UKRI MRC Protein Phosphorylation and Ubiquitylation Unit

University of Dundee

IMMERSIVE CELL

ART SCIENCE WORKSHOPS

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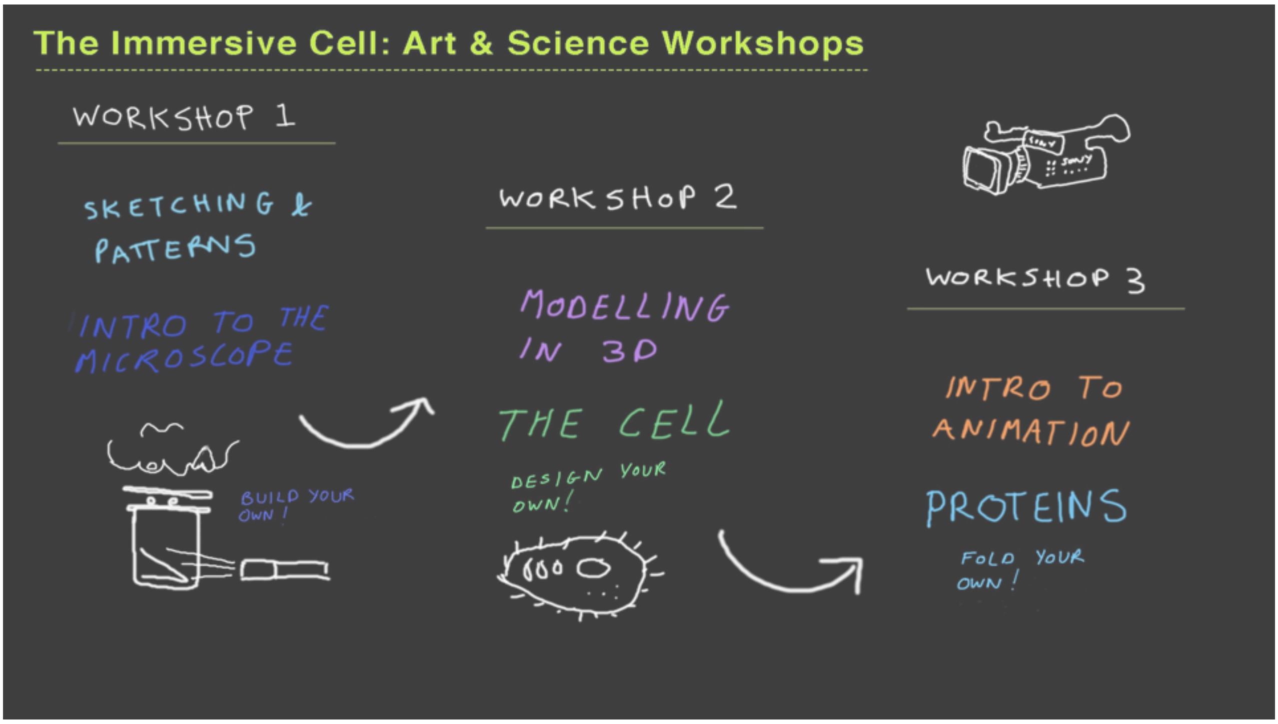


Welcome

The Immersive Cell is a series of three workshops that will encourage you to be curious and explore the natural world around you.

The workshops will enable you to develop your artistic techniques, whilst also exploring some of the scientific concepts at the centre of life sciences research in Dundee.

Art and science both begin with a curiosity about the world. They are not distinct fields, but actually overlap and inform one another. Creative science requires an artistic thought process and the capacity to think abstractly, whilst great art requires knowledge of the natural world and an understanding of perspective.

Artists and scientists are driven by their curiosity about the world around them and take their inspiration in many different directions - whether making a new discovery, performing experiments or producing an artwork or film.

We look forward to hearing where your inspiration takes you as you participate in these workshops!

""All sorts of things can happen when you're open to new ideas and playing around with things"
Stephanie Kwolek

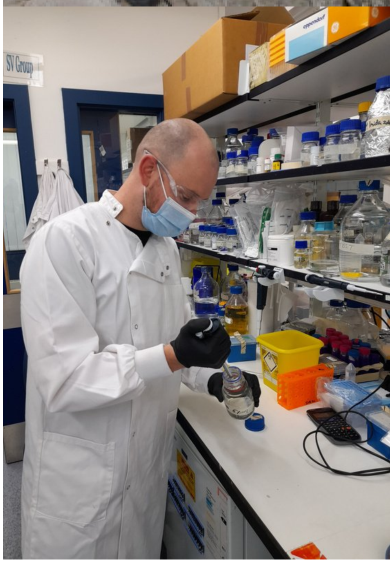
"Creative people are curious, flexible, and independent with a tremendous spirit and a love of play."
Henri Matisse

"I have no special talent. I am only passionately curious."
Albert Einstein

Introduction to our scientist

Daniel, PhD Student at the MRC Protein Phosphorylation & Ubiquitylation Unit (MRC PPU), University of Dundee

Hi, I'm Daniel, and I'm a PhD Student at the MRC PPU at the University of Dundee. I'm fairly local, having grown up in Perth, and I took a slightly less conventional route into science than usual. I've always enjoyed learning about nature, but I first tried my hand at music and writing, before coming back to these interests to study Biochemistry at the University of Dundee. Now, I am doing a PhD in the MRC PPU, a leading biomedical sciences research unit situated in Dundee.



Outside of the lab, I like to get outdoors, either hillwalking, kayaking, or walking the dog!

At the MRC PPU, we try to improve our understanding of what causes many diseases, including cancer and Parkinson's, so that we might be able to develop new treatments. These aren't easy problems to solve but knowing that our work may help people in the future makes it very rewarding. To accomplish this, we work with microscopes, which allow us to study the individual cells which make up our bodies. In fact, we can even look inside cells and study their components. This is a world that many people don't get to see, and I'm excited to share it with you through this series of workshops.

Studying cells is not only interesting; it can be incredibly visual too. Often, our techniques involve the use of bright colours, the formation of crystals, or the study of weird and wonderfully shaped microscopic objects. This imagery lends itself very well to art, both through the recording of new information, as well as in the exploration of new ideas. During this series, it is my hope that you will develop your artistic skills with Marc and use these to explore the scientific concepts I share with you.

I'm looking forward to seeing your art pieces and remember - all the science we discuss is being carried out just down the road!

Introduction to our artist

Marc, Freelance Artist & Designer

Hi there, I'm Marc, an artist and designer from Perth. Art has always been a big thing for me - most of the time growing up I was either drawing or playing music!

After high school I decided to pursue my interest in art and design at The Glasgow School of Art where I studied in the Communication Design department. Whilst specialising in Illustration I was also encouraged to explore my interests in computer animation and sound - for my final year research project I produced a computer animation film which focused on the suburban landscapes I grew up in.

During and after my studies I have worked on freelance projects which have taken a variety of forms (including this very project). These have included music videos, nightclub visuals, album cover design, graphic design and illustration. There is nothing more satisfying than seeing your work out in the world whether that's in a magazine, on an album cover or in a gallery.

I view art and design as fluid disciplines which are only enriched by an involvement in scientific enquiry. My hope with this series of workshops, therefore, is that you can see how both the artist and scientist rely on paying deep attention to the world. This inspiration can then be taken in different directions, whether an artwork, a scientific experiment or a movie. What connects the two disciplines is a real curiosity and openness to what you experience in the world.

Freelance live music video project:
Savage Mansion Live!
@ the Glue Factory, 2019

Capture your thoughts

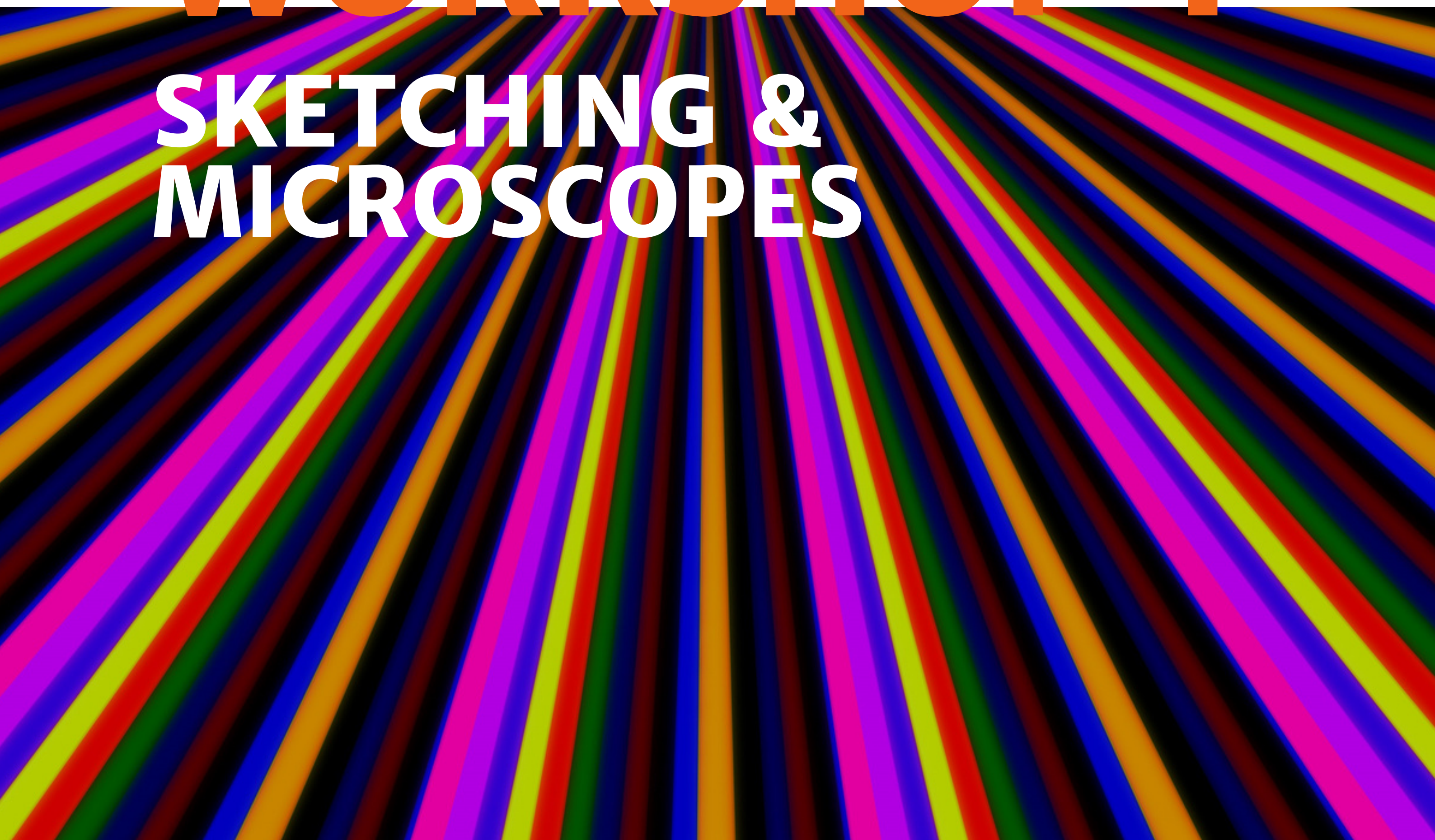
Before you begin the workshops, take a moment to make some notes on your thoughts and feelings about art and science. What do you enjoy? What do you find challenging? What are you curious to learn more about?

