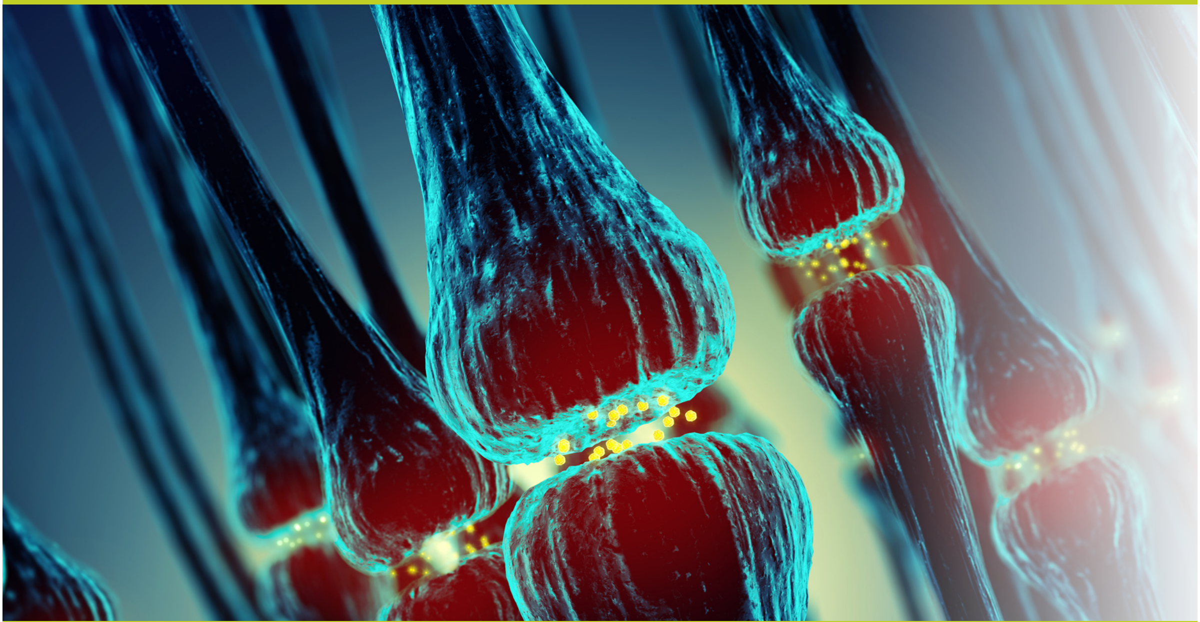
21st Century BioChallenges

CLASSROOM ACTIVITY IDEAS

Royal Society of Biology

21st BioChallenges

BIOCHEMICAL SOCIETY



21st BioChallenges

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4 science

All activities and related resources were devised, written, trialed and designed by 4science

www.4science.org.uk

ABOUT THIS BOOKLET

This booklet contains 10 classroom activity ideas to help young people explore current issues in biochemistry.

It covers five key topics, including stem cells, genetic modification, antibiotic resistance, epigenetics and cancer and other diseases.

There are two activities per topic, one targeted primarily at under 12s and the other at over 12s. All of the activities can be easily adapted and made accessible to most age groups.

Each activity takes around five to 15 minutes to complete .

Supporting materials (referred to in green italics) can be found at:

www.rsb.org.uk/biochallenges

CONTENTS

ANTIBIOTICS

Antibiotic resistance

This practical helps students understand that antibiotics treat bacterial infections, and that antibiotic resistance can occur if the full course is not taken.

First, make up 'urine' samples and reagents, decant into smaller pots for each group and label, as below. You'll also need a pack of glucose test strips – but you need to pretend they test for bacteria, so hide the label!

