
# THE LAB_13 BIOCITY COOKBOOK

# THE LAB_13 BIOCITY COOKBOOK

A SERIES OF SCIENCE EXPERIMENTS INSPIRED BY THE LAB_13 BIOCITY PROJECT IN 2019, PRODUCED BY IGNITE! WITH SUPPORT FROM BIOCITY AND THE RSA

## WHAT IS LAB_13?

Lab_13 is an in-school space dedicated entirely to investigation, innovation and creativity; a space managed by young people; a space where children learn to be scientists as well as learning science.

Inspired by the Room 13 international network of art studios, in Lab_13, pupils form a Management Team that takes all key decision about what happens in the lab, and are supported in their investigations by a 'Scientist in Residence'.

Lab_13 is one of the programmes developed by the Nottingham-based charity Ignite! since 2009. There are now Lab_13s across the UK, Europe and Africa.

## WHAT IS LAB_13 BIOCITY?

Lab_13 BioCity is a variation on the Lab_13 model that Ignite! has developed in collaboration with BioCity. BioCity is a pioneering life sciences incubator and business collective, with locations in Nottingham and Glasgow.

Each month, a class of primary school pupils are invited to spend a day in the BioCity labs to investigate questions that matter to them. All of the activities on the day are inspired by the pupils' own questions that they submit beforehand.

Pupils work through their questions with the Ignite! team and a volunteer Scientist in Residence from a BioCity-based company, discovering how scientists really work. Read the blog from the first Lab_13 BioCity at www.biocity.co.uk/blog/ask-a-scientist-physics

## WHAT IS THE COOKBOOK?

The ten 'recipes' compiled here are highlights from the seven Lab_13 BioCity days in 2019.

This cookbook has been created to support primary teachers to respond to the questions and curiosities of the pupils in their class, and to design and deliver activities that support pupils to think and work like scientists.

For more information, contact Ignite! via the website www.ignitefutures.org.uk or social media @IgniteFutures.

ignite!

BIOCITY

RSA
21st century enlightenment

# BODILY QUIRKS

PUPILS FROM HEMPSHILL HALL PRIMARY WANTED TO INVESTIGATE ALL OF THE STRANGE THINGS THAT THEIR BODIES COULD DO FOR NO APPARENT REASON.

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why do I yawn?

Why can I roll my tongue and wiggle my ears?

How many people are left-handed?

Why are some people double-jointed?

## INGREDIENTS AND EQUIPMENT

- Whiteboard and pens/flipchart
- Data on bodily quirks

## CURRICULUM LINKS

- The human body
- Evolution
- Working and Thinking Scientifically
- Maths - data, tables, percentages

## DATA ON BODILY QUIRKS

- 2% of UK population is Left Handed (Boys are more likely to be left handed than girls)
- Between 65% and 81% of people can roll their tongue (Girls have a higher likelihood of being able to than boys)
- Between 10% and 25% of people are double-jointed (also know as hypermobility, with girls more likely to be double-jointed than boys)

## METHOD

1, We researched different types of bodily quirks and their prevalence in the population on average. In the classroom, pupils could research this themselves.

2. Pupils were presented the information and this provoked a conversation about why there are differences between humans and how this developed through a process of evolution. We learnt that scientists can't actually be sure of the answers, but have put forward several theories related to evolution. We explored some theories of our own:
- Double-jointedness = flexibility, girls smaller so more flexible joints
- Tongue rolling = better eating/tasting
- Ear wiggling = hearing

3. We explored how we might compare our class to the data - are we a 'representative sample' and how might we find out? The pupils decided to take each quirk one by one, go round the class to find out who could and who couldn't do it, and capture this in a tally chart.

4. The pupils then converted their fractions into percentages to work out if they were representative or not.

5. One pupil had heard that you can learn to roll your tongue and so all those who couldn't decided to keep practising, and they would re-do the experiment in a few weeks to test this theory.

# FINGERPRINTS

PUPILS FROM ST TERESA'S PRIMARY WANTED TO DISCOVER MORE ABOUT THEIR FINGERPRINTS

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why do we have fingerprints?

Are my fingerprints the same as anyone else's?

What are our fingerprints used for?