MRC Protein Phosphorylation and Ubiquitylation Unit

University of Dundee

WORKSHOP 1

SKETCHING & MICROSCOPES



Part 1: Sketching & patterns

Sketching is a useful technique to capture observations from the natural world, both as a scientist and as an artist. These observations can then be used to help us gain understanding, explore objects in greater detail, or inspire creativity.

In this workshop, we will investigate the patterns we observe outside in the environment. This could be a garden, a park, or anywhere you might find nature's patterns. Don't worry if you can't get outside though - you can find many examples of natural patterns indoors too, or even patterns in man-made structures.

Why sketch?

Sketching is like thinking with a pencil. In paying close attention to the world and using a pencil to capture what you see you begin to enhance your awareness of your surroundings.

It's not just artists that sketch! A taxi driver may sketch driving routes to memorise them, a dancer may sketch different body poses to understand how the body moves and a scientist may sketch complex proteins to understand how they fold.

A reptile (aboina guana). Etching by James Heath after G. Shaw. Wellcome Collection

The following are some sketching techniques that you can try for yourself.

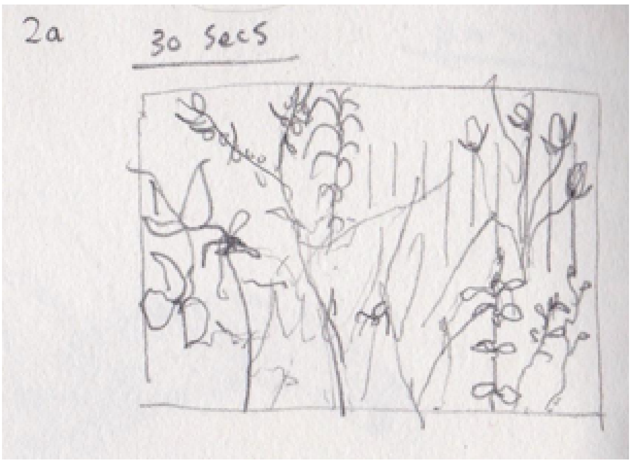
30 Second Sketch

In 30 seconds try to sketch the overall appearance of the scene/pattern in front of you. This technique is a good way of loosening up and getting used to the environment you've chosen.

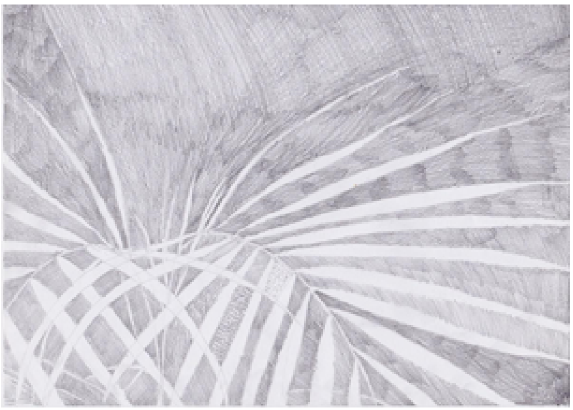
Try using simple lines or shading initially. Capturing the main landmarks in front of you - the biggest objects that give you a good sense of the relation of shapes in the scene.

Some things that might help to think about - are there organic or inorganic objects?

How few pencil marks describe the overall feel of the scene?



Negative space



The negative space technique is about focusing on the space between objects instead of just the objects themselves. In this way you will draw more intuitively rather than get too caught up in the details too quickly.

Paying attention to how shape and outline are affected by background trains your eye and hand to better appreciate what is in front of you.

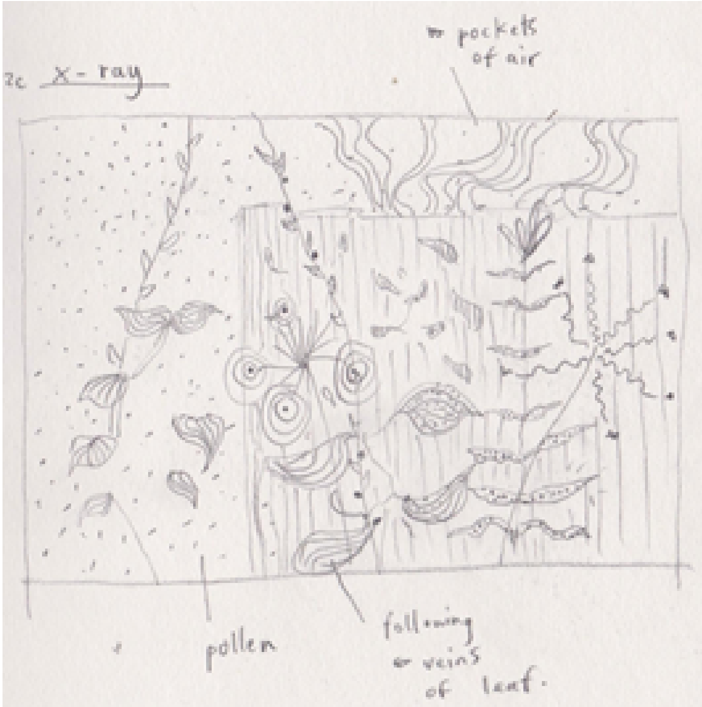
It's best to start with something simple like leaves against a plain background. Sketch lightly the basic outline of the space and shade it in paying attention to how the shading defines the edges of the leaves.

X-ray

Deep in the aboriginal caves of Australia are drawings of animals and their insides much like you would see on a present day x-ray! These drawings were a result of knowing animals intimately but also show a great deal of imagination in trying to communicate the structure and spirit of an animal.

In a similar way, why not imagine the structures of the things you see? Try representing the qualities of an object's internal structure - i.e atoms, skeleton, air - with shapes, marks and patterns like the aborigines.

In this example Marc looks again at the scene he used for his 30 second sketch and tries to sketch the 'insides' of the air, plant stalks and flowers. Try a quick sketch first and develop a more finished drawing if this technique appeals to you.



Patterns to details


An example of working from patterns to details to capture the form of a lichen growth.

Whenever you are sketching a person, scene or object always consider working from 'patterns to details'.

1. Begin first by capturing the overall shape or pattern of what you see - sketching lightly. Work intuitively with flowing pencil lines. You will probably have to erase what you have done if it doesn't quite capture what you see correctly. It may take a while to capture an accurate impression!

2. When you have a good, solid sense of your sketched composition on the page begin sketching the details - still sketching lightly. Using the initial rough lines you drew as a reference.

3. As you have captured the 'structure' of your drawing you know when you work into the details you won't need to make radical changes and so can start using the pencil more firmly to create darker lines.

Try some of the quick sketching exercises yourself:

Sketching page

Sketching page

Sketching page

Development of sketches

Sketching is something you can do when you have free time so it can be quite spontaneous.

Marc often finds himself coming back to sketches when working on a project - they then take on a very important role. Below are some examples of drawings that Marc developed from his initial sketches:

This drawing could form the beginning of an interactive environment.

Inspirational artists

David Hockney, See The Arrival of Spring in 2011 (Detail), 2011, iPad Drawing.
Credit: The David Hockney Foundation

David Hockney, Cut Trees - Timber (Detail), 2008, Private Collection.
Credit: The David Hockney Foundation

Leigh Oates, Turtle, 2003. Credit: ArtMob Australia

Leonardo Da Vinci, Natural Disaster, c. 1517.
Credit: Image by Wikiart.org

Task

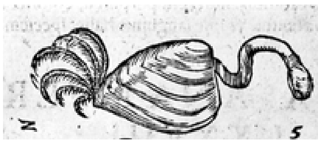
Where do you go from here?

01

Patterns

Go outside and look for patterns that catch your eye. Try some quick sketching techniques such as those detailed earlier - 30 second sketch, negative space and x-ray.

02



Details

Take a closer look at one pattern in particular and try to develop a more detailed drawing - working from patterns to details.