Ingredients	Decant into pots labelled...
100 cm^3 water + ~50 drops of methyl orange indicator	**'Patient X urine sample'**
20 µg glucose solution	**Three pots: 'Day 2', 'Day 10', '2nd Course'**
50 µg glucose solution	**'Day 4'**
1000 µg glucose solution	**'Day 6'**
100 cm^3 1 mol dm^{-3} hydrochloric acid	**'Bacteria Test'**

For all urine samples, add ~one drop of yellow food colouring to make the solution look like urine. Glucose solution is glucose powder dissolved in water; all could be made in bulk using approximate amounts and trial and error. Bacteria test reagent could be made using different acid solutions (lemon juice in water for example) and pH indicators – use trial and error until a clear colour change is visible. Glucose test strips from BHR Pharmaceuticals Ltd work well. Always do a risk assessment before making solutions and carrying out any practical work.

Guide students through the story, as they carry out the practical elements...

Diagnosing an infection: Patient X visits the doctor with a urine infection. Mix two drops of her urine sample with two drops of Bacteria Test reagent; a colour change confirms the infection. The patient is prescribed a 10 day course of antibiotics and provides more urine samples during that time.

Bacteria levels over time: Tell students that the test strips show how much bacteria is in the urine: light colour change = lots of bacteria; dark colour change = low levels of bacteria. Dip test strips into the first four urine samples. Why is Day 10 the same as Day 2? Explain that the patient felt better on Day 8 and stopped taking her tablets – but the bacteria hadn't all been killed and, by Day 10, it had multiplied.

Antibiotic resistance: After another course of antibiotics, the patient still feels ill, so gives another urine sample (2nd Course). The stick turns light green. Why? The bacteria have become resistant – they do not work anymore.

Combining antibiotics

This is a teacher-led game about the decisions doctors and patients face when using antibiotics, and how bacteria can become resistant to antibiotics.

The aim is for pupils to understand that antibiotics are not prescribed lightly, that several antibiotics are sometimes needed to treat bacterial infections, and that not taking the full course of antibiotics can lead to resistance.

Enlist four pupils (or teams) to play the role of bacteria. Give each of them a mini-whiteboard, a different coloured pen and an eraser (or cloth).

Set the scene: A patient comes into hospital feeling unwell; tests confirm he has four strans of bacteria present. Ask the four pupils to each draw three dots on their boards. The dots represent bacteria; different colours represent different types of bacteria. The pupils' erasers represent the antibiotic that can treat the type of bacteria on their board. The doctor treats the patient with ONE type of antibiotic. Choose one pupil to wipe off one dot from their board. Tell the others to double the number of dots on their boards. Explain that, although the antibiotic has started to treat one type of bacteria, the other types have multiplied.

Increasing the dose: The doctor prescribes a different antibiotic and doubles the dose. Choose a different pupil to wipe off HALF the dots from their board; the others should again double their dots.

Combining antibiotics: The doctor is now rather concerned, so she prescribes a course of all four antibiotics. Ask all pupils to wipe off all but one dot from their boards. Success! The patient feels better and leaves hospital. He is given another week's dose of the combined antibiotics, with instructions to take them every day.

Non-compliance and antibiotic resistance: A few weeks later, the patient is back in hospital feeling more ill than ever! Ask three pupils to wipe off their remaining dots and put away their boards and erasers. Their bacteria have been successfully eradicated.

Then, using a black pen, colour over the fourth pupil's remaining dot and add five or more black dots. Explain that, since the patient felt better, he didn't take his last week of tablets. Three types of bacteria were killed off, but the fourth mutated against the antiobiotic and became immune to it.

Take away the remaining pupil's eraser. Explain that the patient took his tablets a few days later, but it was too late. They didn't work anymore. The bacteria had become resistant to the antibiotics.

Urine test diagnoses

This is a wet practical activity based on spot-testing; the aim is for pupils to do a preliminary diagnosis on four patients by analysing their urine.

You'll need to print and laminate the *urine test template* (or use spotting tiles, well plates or filter paper), and print the *disease reference chart*. You also need to make up four reagents (W-Z) and four 'urine' samples (U1-U4), decant into smaller pots and label, as below.