## INGREDIENTS AND EQUIPMENT

- Non-toxic fingerprint ink (we used baby footprints ink) and paper
- Magnifying glasses and microscopes
- Whiteboard and pens/flipchart

## CURRICULUM LINKS

- The human body
- Evolution
- Working and Thinking Scientifically
- Maths - data, tables, percentages

## FINGERPRINT INFO

Loop Whorl Arch

Adermatoglyphia: a genetic condition where you don't have fingerprints.

## METHOD

1. The pupils had heard that everyone has different fingerprints, so we began by looking more closely at our fingers using magnifying glasses and microscopes

2. We learnt that scientists aren't sure about why we have fingerprints, but discussed several of their theories:
- help us grip things that are wet
- increase touch sensitivity
- protects our fingers

3. The pupils agreed that they thought their fingerprints were different to the person next to them because they could see different shapes. We learnt that these shapes are called whorls, loops and arches.

4. The pupils used ink make prints of their own fingers and thumbs. We learnt that this is a similar process to how we leave fingerprints behind - the oils on our skin leave the print in the shape of the small ridges on our fingers. Pupils annotated the prints with the three shape names.

5. The pupils wanted to know which was the most common shape so made a tally chart, with each pupil stating the most prominent shape they found in their own prints.

6. Pupils committed to taking their families' fingerprints to see if the shapes are hereditary. One of the pupils had an identical twin and committed to taking prints to see if they were the same.

# BLOOD TYPES

PUPILS FROM SNEINTON PRIMARY WERE REALLY INTERESTED IN FINDING OUT WHAT IT MEANS TO HAVE DIFFERENT BLOOD TYPES

## QUESTIONS THAT INSPIRED THE ACTIVITY

What makes blood and what is contained in it?

How many blood cells do you have?

What is the difference between different blood types?

## INGREDIENTS AND EQUIPMENT

- Modelling clay
- Drawings of blood cells
- Large paper
- Drawings of blood type antigens

## CURRICULUM LINKS

- The human body
- Health and medicine
- Working and Thinking Scientifically
- Problem solving

## METHOD

1. We presented information about the four different types of cell present in the blood - plasma, red blood cells, white blood cells and platelets - what they look like and what they do in the blood.

2. Pupils chose one type of blood cell to create out of modelling clay and present it back to the group.

3. We talked about what the pupils knew about the immune system, and learnt that our body will only attack a cell that it doesn't recognise, because otherwise it would attack our own cells. It recognises cells by the have markers ('antigens') they have on their outside.

4. We presented the diagram showing the four blood types and the different markers they have on the outside. They either have A antigens, B antigens, A and B antigens or no antigens (type O).

5. The pupils wanted to know why only certain blood types can donate to certain blood types. We explored how the body will attack blood that it doesn't recognise. Therefore if your blood type is A, you can only receive blood from someone with either A antigens on the surface or no antigens (type O), because your body will recognise the antigens. If you received blood with B antigens, your body would attack the blood because it doesn't recognise it.

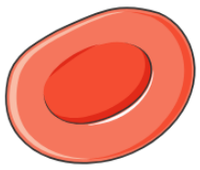
6. Pupils then worked in groups of four and each received a large piece of paper to draw the outline of a person on. Each group were assigned a blood type and had to work out to whom that person could donate blood, and from whom they could receive blood.

7. Pupils fed back about which blood type was most useful for donation, and which blood type was able to receive blood from lots of other types.

# BLOOD TYPES

PUPILS FROM SNEINTON PRIMARY WERE REALLY INTERESTED IN FINDING OUT WHAT IT MEANS TO HAVE DIFFERENT BLOOD TYPES

## TYPES OF BLOOD CELL

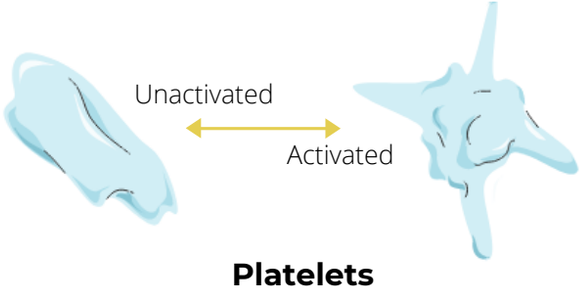


### Red Blood Cells

- Very flexible so that they can fit through narrow blood vessels
- Thinner in the middle and thicker at the edges to maximise their surface area for oxygen absorption
- Give blood its red colour