03

Bonus Task

Develop your sketch further by using your imagination

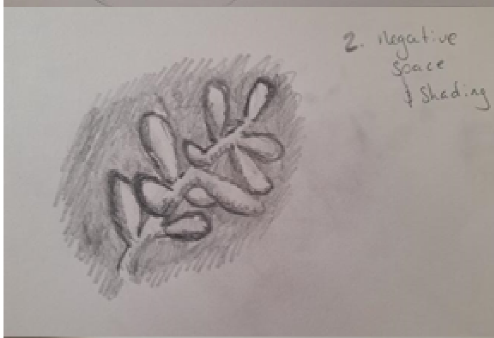
For example, can you take the information in your detailed drawing and use it to create:
A) a design for a new object (think of the leaf and the reptile skin)
B) an expressive artwork (can you take your sketch out with the realms of reality?)
C) a cartoon character (can you bring your sketch to life by giving it character?)

Scientist Dan tries some sketching

Here's scientist Dan's sketches, following the guidance and task set by Marc.

Dan chose a plant that he had in the house, as it was readily available and he thought it was quite varied, both in terms of colour and shape.

First, he tried a quick sketch to get the general shapes of the plant. This was very rough and allowed him to consider the depth of the plant, how it was orientated, and the shapes of the leaves, without feeling a pressure to produce a 'perfect' drawing. Dan often finds it frustrating when he tries to sketch, as he wants the first sketch to be perfect, so this approach was much more enjoyable as he was able to break down his sketch into an 'exploring' stage before trying to improve it.



After the rough sketch, Dan tried to explore the plant using negative space. This was useful for getting a better handle on the depth and shading of the leaves. Again, like the rough sketch, it allowed him to explore the plant in more detail, without trying to be perfect.

Finally, Dan tried drawing the plant with colours. He explored a range of colours he could see in the plant and used the rough sketch and negative space drawings to help him think about depth and shading. Having tried two rough drawings first made this much easier.

"Like me, you don't have to be a natural artist to break down a drawing into steps and create something recognisable. It may even be a useful start for making models or even an animated film!"
Dan

Sketching page

Sketching page

Sketching page

What we've covered

Sketching & patterns

We've explored that you can:

- Use sketching to capture basic aspects of an environment from life (rather than photographs) considering factors such as light, shade and space
- Observe and record a range of patterns
- Identify whether patterns are organic or inorganic
- Use a range of expressive drawing techniques, including Negative Space and X-Ray Technique
- Develop a sketch further with your imagination into an expressive artwork or design
- Consider which areas of art and design you might want to explore in future

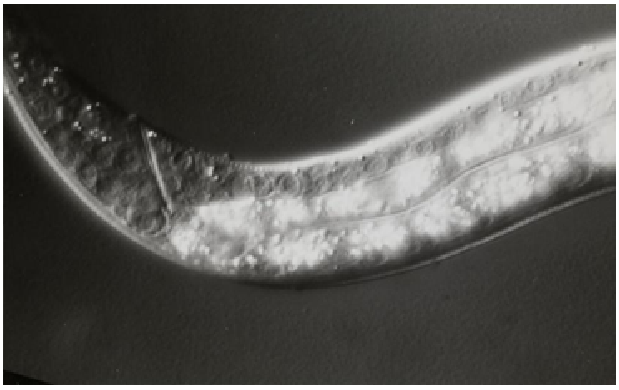
Part 2: Making a microscope

Microscopes are incredibly useful tools in the modern Life Sciences laboratory. We can use microscopes to look at microscopic organisms, observe cells, look inside cells, or even see objects as small as viruses.

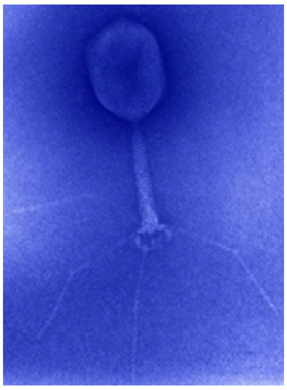
In this section of the workshop, you are going to get creative, build your own microscope, and use Marc's sketching techniques to share your findings with your classmates.

Microscopes

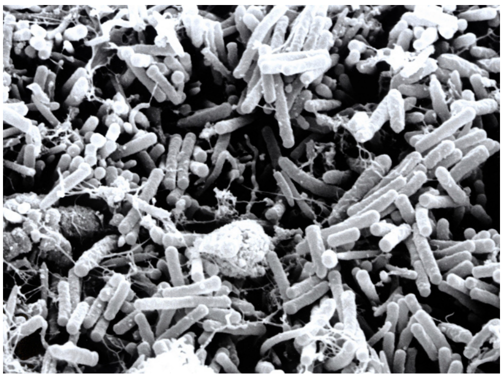
Microscopes work by allowing us to magnify the light reflected by a very small object. This means we can see things which are otherwise invisible to the naked eye (such as single bacterial cells) or see larger objects in greater levels of detail (such as the antennae of an insect)



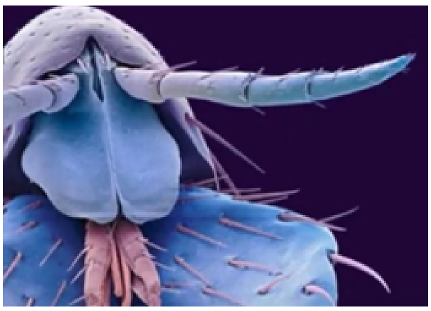
Microscopic C. elegans nematode worm; Wellcome Collection



Bacteriophage virus - D. Gregory & D. Marshall; Wellcome Collection



Bacteria - D. Gregory & D. Marshall; Wellcome Collection



Flea - Steve Gschmeissner

History of microscopes

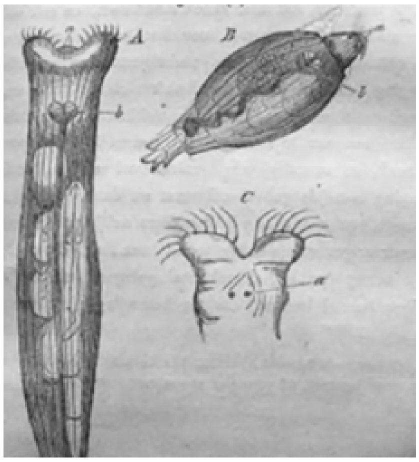
The inventors of the first microscopes, such as Antonie van Leeuwenhoek in 1683, did not know about the microscopic world. They had not heard of cells, bacteria, or viruses. When they built the first microscopes, they were astounded to discover microscopic creatures that were previously hidden from them.

Antonie van Leeuwenhoek described what he called ‘animalcules’ swimming around in the dental plaque from his teeth. Imagine how shocking that must have been!

There were no cameras or mobile phones back then. The only way scientists such as Antonie van Leeuwenhoek could share their discoveries with the rest of the world was through sketching. Leeuwenhoek sketched his animalcules, which turned out to be microscopic animals called rotifers, and single celled organisms called amoebas.

Antonie van Leeuwenhoek

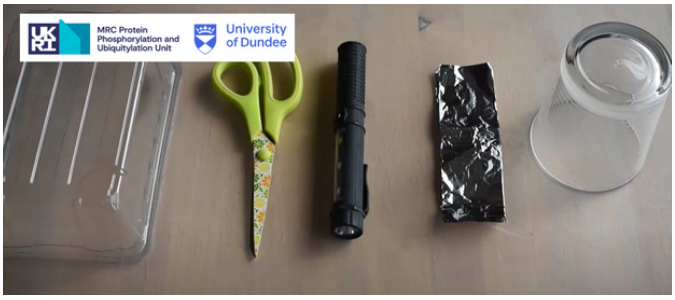
A sketch of a Flea by Leeuwnhoek - observed using his microscope



Leeuwenhoek sketched his animalcules, which turned out to be microscopic animals called rotifers, and single celled organisms called amoebas.

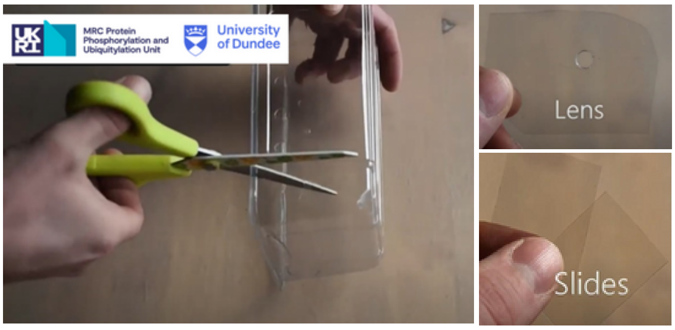
Building a microscope

Amazingly, you can also build a microscope like Leeuwenhoek's, and all you need is a piece of plastic and a drop of water!



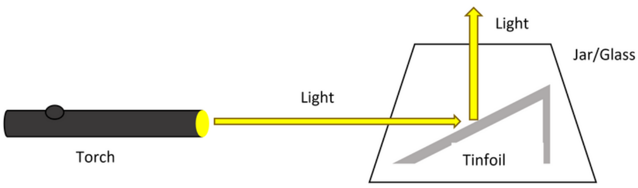
Equipment required

- Plastic carton
- Scissors
- Torch
- Tinfoil
- A glass or jar
- 2 Pencils
- Cotton bud
- Hole punch (optional)



Step 1: Making the slide & lens

- Cut the plastic container to create three flat pieces of plastic.
- Pierce a hole, using a pencil or hole-punch, into one piece of plastic - this will be your lens.