Ingredients	Decant into pots labelled...
100 cm^3 0.1 mol dm^{-3} silver nitrate solution	Reagent W
100 cm^3 1% w/v solution of dimethylglyoxime in 95% ethanol or methylated spirits	Reagent X
100 cm^3 1 mol dm^{-3} hydrochloric acid	Reagent Y
100 cm^3 0.1 mol dm^{-3} iron(III) chloride solution	Reagent Z
100 cm^3 water + 2 drops of milk + 1 drop of red food dye + 4 drops of yellow food dye	Urine sample U1
100 cm^3 water + 1 drop of red food dye + 6 drops of yellow food dye + 1 g sodium chloride + 0.2 g nickel sulfate-6-water	Urine sample U2
100 cm^3 water + ~50 drops of methyl orange indicator solution + 1 g sodium chloride	Urine sample U3
100 cm^3 water + ~50 drops of methyl orange indicator solution + 1 g sodium chloride + 0.2 g potassium (or sodium) hexacyanoferrate(II)	Urine sample U4

Always do a risk assessment before making solutions and carrying out any practical work.

Pupils first assess the urine samples by eye – do they look healthy? Are there any signs of disease? Check against the *disease reference chart*.

Pupils then add a drop of each urine sample to a drop of each reagent W-X, using the *urine test template*. Reagent W tests for a bacterial infection (no change is a positive result). Reagent X tests for bilirubin (red colour change indicates high levels, and could indicate liver problems). Reagent Y tests for protein (red/orange colour change indicates high levels, which could mean high blood pressure or diabetes).

Pupils should find that U1 has an infection and U2 may have liver problems. U3 and U4 are similar and may have high blood pressure or diabetes – so students use Reagent Z with U3 and U4. This tests for glucose (intense blue/green colour change is a positive result) and should indicate that U4 is probably diabetic.

DNA whispers

This is a simple take on Chinese whispers. The aim is for pupils to understand that, when DNA is made, small mistakes during production can lead to faulty DNA – the wrong body instructions being made.

You'll need a pen, paper, and a whiteboard or flip chart.

Write these sentences on three pieces of paper:

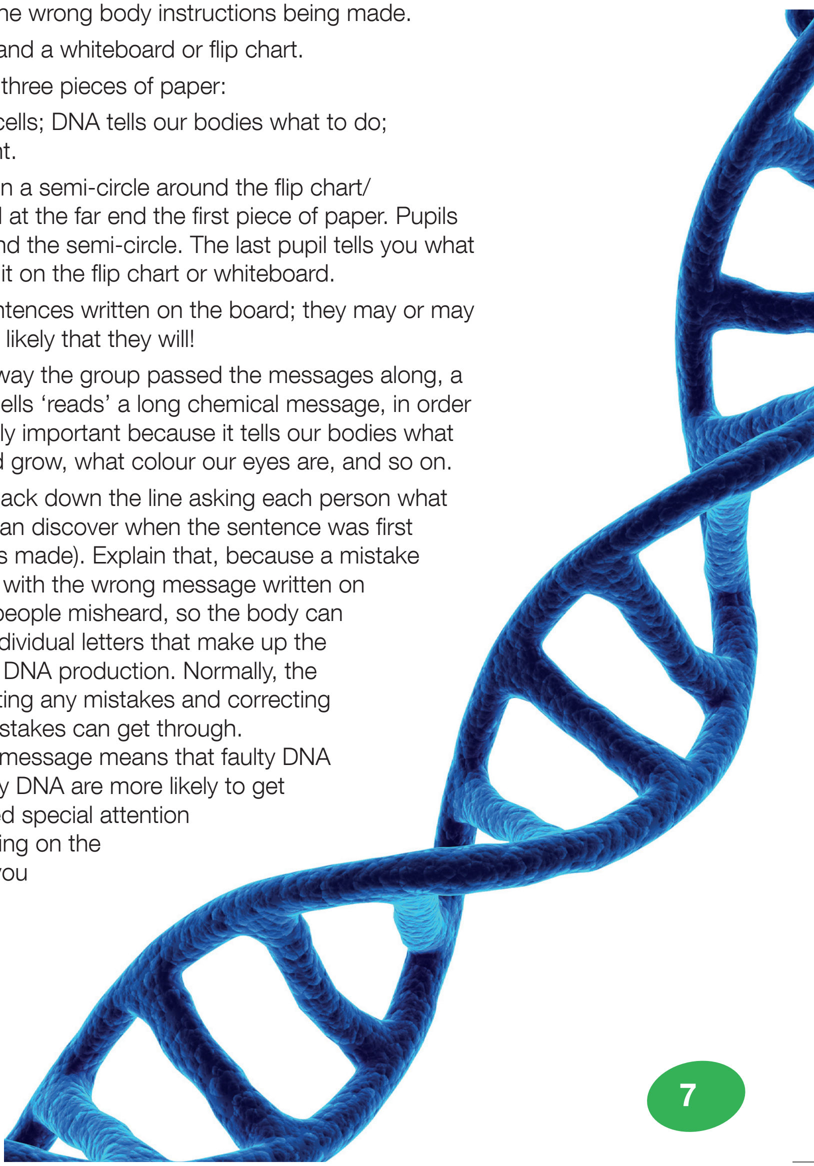
DNA is a chemical in our cells; DNA tells our bodies what to do; Everyone's DNA is different.