### White Blood Cells

- Act as the defenders of the body against infectious disease and foreign invaders
- Destroy the harmful substance by ingesting them



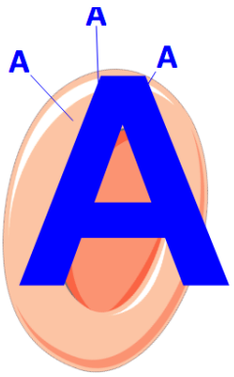

### Platelets

- Sticky cells that move around in the blood until a blood vessel is injured in some way (when bleeding starts) and they become activated.
- The platelets join together to make a sort of web to form a clot, which stops the flow of blood out of a blood vessel, acting like a plaster.

### Plasma

- Straw-coloured liquid that makes up just over half the volume of blood
- Takes nutrients around the body

## ANTIGENS IN DIFFERENT BLOOD TYPES




### TYPE A

- Can receive blood from A and O

(Will attack B antigens on A and AB)

- Can donate to A and AB

(Will be attacked in B and O)

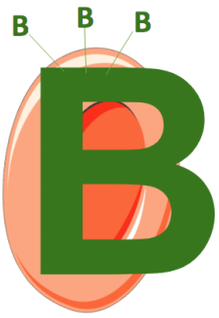
### TYPE B

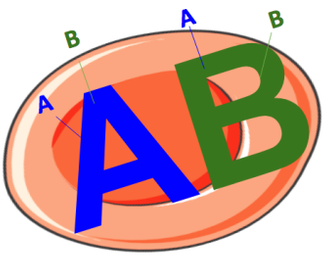
- Can receive blood from B and O

(Will attack A antigens in A and AB)

- Can donate to B and AB

(Will be attacked in A and O)




### TYPE AB

- Can receive blood from A, B and O
- Can only donate to AB

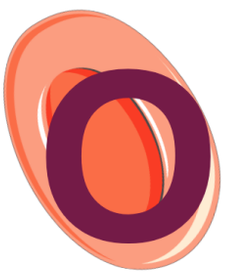
(Will be attacked in A, B and O)

### TYPE O

- Can only receive blood from O

(Will attack A, B and AB antigens)

- Can donate to A, B and AB and O



# PLASTICS

PUPILS FROM RUFFORD PRIMARY WANTED TO KNOW MORE ABOUT WHY PLASTIC WASTE ENDED UP IN THE SEA

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why does our planet have loads of rubbish?

How does recycling work?

How was the Great Pacific Garbage Patch created?

## INGREDIENTS AND EQUIPMENT

- Collection of different types of plastics collected from pupils' recycling bins
- Two tubs/trays of water
- Scissors
- Paper and pens

## CURRICULUM LINKS

- The environment
- Properties of materials
- Working and Thinking Scientifically - categorising

## METHOD

1. Each pupil took a plastic object from the pile and spent five minutes writing down different words to describe the properties of the object - hard, flexible, colourful, transparent - and what they thought it was used for. They then compared their object to their partners'.

2. We then fed back, writing up on a flipchart all the different properties that plastic can have, which is one of the reasons why it is so useful.

3. The different properties of plastics are down to the structure of the molecules (called polymers) that make them up, and the different structures are categorised in six different types of plastic.

4. These different types of plastic are given different symbols, which appear on them. We checked our objects to see if they had the symbols on them.

5. We then undertook three tests to see which plastics from our pile were in which categories:

a) Float or Sink - Most plastics float (hence the Great Pacific Garbage Patch), and only PVC sinks

b) Bendy - Of the remaining plastics, only LDPE is flexible

c) White Marks - Of the remaining plastics, PP should make white marks when it's cut, and HDPE shouldn't.

6. We had a discussion about alternative materials we could use instead of plastics for these objects. We had an example or a plastic bag made from potato starch, and this is something the class decided they would like to make themselves back at school - instructions available online.