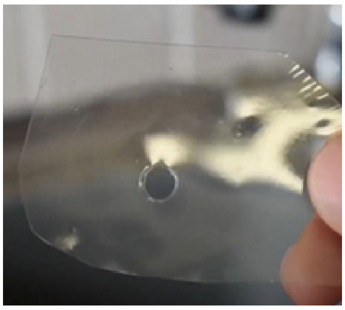
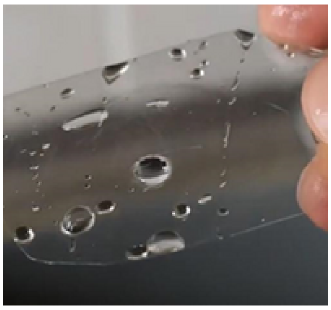


Step 2: Building the microscope

- Fold a piece of tinfoil into a triangular shape, such that it can stand with one straight vertical side and one straight diagonal side.
- Place the tinfoil inside the glass or jar and point the torch such that the light will hit the diagonal edge of the tinfoil and send it up through the top of the jar.

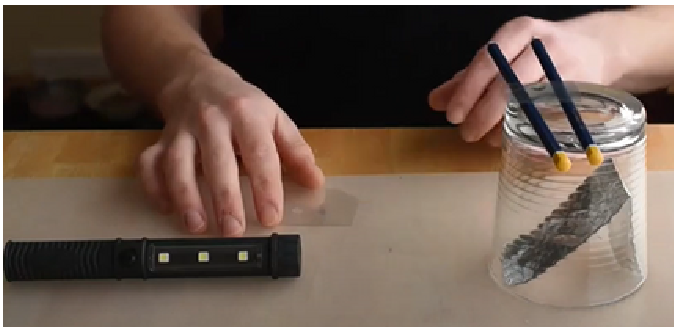
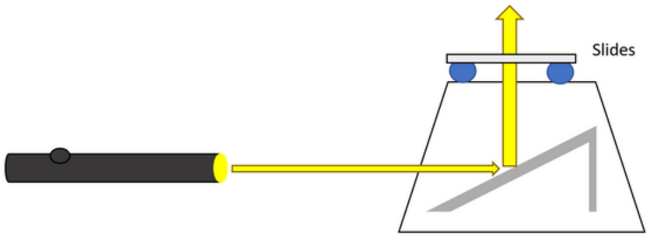

Step 3: Preparing your sample

- Dab some muddy water onto one of your slides using a cotton bud.
- Place your second slide on top of the droplet to flatten it.

Step 4: Making the lens

- Take your piece of plastic with the hole pierced in it.
- Gently run water over the hole to trap a drop of water.

Step 5: Using the microscope

- Using a pair of pencils, place your slides above the top of the jar. Turn on the torch to reflect the light off of the tinfoil and up through your slides.
- Hold the lens to your eye and move your head towards the slides continue to move closer/further away until you can get a good, steady image of the contents of your slide.

Task

Where do you go from here?

☐ **01**

Building

Follow the previous instructions to build your own microscope.

☐ **02**

Record keeping

Using the earlier sketching techniques we explored, draw what you can see down your microscope.

☐ **03**

Discovery

Using your sketch, try to identify what you have found. Did you find plant material? Did you find a microscopic animal? Did you find a single celled microbe?

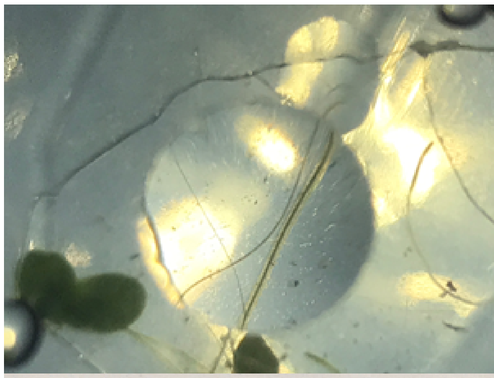
Use the following links to try and help your identification:
https://biologywise.com/protozoa-classification-characteristics
https://rsscience.com/microscopic-organisms-pond-water
https://www.bbc.co.uk/bitesize/topics/znyycdm/articles/zmrtng8

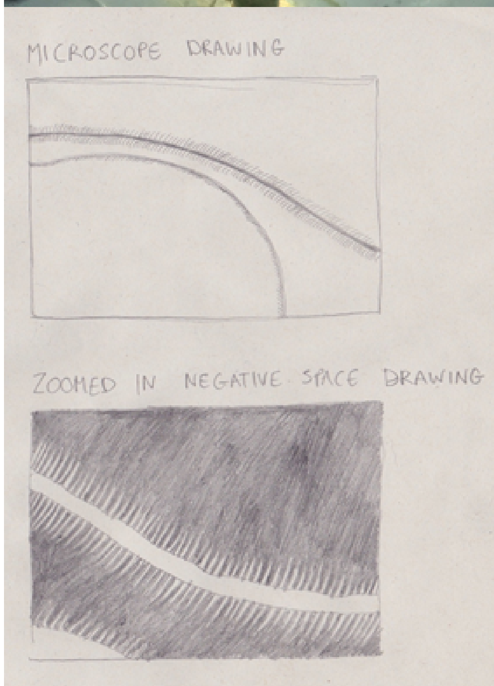
☐ **04**

Bonus task

Can a classmate identify what you found using your drawing?

Marc builds his own microscope





Marc found the microscope relatively simple to make. For his sample he sourced water from a pond as he thought this might contain a good density of organisms and matter to look at. He saw the root of a duck weed plant through his homemade microscope.

Marc used the negative space technique outlined in the sketching section of the workshop to highlight some of the characteristic features of what he saw.

Try using some of the previously mentioned techniques when sketching your microscopic find depending on what kinds of features you wish to highlight.

What features would you want to highlight that might make identification easier?

By highlighting the hair-like follicles in his negative drawing, we can see that this may be something root-like that tries to increase its area to better capture nutrients from its environment.

“I was very surprised at how quick it was to put together the microscope from only a glass, tin foil, a piece of plastic and a torch! The hardest part was getting the water to sit on the hole in the plastic to form the lens but this didn’t take long.

I would recommend using a camera phone and to get as close as possible to the microscope lens experimenting with angles to find where the clearer view is of your slide.

Think about using water from a puddle or pond for your slide specimen as this will more likely contain organisms and debris than tap water.”
Marc

Sketching page

Use this page to sketch what you can see down your microscope.

What we've covered

Microscopes

We've found that:

- Microscopes are an essential tool in the Life Sciences lab
- By magnifying light from small objects, we can see greater detail or objects that are too small for the naked eye
- The inventors of the first microscopes were shocked to discover the existence of microbes
- Sketching was required to share early scientific discoveries
- Antonie van Leeuwenhoek invented one of the first microscopes, and sketched what he observed
- Microscopes can be made of very simple items, as long as you have a magnifying lens
- A drop of water can be used as a suitable lens for a microscope

New word bank

Here, you can make a list of any new words you read or heard during this workshop. Feel free to ask an artist or scientist what these words mean!

Questions

Did you think of any questions during this workshop you would like to ask an artist or scientist? You can keep a note of them here!

UKRI
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WORKSHOP 2

3D MODELLING & THE CELL

Part 1: Modelling in 3D

Making models in 3D, either by hand or on the computer, is an important step towards creating an animation, building a sculpture, or studying an object in greater scientific detail.

We can see how the parts of an object, such as the limbs of an insect or parts of a machine, fit together. This can allow us to explore how these objects function and move, which can in turn inform artistic expression or scientific study.

In this workshop, we explore Tentsmuir Beach in Fife to look for specimens we can use to model from.

Explore

First we need to find some specimens to model and so we need to explore! There are many benefits to exploring an environment close to you for inspiration - from finding specimens unique to your local environment to capturing lots more detail than you can find with a Google search! You also get to know your local environment in a much deeper way.

Documenting

As you explore you can document your specimens with photography, as highlighted in this workshop, or you could use the sketching techniques we explored in Workshop 1.

When documenting a specimen you want to consider 3 things:

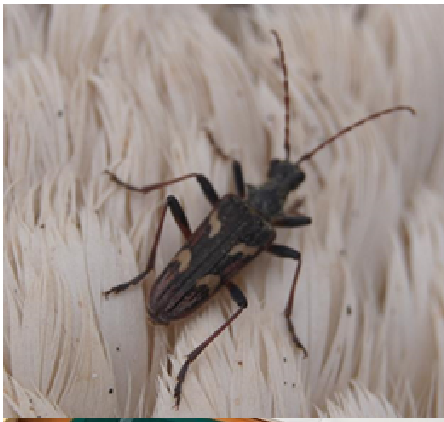
1. Capturing from a **variety of angles** (Front, Top, Left, Right)
2. Capturing the specimen in its natural **context** - i.e does it live beside other organisms, plants?
3. Close-up **texture** shots that capture colouring and the fine detail on an object

Capturing different angles of a specimen and capturing the close up details

Focus on a few specimens in particular with which to capture enough details to work from when modelling

Examine & model

In order to model our specimen - the Longhorn Beetle - we will now focus on two techniques - the body plan and the blow up.



Body plan

Whenever you are thinking of making a larger model it is handy to make a small prototype ‘body plan’. Think of this like a slightly more in depth ‘30 second sketch’ from the previous sketching workshop - the aim is to familiarise yourself with something new, in this case by ‘sketching’ with clay.

There are several advantages to this technique. You start to get a sense of the overall scale of the parts of an object to each other, providing a handy reference for when scaling up your model. You also begin to familiarise yourself with the clay itself, getting used to how to manipulate the clay with your hands, when to add more water to keep it workable and what kinds of structures are possible to model. As always, the best way to learn is to get your hands dirty!

Blow up

The blow up is a technique you can use to examine your specimen in order to learn about its structure. By focusing on a small section of your specimen and blowing it up in size you can learn all sorts about how its form affects its function.

