A Swansea University Science for Schools Scheme (S4) lesson plan and hands-on experimental workshop.

All S4 workshops follow the same format. They contain background information, a kit list, an experimental design, key words and concepts and learning outcomes and signposts for further information. You can also email any questions or queries to s4science@swansea.ac.uk

Banana DNA: a workshop on genetics.

1. What is the workshop about?

What do you have in common with a banana? It may seem unlikely, but all living things – from bananas to people – are made up of the same basic building blocks. This workshop introduces students to the concept of DNA as the building block of living things, and basic genetics. Students are given an insight into the function and structure of DNA, what a gene is, and the process of inheritance.

The workshop begins with an introduction to the importance of DNA in living creatures. Students are taught what DNA is, where it is found in the cell, what it is made of, and the vital job it has. The principle of inheritance is also introduced. Students are taught the process of passing on traits (different features) to offspring (young/babies), and the concept of dominant and recessive genes. The experiment is then carried out to extract the DNA from a banana. The experimental component has multiple stages, some of which do involve waiting before the next stage. The gaps in between stages can be used to further discuss genetics and inheritability.

Summary: the lesson/workshop plan has two parts:

- **A) Introduction** – DNA ''the building blocks of life", what are genes and how they are passed on to offspring.
- **B) The Experiment** – Banana DNA extraction

Part A can take up to 30 minutes, the discussion points can be split to fill gap in between stages of the experiment. Part B can take up to 40 minutes.

2. Learning outcomes

- Students will be able to explain what DNA is, where it is found & the role it has in creating life-forms.
- Students will understand the principle behind the process of inheritance
- Students will understand why some hereditary traits are more common than others, and will be able to explain the difference between dominant and recessive genes.

3. Topics covered

- What DNA is, where in an organism it is found, its structure and function within a living organism
- What a gene is and the process of passing genes on to offspring through inheritance
- Why some traits and characteristics are more common than others, explaining the difference between dominant and recessive genes.

Keywords and definitions

1. DNA – *Deoxyribonucleic acid. This is the stringy substance found in all cells of living animals which acts as a blueprint for life. DNA contains a code for how to build the different parts of an organism and the instructions to keep all of it functioning properly through a life time.*
2. Nucleus – *This is a highly specialised organelle found in the cells of living organisms. It is inside the cell nucleus that the DNA is found.*
3. Gene – *A gene is a segment of DNA that carries the code for particular traits or characteristics that are passed onto offspring.*

4. Dominant gene – *A strong genetic trait. If a dominant gene is passed onto an offspring by at least one of the parents, the offspring will have the trait that is given by that gene. For example, the gene for brown eyes is dominant, so if one parent passes the gene for brown eyes onto its offspring, the offspring will have brown eyes, no matter what gene for eye colour they get from the other parent.*

5. Recessive gene – *A weaker genetic trait. An offspring will only have the traits that come from a recessive gene if they inherit that recessive gene from both of their parents. For example, the gene for blue eyes is recessive and so an offspring will only have blue eyes if both of their parents pass on the gene for blue eyes to them.*

6. Hereditary – *The process of passing on physical or behavioural traits to offspring, from one generation to another.*

4. Materials needed for the lesson/ workshop

Consumables:

- Salt
- Banana
- Fairy Washing Up Liquid
- Rubbing Alcohol
- Filter Paper
- Tooth Pick

Re-usable items

- Plastic Bowl
- Plastic Beaker
- Plastic Funnel
- Spoon

Access to a sink/water needed to fill mixture for filtration. Access to a bin for waste post experiment.

5. Preparation

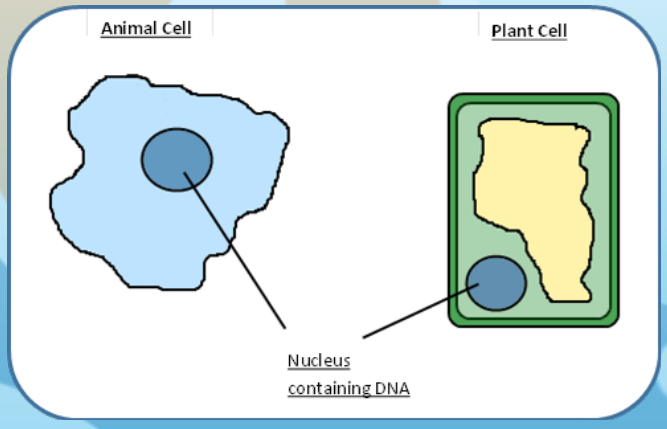
Keep rubbing alcohol refrigerated until in use.
Peel ripe bananas beforehand ready for use.

6. Plan

A) Introduction

We suggest making up some introductory slides/worksheets from the information below.

All living things, no matter their size or type, share one thing in common. They are all made from DNA – the basic material that forms the blueprint for life. DNA is a long, complex protein strand contained in the nucleus of our cells. It contains the code that is used to make living organisms. Plant and animal cells differ in shape and vary in content, but both have a nucleus containing DNA.



DNA is made up of smaller blocks called genes. Different genes are found in different areas along the DNA strand, and each gene is responsible for building different parts of an organism - we have genes for eye colour, a different gene for hair colour and specific genes for all the different process that go on in our body.