# PLASTICS

THIS ACTIVITY WAS INSPIRED BY THE PRACTICAL ACTION PLASTICS CHALLENGE: WWW.PRACTICALACTION.ORG/PLASTICS-CHALLENGE

## TYPES OF PLASTICS


### PET (Polyethylene terephthalate AKA polyester)

- Used in car engineering for bonnets and wing mirrors, clothing, food/drink containers including plastic bottles
- Can be processed to be flexible or rigid, strong and lightweight
- Commonly recycled at cerbside


### HDPE (High density polyethylene)

- Used for water pipes, garden chairs, crates, toys, jerrycans, bottle tops
- Hard, opaque and can withstand high temperatures
- Commonly recycled at cerbside


### PVC (Polyvinyl chloride)

- Used for window frames, road signs, electric cables, flooring, waterproof clothing, cling film, credit cards and vinyl records
- Can be made to be rigid or flexible, good insulator, strong and weatherproof
- Can be recycled through certain initiatives


### LDPE (Low density polyethylene)

- Used in trays and containers, six-pack rings, computer hardware, playground slides, squeeze bottles, plastic bags
- Flexible and mouldable, can be transparent, cannot withstand high temperatures
- Can be recycled at recycling centres


### PP (Polypropylene)

- Used in washing machines and cooking appliances like kettles and microwavable tubs, flip-top bottles, stationary
- Semi-rigid and strong, can be transparent or coloured, heat resistant, durable
- Can be recycled at recycling centres


### PS (Polystyrene)

- Used in packaging, CD cases, trays, foam (eg. Styrofoam brand), cups
- Easily moulded, breakable
- Not commonly recycled and not biodegradable

# PLANTS

PUPILS FROM HEMPSHILL HALL PRIMARY WERE INTERESTED IN FINDING OUT MORE ABOUT PLANTS

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why are leaves green?

How do plants grow?

How do trees work?

## INGREDIENTS AND EQUIPMENT

- Lots of different coloured leaves
- Pestle and mortar
- Rubbing alcohol or nail varnish remover
- Sand
- Beakers
- Chromatography paper
- Pipettes

## CURRICULUM LINKS

- Plants - healthy plants, different parts of a plant, life cycle
- Chemicals and pigments
- Working and Thinking Scientifically

## BIOLOGICAL PIGMENTS FOUND IN PLANTS

- Chloryophyll - greens
- Carotenoids - reds, oranges, yellows
- Anthocyanins - reds, purples, blues
- Betalains - reds

## METHOD

1. We collected lots of different coloured leaves. In the classroom, pupils could collect them themselves.

2. We had a conversation about the different colours we could see. We learnt that the different colours are caused by different pigments.

3. We began by mashing up one of the leaves in the pestle and mortar, mixing it with a little bit of sand and a few drops of the rubbing alcohol. We then put this mixture into a beaker.

4. We then added a strip of the chromatography paper to the beaker and watched as the different pigments of colour climbed up the paper. Once they had dried, we labelled them with the different pigments.

6. We compared the different colours that appeared in different coloured leaves. Most leaves had multiple colours, meaning there were likely multiple pigments in each plant.

7. We learnt that when leaves lose their green colour in the autumn, it's because they produce less chlorophyll. The class decided they would repeat the test in the autumn to test.

8. We learnt that some diseases affect plants' abilities to produce pigments, meaning their leaves change colour.

# DNA

PUPILS FROM WILLIAM BOOTH PRIMARY WERE INTERESTED IN LEARNING ABOUT WHAT DNA LOOKS LIKE

## QUESTIONS THAT INSPIRED THE ACTIVITY

How do we grow?

What is DNA?

Why do we get cancer?

## INGREDIENTS AND EQUIPMENT

- Very cold 70% ethanol, isopropyl alcohol or rubbing alcohol
- Warm water bath
- Washing up liquid
- Salt
- Pipettes
- Toothpicks or skewers
- Cups or beakers

## CURRICULUM LINKS

- Living things
- Working and Thinking Scientifically

## METHOD

1. We began by discussing what we knew about DNA. We learn that is stands for Deoxyribonucleic acid and that it's found inside the nucleus of our cells, wrapped up in threads. There's so much DNA in our cells that if you stretched out the DNA in one cell, it would reach almost 3 metres.