In this case we ‘zoom in’ on the antennae of our beetle so that we can observe how the forms that make up the antennae influence its structure and movement.

It was only after blowing up the antennae that I discovered how they can move so effectively to sense their environment. The triangular bone-like shapes that make up the antennae act as joints that maintain much flexibility whilst also being incredibly tough.

*Flashback - During the ‘blow up’ stage, think back to the microscope task of workshop one. To see your structure in greater detail, could you use your microscope to help?

Inspirational artists

Nikki De Saint Phalle, The Tarot Garden, 1998, Credit: Hans Jan Dürr

Nikki De Saint Phalle, Les Footballers, 1993, The Olympic Museum, Lausanne, Credit: Sailko

Louise Bourgeois, MAMAN, 1999. Credit: Chuck Heiney/The Easton Foundation/VAGA/ARS

Task

Where do you go from here?

01

Explore

Visit an environment that you either know well or are interested in exploring. Document some specimens of organisms or objects that you might like to model - narrow these down to three choices. Document using either photography or the sketching techniques explored in workshop 1.

02

Examine

Choose one specimen and create both a body plan and a blow-up model using clay or another material that you can model with in 3D.

03

Bonus task

Look back at the bonus sketching task of Workshop 1. Can you use your imagination to develop your model further?

Sketch, or include a photo of, your body plan here:

Sketch, or include a photo of, your blow up here:

What we've covered

Modelling in 3D

We've explored that you can:

- Explore an outdoor environment of your choosing to document a range of specimens
- Use photography or sketching to capture important information about specimens that you can reference when modelling
- Use clay to model a prototype of your chosen specimen
- Consider scale when modelling in 3D in order to create an accurate representation of the structure of your specimen
- Consider how the form of an object - organic and inorganic - affects its function
- Use two different methods of modelling - body plan and blow up - to assess structure and function of specimen

Part 2: Cells: the limit of life

Cells are the ‘basic unit of life’, but what does this mean? For something to be considered ‘alive’, it must be capable of undertaking certain tasks independently.

In workshop 1, we looked at building our own microscope to look for microscopic organisms. In this workshop, we will explore the primary use of microscopes in the modern Life Sciences laboratory - the study of cells.

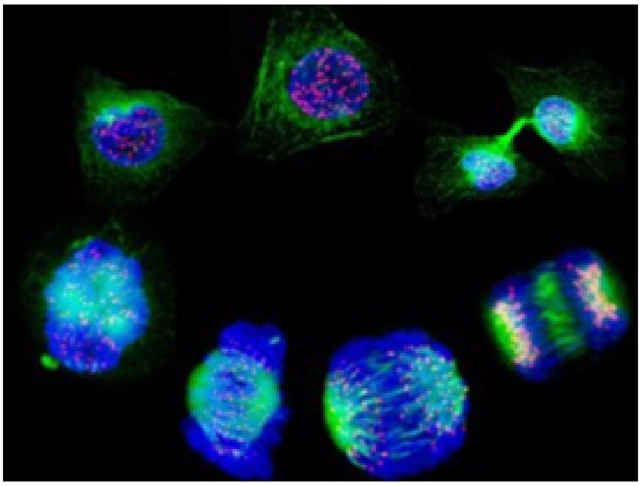
Cells are the ‘basic unit of life’, but what does this mean? For something to be considered ‘alive’, it must be capable of undertaking certain tasks independently. These include:

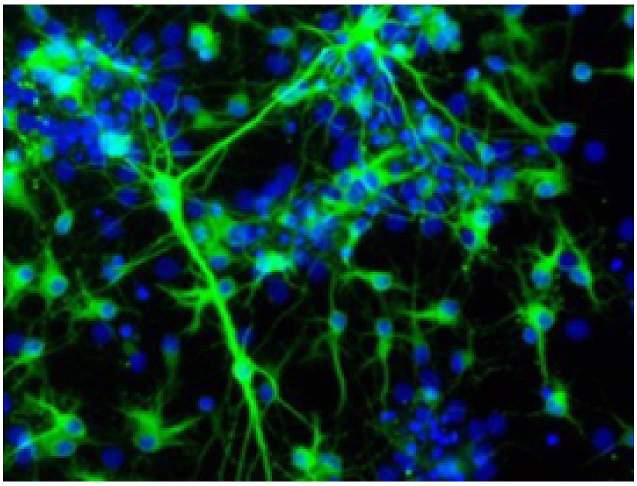
- Obtaining a food source
- Generating energy
- Removing waste
- Growing and developing
- Reproducing the next generation

The images below show two very different examples of human cells.

The left image shows a cell dividing into two cells (anticlockwise from top). The cells in the left image are very rounded and circular.

The right image shows cells that have grown and developed into neuronal cells; cells which make up part of our brain.

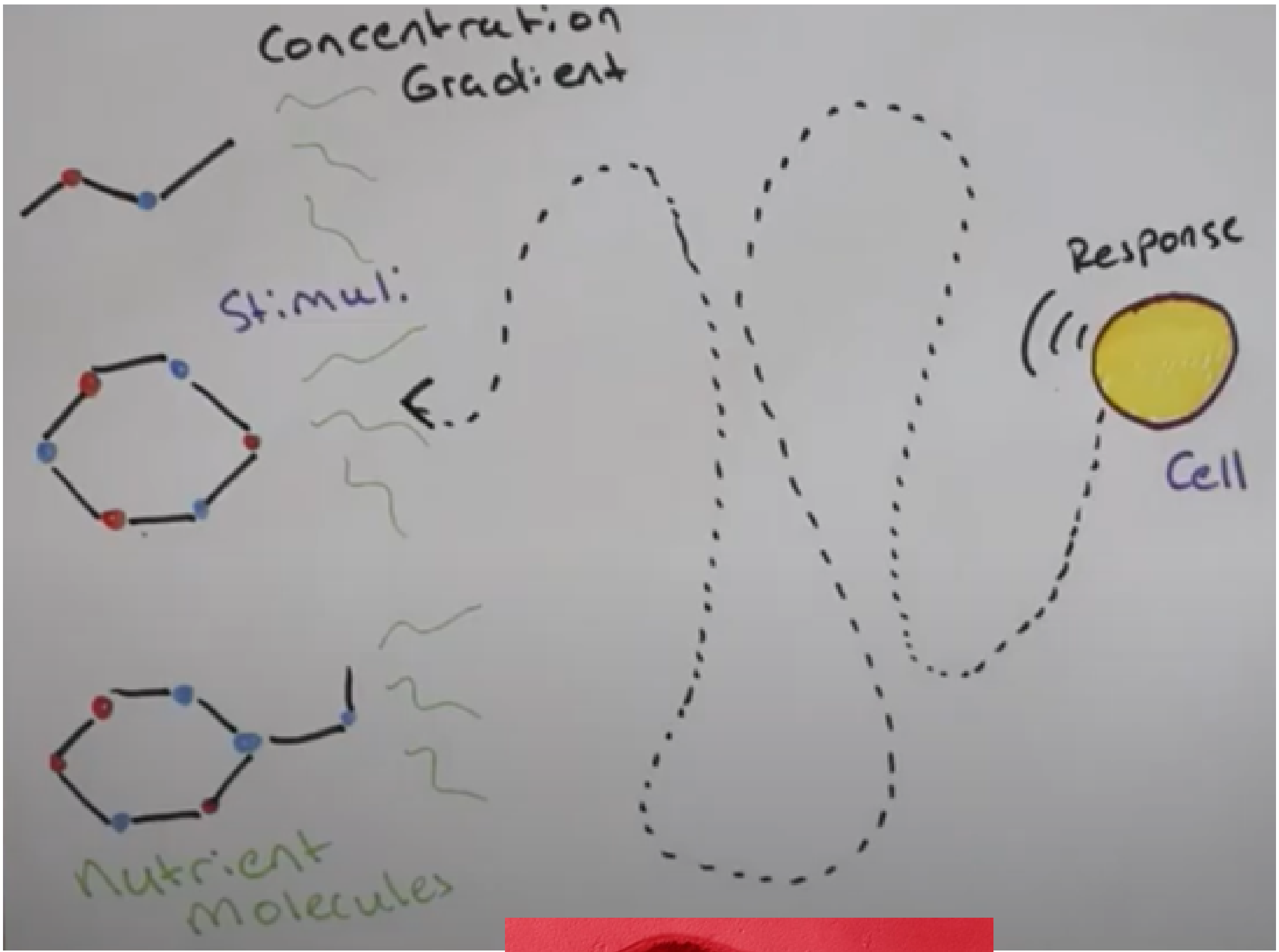


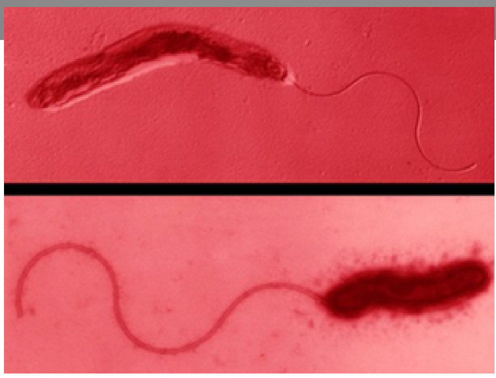


Cells can be single celled organisms, such as bacteria, or can come together to form multi-cellular organisms such as humans, starfish, trees, mushrooms... the list goes on!

Cells are capable of independent existence and respond to stimuli from their environment. In order to find food, gain energy, grow, and divide all cells must receive signals from their environment. These signals are converted into messages which encourage the cell to respond in a certain way. This might include moving towards a food source or dividing into two.

In order to adapt to their environment and be capable of undertaking these tasks, cells have developed special structures to help them. For example, some bacterial cells have developed tail-like structures (flagella) which help them swim towards food.