Arrange five to ten pupils in a semi-circle around the flip chart/whiteboard. Give the pupil at the far end the first piece of paper. Pupils whisper the sentence round the semi-circle. The last pupil tells you what they heard, and you write it on the flip chart or whiteboard.

You should have three sentences written on the board; they may or may not contain mistakes – it's likely that they will!

Explain that, in the same way the group passed the messages along, a tiny body part inside our cells 'reads' a long chemical message, in order to make DNA. DNA is really important because it tells our bodies what to do – how tall we should grow, what colour our eyes are, and so on.

If there are mistakes, go back down the line asking each person what they heard, to see if you can discover when the sentence was first misheard (the mistake was made). Explain that, because a mistake was made, you ended up with the wrong message written on the board. Just as some people misheard, so the body can sometimes misread the individual letters that make up the chemical message during DNA production. Normally, the body is very good at spotting any mistakes and correcting them. But, sometimes, mistakes can get through. Mis-reading the chemical message means that faulty DNA is made. People with faulty DNA are more likely to get ill in the future so they need special attention from their doctor. Depending on the age/level of participants, you could specify some types of illness (cancers, other genetic abnormalities, and so on).



EPIGENETICS

Dice roll choices

Two pupils or teams play a dice rolling game to see how different identical twins can look throughout their lives, depending on lifestyle choices. The aim is for the participants to understand that environmental factors, such as smoking – brought about by either choice or circumstance – can change the expression of genes in people with the same genetic makeup.

You will need the *twin templates*, the *epigenetics question cards*, and a dice. Arrange the pack of cards, face down.

Give each pupil/team a twin template. Ask them five questions (shown below). After each question, the pupils roll the dice. Whoever rolls the highest number takes the corresponding red card; the other takes the green card.

They place the cards in the correct box on their template. Depending on the age/ability of the pupils, they can work out what the body part is and where it goes, or you can help them.

Q1: When your twin turns 15, she is offered a cigarette. Does she smoke it?

Q2: When your twin turns 18, she is offered an alcohol drink at a party. Does she drink it?

Q3: Your twin goes to the gym but, as she enters her 30s, she goes less frequently and enjoys eating out at restaurants. What sort of food does she usually choose?

Q4: When she's 40, your twin goes for a promotion at work; it pays well, but is a really stressful position. Does she get the job?

Q5: As she enters her 70s, your twin finds it harder to be active. Does she sign up to a pensioner's fitness class, or accept that she's getting old and stop exercising altogether?