2. Each pupil was given a plastic cup or glass beaker that they discreetly spit into until there was about 1cm of spit in the cup. This was because in our spit there is lots of cells from our cheeks that we could take DNA from. Pupils who don't want to spit in a cup could use mashed-up pieces of strawberries, banana or kiwis instead to look at fruit DNA.

3. To this cup, a few drops of washing up liquid, a pinch of salt and a few drops of water were added and the mixture was carefully stirred. This breaks down the cell membranes so the DNA can come out of the nucleus.

4. Pupils then placed their cups into a warm water bath, where they were left for 15 minutes to help speed up the process. While this was happening, pupils wrote down what they had done, and what they predicted would happen.

5. The plastic cups were removed from the water bath, and very carefully, a few pipettes of the ethanol was poured down the inside of the cup so that it formed a layer on top of the mixture. This helps the DNA come out of the mixture so we can see it.

6. Pupils began to see that a cloud-like substance began to form between the layers; this was the strands of DNA. Pupils used toothpicks to gently remove the threads and looked at them more closely under a microscope.

# WATER CYCLE

PUPILS FROM ST TERESA'S PRIMARY WANTED TO INVESTIGATE WATER AND THE WEATHER

## QUESTIONS THAT INSPIRED THE ACTIVITY

How do clouds form?

What makes the weather?

How much water is in the sky?

## INGREDIENTS AND EQUIPMENT

- Kettle and water
- Cold/metal plate
- Clamp stands and clamps
- Beakers

## CURRICULUM LINKS

- Changes of materials
- Habitats
- Geography
- Working and Thinking Scientifically

## METHOD

1. We discussed what we knew about water and the water cycle - the different states of water, what happens to water when it goes over land, what happens to water when it falls on the Earth? We discussed how we we were going to demonstrate the water cycle with other objects - to illustrate it in another way and we needed some help from the pupils to refine it.

2. We began by boiling a kettle and placing a pre-cooled plate above the steam at an angle using the clamp stands and clamps, with a glass beaker underneath it.

3. We observed the steam evaporate from the kettle, condense on the plate and then precipitate into the beaker. We discussed in the group which parts of the demonstration represented which part of the water cycle.

4. The pupils then came up with their own ideas for improving the demonstration - how could they represent the water in rivers going back to the sea or the water evaporating at a slower rate? How could we represent the sun or the water table underground?

5. Pupils knew that sea water is salty but rain and river water isn't - they asked to try this with the demonstration and discovered that the salt doesn't evaporate with the water.

6. We talked about you can see this process happening when you cover a plant with cling film or a propagation lid - the water in the soil evaporates and condenses on the lid and falls back down as 'rain'.

7. The pupils practiced presenting the demonstration to their peers back at school.

# BACTERIA

PUPILS FROM HENRY WHIPPLE PRIMARY WANTED TO LEARN ABOUT BACTERIA, GERMS AND MICROBES

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why does our breath smell in the morning?

What are microbes?

Where do germs come from?

## INGREDIENTS AND EQUIPMENT

- Petri dishes with agar
- Swabs
- Bread - white and brown
- Plastic sandwich bags

## CURRICULUM LINKS

- Human body
- Microbes and health
- Working and Thinking Scientifically

## METHOD

1. We discussed what we knew of germs and bacteria and explored the vocabulary of microbes, germs, virus, fungi and bacteria. Some of the pupils identified that not all bacteria are harmful and that some help us for example in foods like bread and yoghurt.

2. We discussed transmission of bacteria and other microbes. Where were some of the bacteria 'hot-spots' in our daily lives and some myths and misconceptions.

3. In this experiment, the pupils chose parts of their bodies to swab and grow the bacteria in a petri-dish. Pupils swabbed their nails, behind the ears, armpit and the teacher swabbed his phone. These swabs were wiped across the agar and the petri-dishes taped shut and labelled. They were places in a secure cabinet and left for two weeks.

4. We took photographs of the plates and sent them to the schools to compare across different parts of the body, and what surprised them.