Task

In the 3D modelling section of this workshop you looked at using a body plan and blow-up to examine key structures of an organism for making models. Here, you are going to apply the same concept to **design your own cell**.

01

Things to consider

- What environment does your cell inhabit? (e.g water, soil, warm, cold - maybe your cell lives inside another organism?)
- Is your cell a single celled organism? Or do many of your cells come together to form a multi-cellular organism?
- How does your cell get food?
- How does it create energy?
- How does it grow and develop?
- What is its life cycle?
- Can your cell move? Or is it stuck in the same place?
- How does your cell receive signals from the environment?

For now, we are not going to worry about the real mechanisms cells use to achieve these objectives. Instead, we want you to think about examples from the world you are familiar with and apply these to cells. For example, a car burns petrol to obtain energy, whereas a windmill generates energy by turning in the wind. Could your cell use similar techniques to gain energy?

Similarly, does your cell swim from place to place? If so, what kind of apparatus does it use to do this? Are there any other alternative movements you can think of?

Does your cell catch its own food? If so, what does it need to do this? Maybe it sucks food from the environment with a straw-like device? Think about how animals and plants obtain food, and think of the structures they use. Can you apply these to your cell?

02

Choose your technique

You can use sketching, clay modelling, or any other technique you like to create your cell. To accompany your cell, please provide a few lines of description to explain your cell's environment and how it survives in it.

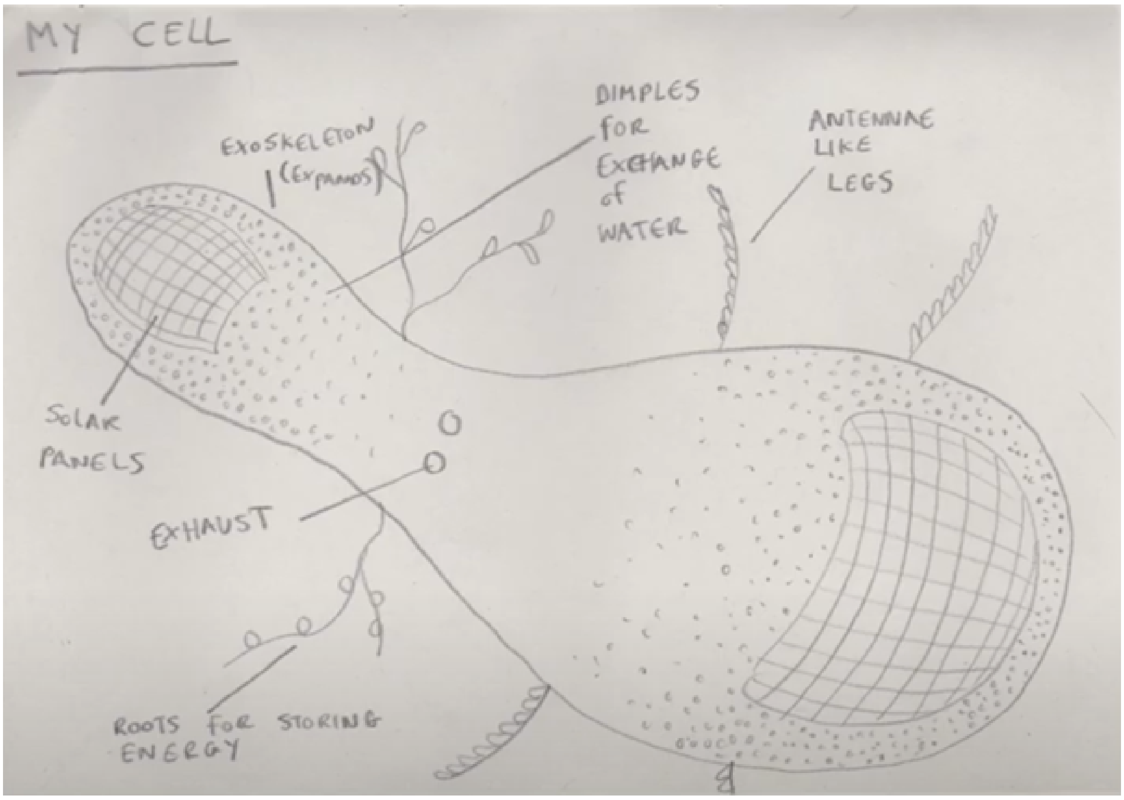
Marc designs a cell

For inspiration, Marc had a go at the task and designed his own cell. Here's how he thought about his cell's environment and how it survives in it.

"Helicopter Cell"

To design his cell, Marc began considering how his cell might move. He remembered that the seed cases of the sycamore tree are shaped like helicopter blades so they can glide on the air and travel great distances. This would allow far enough dispersal to spread the cell amongst the environment. He also thought that if it was rotating it could store the energy like a wind turbine might either in the form of a battery or as roots like a plant.

He thought of a dimpled insect exoskeleton that had pores which could enable gases to be exchanged, reminding him of the kinds of sculptures you can 3D print now - prompting the idea that if the cell could make clones of itself, it could reproduce itself to survive when it reaches the ground.



"The helicopter cell glides down through the clouds, as it spins it generates electricity which it stores as carbohydrates in root nodules. The cell is made from an exoskeleton similar to insects allowing an exchange of gases and nutrients whilst also retaining a solid structure. When the cell lands on ground or a water body it can reproduce via an internal miniature 3D printer."
Marc

Your cell

Include a sketch/photo of the cell you designed here. Have you given it a name? Provide a few lines of description to explain your cell's environment and how it survives in it.

What we've covered

Cells: the limit of life

We've explored that:

- Cells are the basic unit of life
- All life is composed of cells
- Life can be single celled, or multi-cellular
- All life must
    a. Obtain food
    b. Generate energy
    c. Grow
    d. Reproduce
- This is achieved by responding to signals from the environment

New word bank

Here, you can make a list of any new words you read or heard during this workshop. Feel free to ask an artist or scientist what these words mean!

Questions

Did you think of any questions during this workshop you would like to ask an artist or scientist? You can keep a note of them here!

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WORKSHOP 3

ANIMATION & PROTEINS

Part 1: Animation

Animation is everywhere now - music videos, scientific research, film, art, fashion, education. The list goes on. The benefit of animation is that we can create worlds that we could never photograph - the only limit is our imagination!

Now that you have experience in sketching designs and making models, we are going to look at making your own animation. You've heard of film and you've heard of animation, but what is the difference between the two? In this workshop we're going to find out!

Animation

We see a moving image because roughly 24 images - or frames - flash up on screen per second. When images change this quickly in front of our eyes we perceive movement. Animation and film both use roughly the same rate of frames - 24 or 29.

To create a film we shoot footage with a video camera.

To create an animation we build up each frame one at a time through all sorts of means - sometimes we can even build up an animation frame by frame by taking photographs like we will be doing in this workshop.

Gertie the Dinosaur. 1914. [Film]. Winsor Mccay. dir. USA: William Randolph Hearst

Pixilation

Pixilation is a form of animation much like stop-motion. The animation is created by taking a series of photos and stitching them together using computer software to create a moving image. This technique is often seen in films that use puppets such as Fantastic Mr. Fox or Wallace and Gromit.

The main advantage of pixilation or stop motion is to create scenes that you wouldn't be able to film with a video camera - you can make the seemingly impossible happen right in front of your eyes. This is why early animation had a close relationship with performing magicians!

Wallace and Gromit: The Wrong Trousers. 1993. [Film]. Nick Park. dir. UK: Aardman Animation

Concepting and shooting a sequence

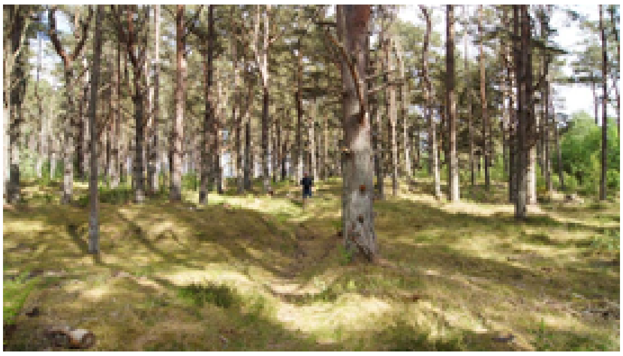
We planned a pixilation animation that would show Daniel hovering through the forest like a ghost or an alien. This would be humorous and strange and would highlight the technique of pixilation quite simply.

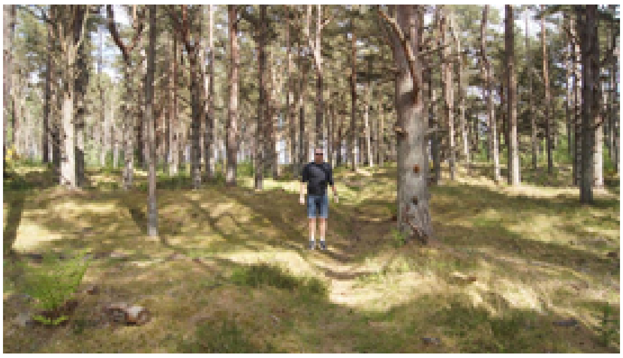
We chose a clearing in Tentsmuir Forest that made for a distinctive composition and also framed Daniel as he hovered through the trees.

For maximum impact Marc had to remain still as he took each photograph - this emphasises Daniel's movement. Holding the camera on a tripod would have been another way of achieving this.

With each photograph Daniel jumped into the air so in each frame he appears mid-air. When these photos are stitched together it appears as if he is hovering.