Once all five questions are asked and the templates are complete, explain that the dice roll (or lifestyle choice) for each question led to a physical consequence, even though their genes are the same. And the decisions the twins made don't only affect them – they may affect their children too (and, potentially, their children's children, and so on). Explain that, even though the twins genes were EXACTLY the same, some lifestyle choices put labels on or took labels off particular genes. You inherit your genes from your mum and dad, but most gene labels are taken off during reproduction, so the baby can acquire its own labels unaffected by mum and dad. Sometimes, though, gene labels slip through to the next generation. So, drinking too much and getting liver disease could affect the health of your child as a result. These gene variations in gene labelling are called EPIGENETIC CHANGES.

Kitten conundrums

This is an outcome quiz about looking after a kitten. The aim is for pupils to understand that certain lifestyle factors can switch the kitten's genes on and off (or change the way the kitten's body reads its instructions), which can affect the kitten's descendants.

Pupils can take the quiz alone or as part of a classroom activity – all it requires is a computer connected to the internet.

Pupils answer the quiz questions and their answers will determine how their kitten turns out. As a class, you can discuss the variation in answers, and the effect the kittens' environment could have on their descendants.

The quiz can be found at: tinyurl.com/kittenquiz

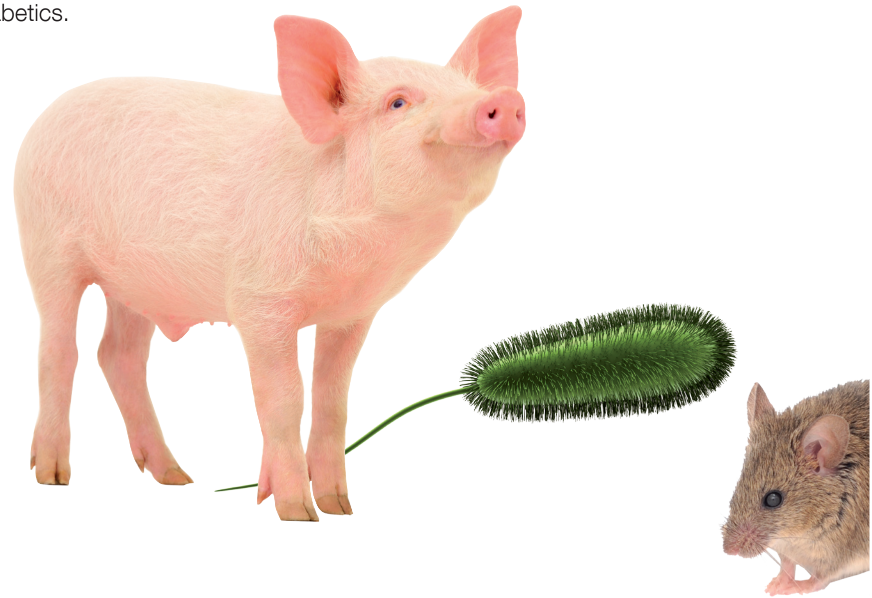
GENETIC MODIFICATIO

GM jigsaw

This is a 30 piece jigsaw puzzle showing examples of selective breeding and genetic modification.

You can download the *jigsaw image*, print and mount it on card, and cut it into pieces. There's also a factsheet with a little more info about the pictures.

The aim is to introduce the concept of gene manipulation to pupils. The jigsaw illustrates some examples of selective breeding and of genetic modification. You can use the examples to discuss the differences between these two methods. You can relate these concepts to more everyday examples, such as the variation in dog breeds due to selective breeding, and how scientists have genetically modified bacteria to produce human insulin for diabetics.



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Fish oil debate

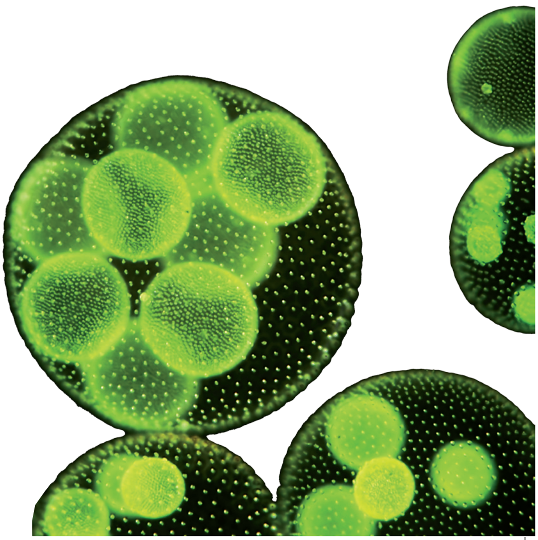
This is a debate about a real GM scenario: “Should we genetically modify algae to feed farmed fish?”

