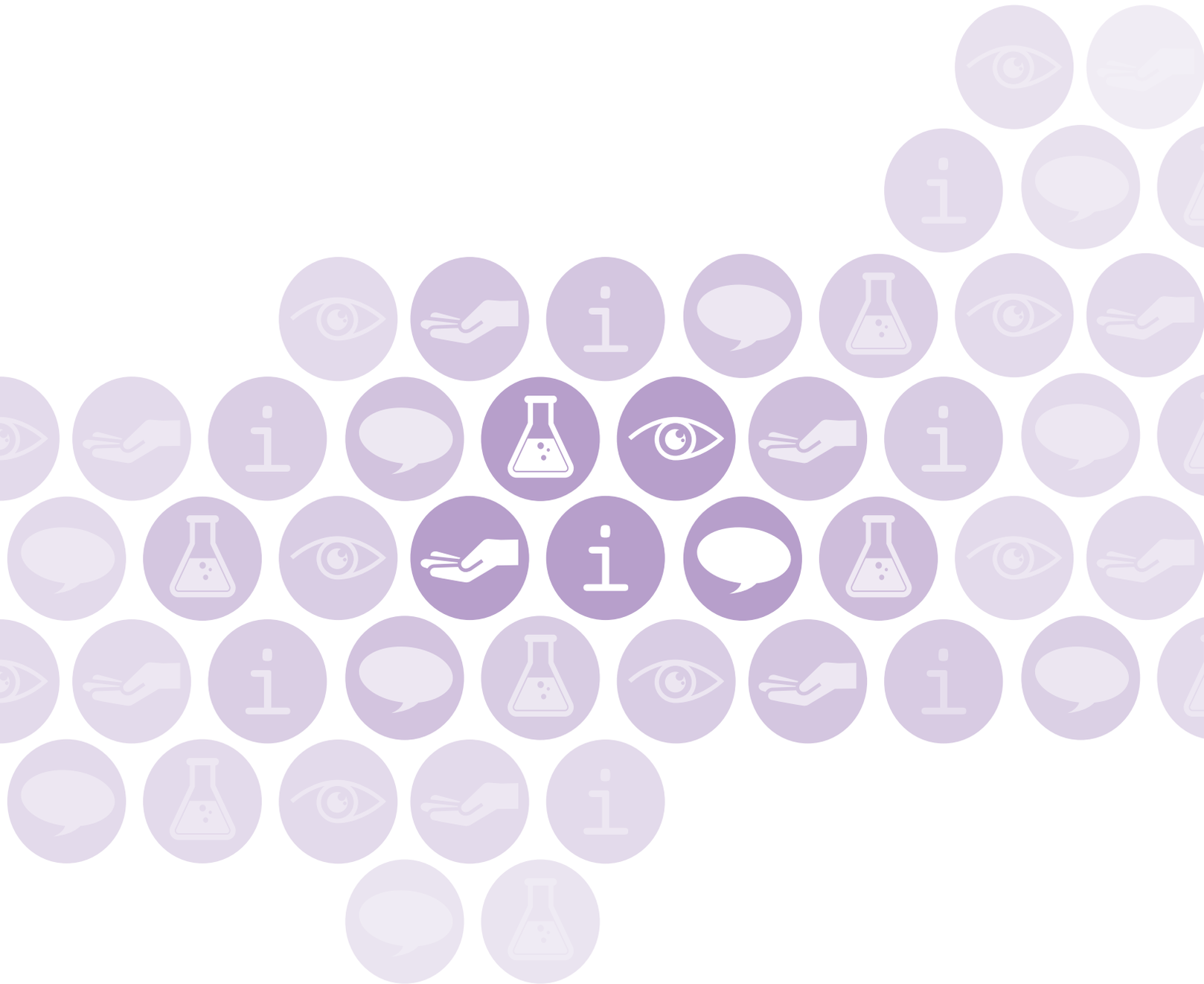
The Royal College of Pathologists
Pathology: the science behind the cure



SPLIT YOUR GENES
RESOURCE PACK

This activity is suitable for higher Key Stage 2 (9- to 10 year-olds) and Key Stage 3 (11- to 14 year-olds) with some adaptations. Also suitable for drop-in events. This pack includes guidance on how to simplify the narrative and activity for very young children.

Learning Objectives

- learning about gene inheritance: phenotypes, genotypes, dominant and recessive traits, homozygous and heterozygous allele pairs
- working out how to use a Punnett square
- learning about real-life diseases and the roles pathologists play in testing for these
- learning to question and discuss issues that may affect their own lives and the wider world.