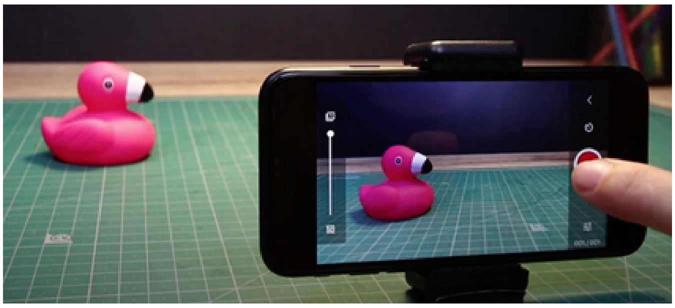
The more photos taken of Daniel at small intervals, the more frames and the smoother the motion.





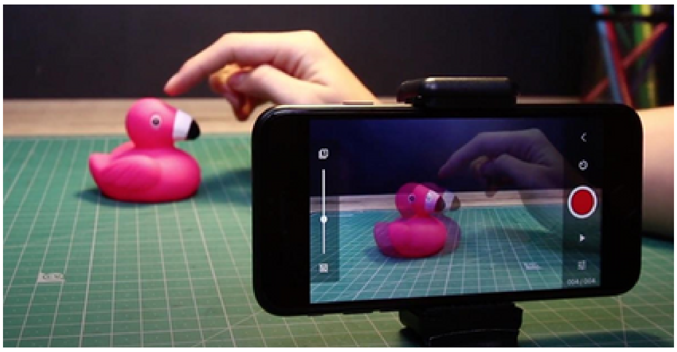

Stitching the frames together

To put together our sequence we used Adobe Photoshop which is an industry standard software. If you don't have access to Photoshop then we recommend StopMotionStudio which comes with a free version, is very easy to use and means you can use your iPhone or Android phone for the whole process.



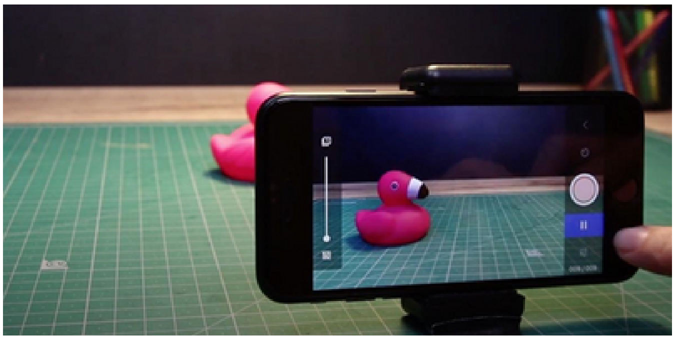
Step 1

- Place camera phone in front of scene, kept steady with a tripod or by holding. Arrange composition within camera scene. Take your first frame photo by pressing the usual red trigger button.



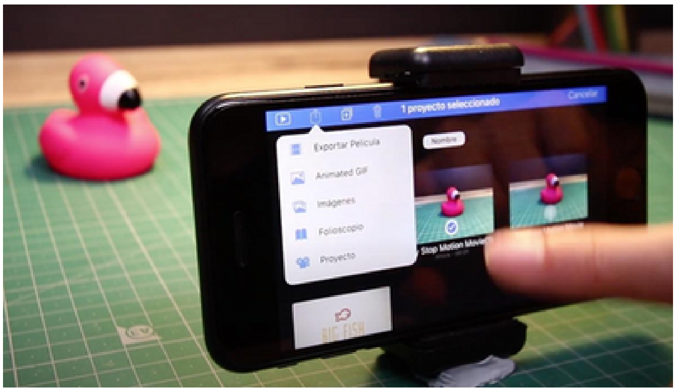
Step 2

- Move object to be animated slightly. You can adjust the transparency (onion skin) setting on the left which will show you frame 1 overlaid on your current photo setup to double check where you want to move the object. Moving the object slightly each time will result in a smoother animation. Press the red trigger button to take the photo for frame 2.



Step 3

- Continue this process for your entire sequence. When you have a sequence you can press the play button to preview it as a moving image. It is at this stage you can adjust the frame rate to observe how different speeds affect the animation.



Step 4

- When you are happy with your animation exit the movie making screen and select your sequence in the file menu, go to the share selection and export as a movie.
- You can then either save this movie file to your phone or send to a computer via bluetooth or USB.

Further app tutorials

In-depth video tutorials are available at the StopMotionStudio website: www.stopmotionstudio.com/tutorials.html

We recommend the ‘01 First Steps - Stop Motion Studio Tutorial’ for a good introduction to the App and stop-motion animation in general.

Interesting note:

This is also the way you make gifs!

Inspirational art: examples of pixilation & stop-motion animation

Fantastic Mr. Fox. 2009. [Film]. Wes Anderson. dir. USA: 20th Century Fox Animation

The Adventures of Prince Achmed. 1926. [Film]. Lotte Reiniger dir. Germany: Milestone Films

King Kong. 1933. [Film]. Merian C. Cooper, Ernest B. Schoedsack dir. USA: RKO Pictures

Task

Where do you go from here?

01

Plan

Draw out an idea for a short pixilation sequence with a friend or using the 3D model you made in workshop 2.

02

Create

Create the sequence using a phone camera or other digital camera.

03

Animate

Put your frames together using either photoshop or your app.

Your ‘exported’ animation should be a short movie file (.mp4 or .wmv)

Plan your pixilation animation

Use this space to plan a concept for your pixilation animation. Think about using your own skills - such as humour, dance, model making, writing - when producing a simple concept.

Your animation

Here, you can include a photo of you working on your animation, notes about how you made the animation or some screenshots of your final animation.

What we've covered

Animation

We've explored:

- The main differences between animation and film
- Several modern uses of animation as an expressive and communication medium
- The pixilation animation technique and its use in movies
- Concepting a short narrative sequence on your own or with a friend
- Considering composition, lighting and location in the narrative of your sequence
- Using other skills you may have to showcase with animation - dance, humour, acting, model making, writing etc.
- Using basic editing techniques to combine your frames into a final animation file

Part 2: Proteins: folded for function

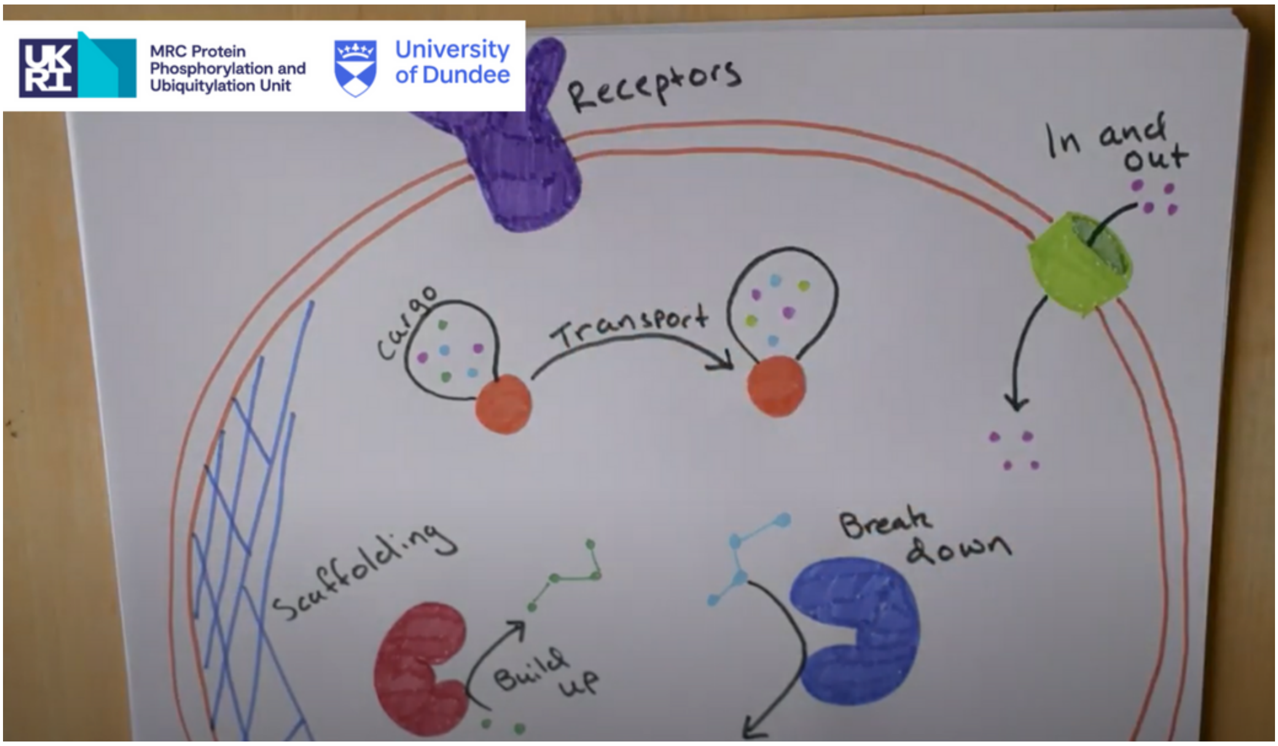
Proteins are large molecules which carry out nearly all the functions of the cell. When a protein cannot do its job properly it can lead to disease.

So far, we have made our own microscopes to examine the microbial world, and we have looked at cells, the basic unit of life. During the cell workshop, you designed your own cell, and thought about the kind of structures cells might use to achieve the tasks required for survival.

Proteins

In this workshop, we are going to think about proteins. Proteins are large molecules which carry out nearly all the functions of the cell.