The aim is for pupils to think through various views on genetic modification, and then decide which they agree with most (justifying why, if they can).

This can be a short activity where the students simply read the question and think over the views by themselves or in small groups. Alternatively, it could lead to an involved classroom debate.

You can download and print the four *GM character boards*, the *GM scenario board* and the *GM scenario sheet*. Students can write their opinions on sticky notes and add them to the characters that they agree with.

You could ask four pupils to each take on a character role, and express their views in front of the class.



STEM CELLS

Lego™ cells

In this activity, pupils make stem cell models from building blocks. The aim is for pupils to understand that stem cells are the precursors to the variety of cells in the body – some stem cells can produce lots of different cell types, some can produce only one type of cell.

You will need about 80 building blocks – Lego™ works well. The blocks need to be at least two different shapes and plenty of different colours.

Discuss examples of different cell types with the class:

- Unipotent stem cells can only produce one cell type, for example a muscle cell.
- Multipotent stem cells can produce a few cell types, for example brain cells and liver cells.
- Totipotent stem cells can produce any cell type in the body.

Two or three pupils (or teams) compete to construct as many unipotent stem cells (two blocks of the same colour and the same shape) as they can in, say, one minute.

Repeat this with multipotent stem cells (two pieces of different colours but the same shape) and totipotent stem cells (two pieces of different colours and different shapes).

For older pupils, you could follow this activity with a discussion on the ethics of using stem cells, particularly using foetal stem cells.

Stem cell card matching

This is a card matching game. The aim is for pupils to match four specialised cells to the job they do in the body.

You will need the *stem cell cards.* There are 12 in total:

- 4 x cell types (with images of brain, liver, skin and white blood cells)
- 4 x cell jobs (explaining what function those cells perform in the body)
- 4 x related stem call facts (with an example of problems that can damage those cells, and possible stem cell treatments)

The simplest exercise is to lay out the ‘cell type’ cards, face up, and ask the pupils to match the ‘cell jobs’.

It can be made more challenging by then asking pupils to match the ‘related stem cell facts’ cards. Alternatively, you could place a different set of cards face up to start the game.

For example: show the ‘related stem cell facts’ cards and ask pupils to match the ‘cell types’.

CURRICULUM LINKS A

Curriculum links

KS1 and KS2

These activities are a useful extension to the 'Animals, including humans' strand of the KS1 and 2 science curricula.

KS3

The activities complement a variety of KS3 science strands; epigenetics and genetic modification fit in with 'genetics and evolution', stem cells, antibiotic resistance and cancer and other diseases fit in with 'structure and function of living organisms'. The genetic modification debate also ties in well with the food security aspect of 'interactions and interdependencies'.

KS4

At KS4, the activities fall into a variety of the GCSE biology modules. The epigenetics, cancer and other diseases and antibiotic resistance activities fit with 'Health, disease and the development of medicines'. The genetic modification debate complements 'Ecosystems' and 'Evolution, inheritance and variation', and the stem cell activities could be used alongside teaching the 'Cell Biology' strand.

Further resources

SciberMonkey and SciberBrain

SciberMonkey and SciberBrain are the Royal Society of Biology and the Biochemical Society's websites which contain a range of science activities across different age groups:

www.scibermonkey.org / www.sciberbrain.org

Get involved

You can bring your own event to Biology Week in October! For more information, and how to get involved, visit the website:

www.rsb.org.uk/biologyweek

AND OTHER INFO

www.rsb.org.uk/biochallenges