5. Pupils also tested the bacteria on their hands before and after washing. They were each given two pieces of bread which they pressed their hands on before and after washing them. Pupils placed them in plastic sandwich bags, which they carefully labelled.

6. Pupils took these back to school and waited a few weeks for them to grow. They then observed the bread and discussed hypotheses for differences according to:
- different types of bread (white or brown)
- washed vs unwashed hands
- girls vs boys

# FUTURE CREATURES

PUPILS FROM HEMPSHILL HALL WERE INTERESTED IN HOW ANIMALS EVOLVE AND WILL EVOLVE IN THE FUTURE

## QUESTIONS THAT INSPIRED THE ACTIVITY

Why do mammals have hair?

Why do we have four fingers and thumb?

What will creatures of the future look like?

## INGREDIENTS AND EQUIPMENT

- Examples of animals - we borrowed specimens from Wollaton Hall Natural History Museum
- Drawing materials

## CURRICULUM LINKS

- Evolution
- Animals and their habitats
- Working and Thinking Scientifically

## RULES OF EVOLUTION

We used our imaginations but noted that as we investigated the creatures of the future, there are three laws of evolution:

1. Creatures must be possible (no pigs sprouting wings)
2. No merging of different species (sheep and pigs will not interbreed to produce peeps)
3. Creatures of the future will evolve from creatures of the present.

## METHOD

1. We revealed the example of different animals and invited the pupils to look really closely at their distinct features. What would make these creatures successful? What features have evolved to help them in different environments?

2. What do we already know about where these creatures live? And how do they survive? Catch their prey? Or locate their diet and feed? The pupils made drawings of the creatures with particular attention to the distinct features of each.

3. In groups or with a partner they discussed how a chosen creature might evolve in the future, bearing in mind the laws of evolution and made drawings of the evolved creatures of the future.

5. Pupils shared their drawings the class, discussing why they had focused on that animal, and the distinct features they thought would evolve to ensure that the creatures survived, or became even more successful.

6. Pupils explored other factors they might they need to consider in discussing the evolution of creatures, such as environmental change and the impact of this on habitats. We discussed the features of animals that have survived the longest that humans have found in fossils from millions of years ago - crocodiles, jellyfish, lice, duck-billed platypus.

# ACIDS

PUPILS FROM ST TERESA'S WANTED TO KNOW MORE ABOUT WHAT ACIDS ACTUALLY ARE AND WHAT THEY DO

## QUESTIONS THAT INSPIRED THE ACTIVITY

What are acids and how do they work?

What is stomach ache?

How do medicines work to make us feel better?

## INGREDIENTS AND EQUIPMENT

- Beakers
- Vinegar, lemon juice and other familiar liquids like tea and coffee (black), distilled water, baking soda solution, washing up liquid, almond milk
- Milk of Magnesia
- pH test paper

## CURRICULUM LINKS

- Properties and changes of materials and chemistry
- Human body and health
- Working and Thinking Scientifically

## ACIDS AND BASES

Common acids include:
citric acid, hydrochloric acid, nitric acid, sulphuric acid

Common bases include:
sodium hydroxide, calcium carbonate, potassium oxide, sodium bicarbonate

1. We discussed what we knew about acids, and whether or not we'd heard the term 'bases' or 'alkali'. We learnt that the scale for how acidic or base something is is called the pH scale.

2. We investigated where our different liquids sit on the pH scale by pouring a small amount of the liquid a beaker, diluting it and dipping in pH indicator paper. We saw a colour appear on the paper, and saw that that colour corresponded to a number 1 to 14, 1 - 6 indicating acidic, 7 indicating neutral and 8 - 14 indicating basic.

3. The pupils recorded their observations using grids and charts, marking each result with matching coloured pens.

4 We learnt that there is acid in our stomach that is there to help break down food. Sometimes when we're unwell or we've eaten something that disagrees with us, there becomes too much acid in our stomach. This makes us feel unwell and we can take milk of magnesia or antacid tablets to make us feel better.

5. We represented this by taking a beaker of lemon juice, testing the pH, and adding in milk of magnesia. As we added it, the pH raised, becoming less acidic.