future' (http://youtu.be/CkgsbAqeK48)
2. Conduct a strawberry DNA extraction http://www.imb.uq.edu.au/download/large/strawberryDNAextraction.pdf (http://www.imb.uq.edu.au/download/large/strawberryDNAextraction.pdf)
3. Discuss with students about there own DNA. Why is it important, what does it tell us about ourselves, do students know how DNA being used in forensic science today?
4. Provide each student with a copy of worksheet 1
5. Review the website (http://www.pbs.org/wgbh/nova/education/activities/2809_genome.html (http://www.pbs.org/wgbh/nova/education/activities/2809_genome.html)) and prepare the solutions for the class experience
6. Discuss with students about how the DNA may be used from this extraction. The following website looks at the process of electrophoresis and how it can be used http://www.vce.bioninja.com.au/aos-3-heredity/molecular-biology-technique/dna-

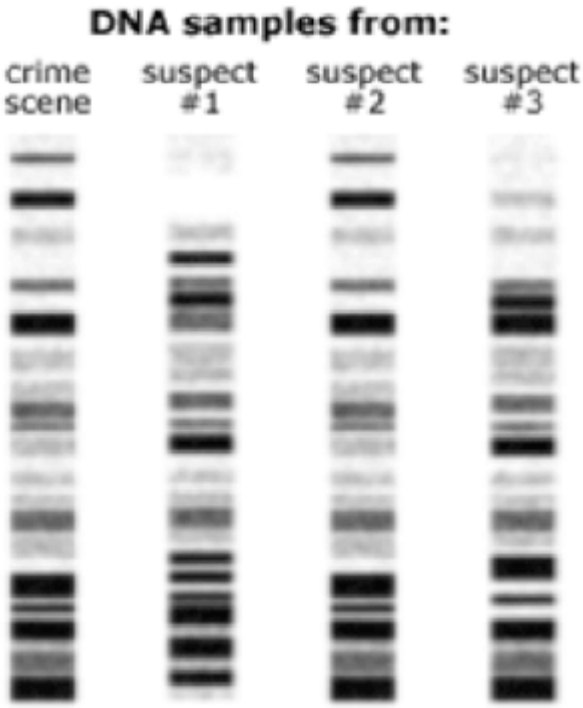
profiling.html (http://www.vce.bioninja.com.au/aos-3-heredity/molecular-biology-technique/dna-profiling.html)

7. Get the students to read and answer the following electrophoresis diagrams.



Source: https://molecularbioanditsuses.wordpress.com/ (https://molecularbioanditsuses.wordpress.com/)

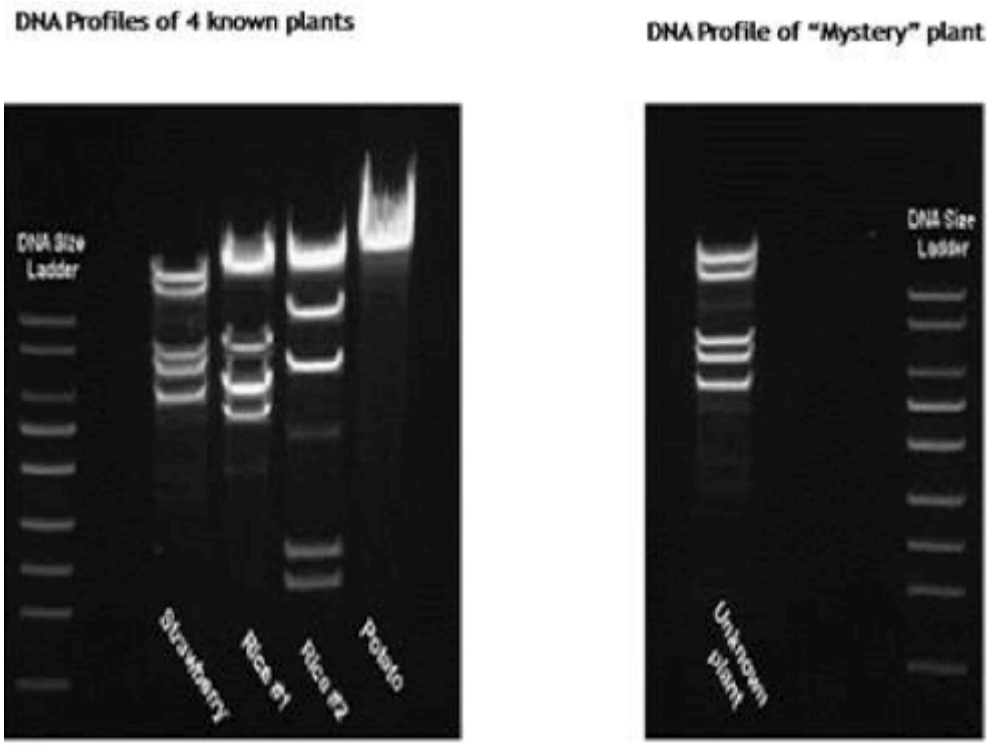
Which person's DNA matches the blood stain DNA sample provided?



Source: http://evolution.berkeley.edu/evolibrary/news/060301_crime

(http://evolution.berkeley.edu/evolibrary/news/060301_crime)

Which suspects DNA was found at the crime scene?



Source: http://www.apsnet.org/EDCENTER/K-12/TEACHERSGUIDE/PLANTBIOTECHNOLOGY/Pages/Modifications.aspx

(http://www.apsnet.org/EDCENTER/K-12/TEACHERSGUIDE/PLANTBIOTECHNOLOGY/Pages/Modifications.aspx)

Using electrophoresis determine what is the 'mystery plant'?

8. Research and identify 5 ways electrophoresis and DNA marker assisted technology is being used in agriculture

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Resourcing the unit

Reference 1. http://www.seplessons.org/node/222 (http://www.seplessons.org/node/222)

Reference 2. http://biotechlearn.org.nz/themes/dna_lab/gel_electrophoresis

(http://biotechlearn.org.nz/themes/dna_lab/gel_electrophoresis)

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Additional biotech resources

https://bio4esobil2009.wordpress.com/2010/04/08/questions-about-dna-fingerprinting-and-electrophoresis/ (https://bio4esobil2009.wordpress.com/2010/04/08/questions-about-dna-fingerprinting-and-electrophoresis/)

http://www.livescience.com/37252-dna-science-experiment.html (http://www.livescience.com/37252-dna-science-experiment.html)

http://aworldofbiology.weebly.com/genetic-modification-and-biotechnology.html (http://aworldofbiology.weebly.com/genetic-modification-and-biotechnology.html)

http://www.thirteen.org/edonline/concept2class/constructivism/lp_dna2.html (http://www.thirteen.org/edonline/concept2class/constructivism/lp_dna2.html)

http://www.apsnet.org/EDCENTER/K-12/TEACHERSGUIDE/PLANTBIOTECHNOLOGY/Pages/Modifications.aspx (http://www.apsnet.org/EDCENTER/K-12/TEACHERSGUIDE/PLANTBIOTECHNOLOGY/Pages/Modifications.aspx)

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