Materials Required

- Punnett square diagram (wipe-clean laminated card, so people can fill in genotypes)
- wipe-clean marker pens and eraser/cloth
- Twister®-style floor set-up
- genotype cards.

Health & Safety

Warn all participants to take care not to hurt themselves when rushing to reach a coloured circle.

Time taken

Thirty minutes for a class session, reinforcing previous lessons on inheritance;
10 minutes for event sessions.

Practical

Set up the Twister®-style mat on the floor, and have the laminated Punnett square diagram ready.

Introduce the topic of genetics: how we all have cells and within all our cells is our genetic material, DNA (deoxyribonucleic acid), that is the unique code making each of us who we are. Modify explanation of DNA for younger audiences – e.g. analogy of DNA being a 'recipe book' for making living things.

Sequences of our DNA, known as our genotype, determines an observable characteristic, or phenotype. For example whether your ear wax is wet or dry (you can touch it to find out). You can't see/ touch your genotype. This is the code that determines what your ear wax is like.

Now, pathologists don't care much for ear wax. They want to know about inherited diseases, such as sickle cell disease, cystic fibrosis, thalassemia and retinoblastoma, and how to test for these. The heel prick test carried out on newborn babies allows blood to be tested for diseases such as sickle cell anaemia and cystic fibrosis, as well as various inherited metabolic diseases.

Sickle cell disease affects around 1 in 2000 babies born in the UK. This is where the oxygen-carrying protein, haemoglobin, is affected resulting in abnormally-shaped red blood cells (again simplify and reduce detail for younger participants). If oxygen cannot get to all areas of the body, it can be life-threatening.

Show participants the Punnett square diagram. These two parents are going to give one each of their alleles to their child. Biological parent 1 is homozygous dominant (AA) and has normal blood cells. Biological parent 2 is heterozygous recessive (Aa) and is a carrier for sickle cell anaemia.

Your genotype is made up of two alleles, you receive one from each parent. We write these as letters. Dominant alleles are given a capital letter (e.g. 'A') and recessive alleles are given a lower case letter (e.g. 'a').

A dominant allele can mask the recessive allele, so it is only when you have two recessive alleles that you will see the recessive phenotype. Two of the same types of allele are known as homozygous, if different they are known as heterozygous.

For really young children, help them understand what sickle cell anaemia is and help them fill out the Punnett square, then ask them to use their hands and feet to find those four combinations as seen on the Punnett square (as it's easier for them to see it written down rather than working it out in their head from the genotype cards).

Most young children will have heard adults tell them that they have features that make them look like their mum or dad and will understand that some information about their appearance comes each parent. (Note: Explain this is in a general form if the children are with guardians/carers rather than their parents). Explain that these features are 'written in their DNA': a code, or recipe book, in each of their cells that

makes them who they are. You can help them understand what sickle cell anaemia is (i.e. it is more difficult for the different crescent-shaped blood cells to get around the body, making things we take for granted, such as breathing, quite difficult) and help them fill out the Punnett square. While you do not need to use detailed vocabulary, you can explain that someone needs to have 'aa' (little-a-little-a), to have sickle cell anaemia. But if there's a 'big-A', they don't; they have normal blood cells. Then ask them to use their hands and feet to find those four combinations as seen on the Punnett square.

Ask participants to come towards the Twister®-style mat and to put a left/right foot/hand on different genotype combinations, e.g. 'left-foot homozygous recessive', 'right-hand heterozygous', to help them become familiar with the terms. It is worth telling participants that the colours are irrelevant - i.e. they don't need to find the blue circle with 'Aa' exactly like their genotype card.

What could their child's possible genotypes be?

Ask participants (in pairs) to return to the Twister®-style mat, and give them each a genotype card. They are parents now, and looking at their own genotypes have to put one foot on each of the possible genotypes of their children, in the same way they filled the Punnett square (They will have four feet to do this as they will be working in a pair.).

Now swap one of the genotype cards and ask them to put their hands on the four possible genotypes of the new child. Other pairs can take part at the same time (if there is enough space).

Alternative ways to play the game:

If only one person is available to play, give them two genotype cards to represent the parents, and ask them to use their feet and hands to find the four possible combinations of the child's genotype.

Useful Links

Useful glossary:

http://www.bbc.co.uk/bitesize/intermediate2/biology/environmental_and_genetics/phenotype_and_genotype/revision/2/

Sickle cell anaemia/disease:

http://www.nhs.uk/conditions/Sickle-cell-anaemia/Pages/Introduction.aspx

Based on the popular game Twister®:

https://en.wikipedia.org/wiki/Twister_(game)