- Cells need to obtain food - some proteins form channels in the cell which allow food particles to enter
- Cells need to interact with the environment - some proteins form receptors (think satellite dishes) outside the cell to receive signals
- Some proteins provide structure to the cell, like scaffolding
- Others break down food particle to make energy
- Some proteins even transport molecules from one part of the cell to another



Protein folding

In order for proteins to function effectively, they need to fold into the correct shape. If a protein does not fold correctly, it will not be able to do its job properly. This is similar to a piece of paper being folded into a paper aeroplane.

When a protein cannot do its job properly, it can lead to disease. Examples of diseases where proteins have failed to fold correctly include Alzheimer's and Parkinson's Disease.

Much of the research conducted at the MRC PPU at the University of Dundee focuses on Parkinson's Disease.

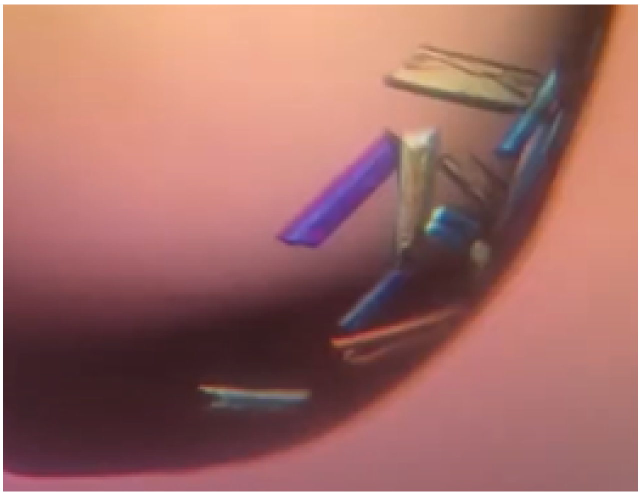
MRC Protein Phosphorylation and Ubiquitylation Unit

University of Dundee

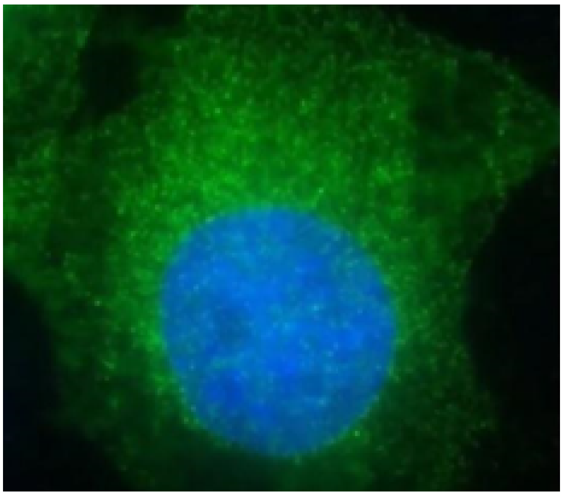
In the lab we study proteins in different ways. We can:

- Burst cells open to count the proteins they have
- Make protein crystals
- Use microscopes to look at proteins while they are still inside the cell

Combining the knowledge from all of these techniques enables us to better understand how proteins work, and what goes wrong in disease. This helps us design potential treatments and cures.



Protein Crystals



Proteins (green) inside a cell

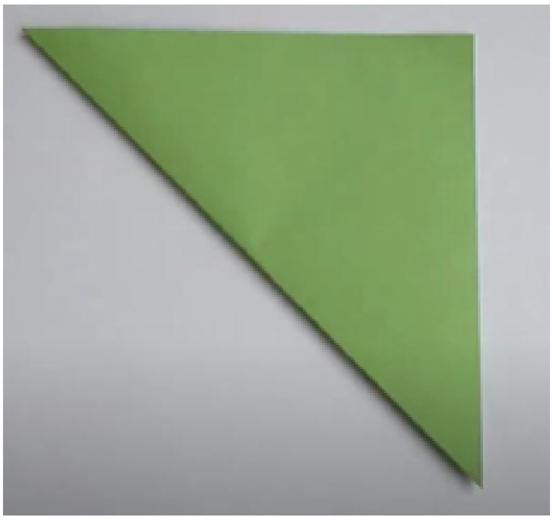
Task

Proteins need to fold correctly to be functional. In this task, you are going to use origami to fold your own functional protein. Follow the instructions below and in the video to see if you can make a functional protein channel.

Bonus task: can you use your folded protein in a pixilation animation?

☐ **01** **Start with a piece of square paper**

☐ **02** **Fold diagonally**



☐ **03** **Fold again corner to corner**

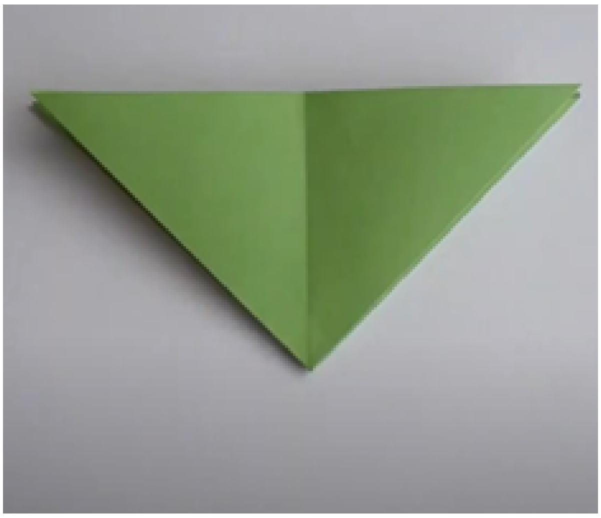
☐ **04** **Unfold the paper**

05 Fold across the middle

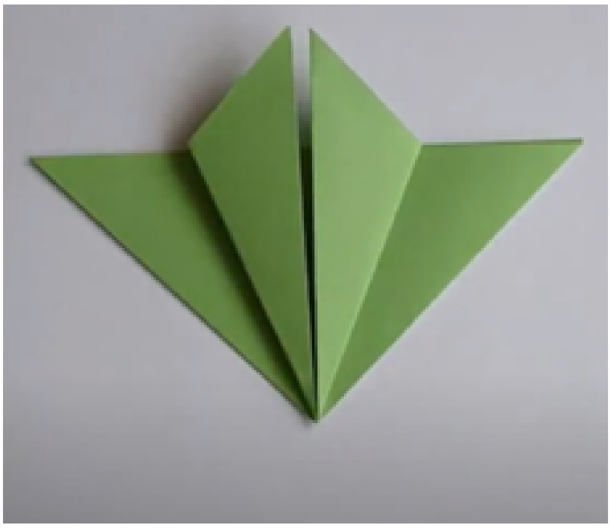
06 Fold again to make a square

07 Unfold the last fold, and fold the corner inwards

08 Do the same on the other side



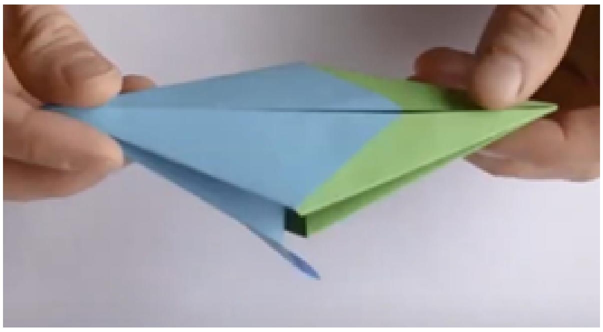
09 Fold the flaps inwards to the middle



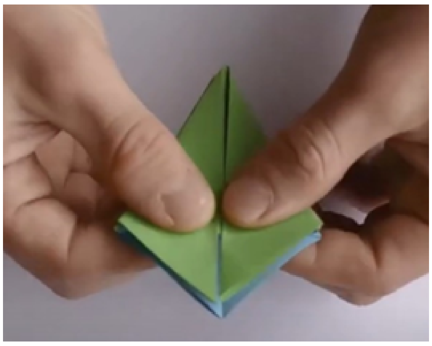
10 Do the same on the other side

11 **Repeat to make 8 separate pieces**

12 **Fit the pieces together end to end**



13 **Fold back on themselves**



14 **Repeat until all 8 pieces are connected**

15 **Unravel the connected pieces & attach free ends together to complete chain**

16 **You now have an open protein channel**

17 **Fold inwards from the corners to close your protein channel**

Your origami protein channel

Here, you can include a photo of your origami, notes about how it worked or even screenshots if you used it to make a pixilation animation.

What we've covered

Proteins

We've explored that:

- Proteins are molecular machines which carry out most of the jobs inside a cell
- Proteins are built to perform very specific tasks, including:
  - allowing things in and out of the cell
  - breaking down nutrients to create energy
- For a cell to function properly, all proteins must be doing their job effectively
- When proteins don’t work properly, this can lead to disease
- Studying proteins allows us to understand what causes diseases - this can help us to develop cures
- For proteins to work, they must fold into the correct shape
- If proteins don’t fold correctly, they won’t work properly
- Alzheimer’s and Parkinson’s are examples of diseases where proteins don’t fold correctly

New word bank

Here, you can make a list of any new words you read or heard during this workshop. Feel free to ask an artist or scientist what these words mean!

Questions

Did you think of any questions during this workshop you would like to ask an artist or scientist? You can keep a note of them here!

Capture your thoughts

Well done taking part in these workshops, we hope you had fun!

Now you've completed the workshops, take a moment to make some notes on your thoughts and feelings about art and science. What did you enjoy during these workshops? What did you find challenging? What have you learnt? What are you curious to learn more about?

Once you've noted these down, look back at your thoughts and feelings from before you started the workshops (page 6). How do your two sets of notes compare? Have any of your thoughts or feeling grown stronger or changed?

Many thanks to everyone who contributed to these workshops & this workbook.

Project Team

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- Daniel Squair, PhD Student, MRC PPU
- Sarah Patrick, Public Engagement & Communications Consultant
- Marc Johansen, Freelance Artist
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