These different genes get passed along generations in a process call inheritance. This is when different traits get passed from parents to their babies – which is why babies look like their parents. Both sets of genes, from each parent get passed on and used as the blueprint for their offspring.

Some traits are more 'heritable', or more common, than others. For example, you probably know more people with brown eyes than green eyes. This is because some genes are more dominant while others are recessive. For every trait (hair colour, eye colour, etc.), an offspring will inherit one gene from each of its parents (e.g. they might inherit a gene for blue eyes from one parent and a gene for brown eyes from the other). These genes

will determine the trait that the offspring shows (their hair colour, eye colour, etc.), but offspring can't have the trait that is given by BOTH of the genes in this pair (i.e. their eyes can't be BOTH blue and brown). Passing on genes is a bit like playing the game 'rock, paper, scissors' some genes always 'win', they are called the dominant genes. For example if the gene for brown eyes is passed on from one parent to a baby, that baby will have brown eyes, even if the other parent passed on the gene for blue eyes. In the genetic game of 'rock, paper, scissors' brown eyes beats blue eyes. The genes for brown eyes are dominant genes and the genes for blue eyes (and green eyes) are recessive genes. For recessive genes to be expressed in offspring, both parents have to have the gene and pass it on to their babies.

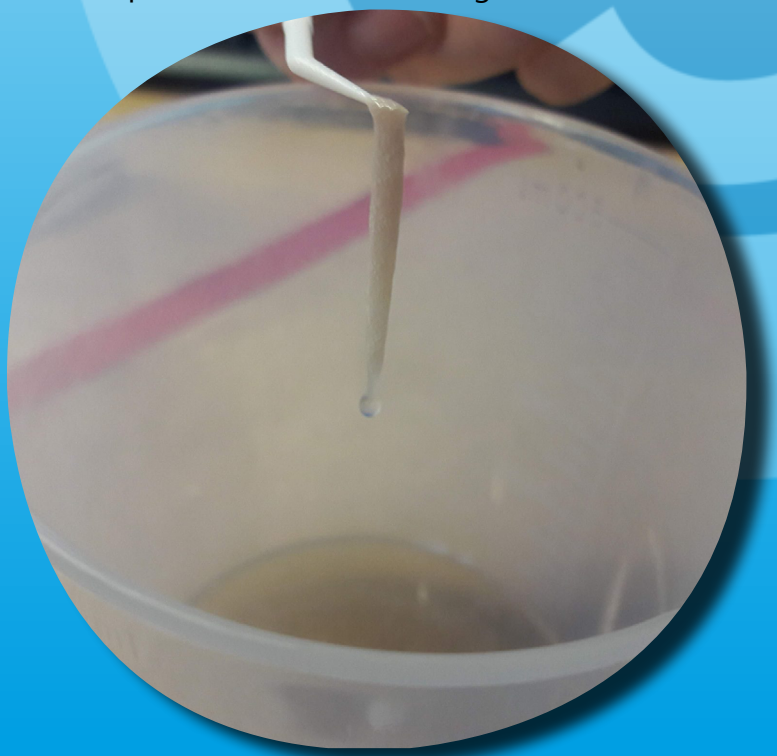
You can draw a punnet square to visually show possible genetic outcomes of offspring from the genes their parents have.

The capital B represents a dominate gene, and the lower case represents a recessive gene. Whenever a capital letter is present, that is the trait that will be expressed in the offspring.

An example of a punnet square with dominant genes (B) and recessive genes (b)

	B	**b**
B	BB	Bb
b	Bb	bb

This can be used to show eye colour or hair colour differences – brown eyes are a dominate gene compared to blue or green. Dark hair is dominate over blonde or red. These are easy and accessible examples to use while teaching inheritance.



B) The experiment

B1 Extracting banana DNA:

1. Place the banana pieces into the beaker, add a teaspoon of salt.
2. Mash the banana well until it becomes smooth and then add warm water
3. Mix in the beaker for about 1 minute, make sure it is not too runny
4. Pour the mixture into the second beaker through the funnel and filter paper. You want the beaker to be about half full. You may need to replace the filter paper.
5. Add two teaspoons of liquid soap and stir the mixture. Make sure to do this gently - you don't want too many bubbles
6. Carefully pour very cold rubbing alcohol down the side of the beaker stopping near the top.
7. Wait 5 minutes to allow the DNA to separate from the solution – Do not touch the beaker during this time.
8. Carefully use a toothpick to extract the DNA that is floating on the surface. It will be a white, globular string

Further discussion points

- **What do we mean when we say that humans share DNA with a banana?**
  Humans and bananas obviously look and act very differently from each other, but some of the genes that make up their DNA are the same. The genes that we share with banana clearly aren't the ones that make bananas yellow or that give us different colour eyes; so what do the genes that we share actually do? All living things are made of cells and these cells have to do certain things to stay alive. They need to be able to do things like make energy from food; repair themselves; reproduce; make copies of their DNA to pass on to their offspring, etc and its those genes that we share. Even if a human and a banana look so different we share some of the genes for doing things like making energy from food and how we repair damaged cells. And we don't just share those genes with bananas, we share them with pretty much everything else that is alive. There are some genes that evolved early and turned out to be so useful that every living thing on the planet contains them. So that's why we're a bit like a banana!