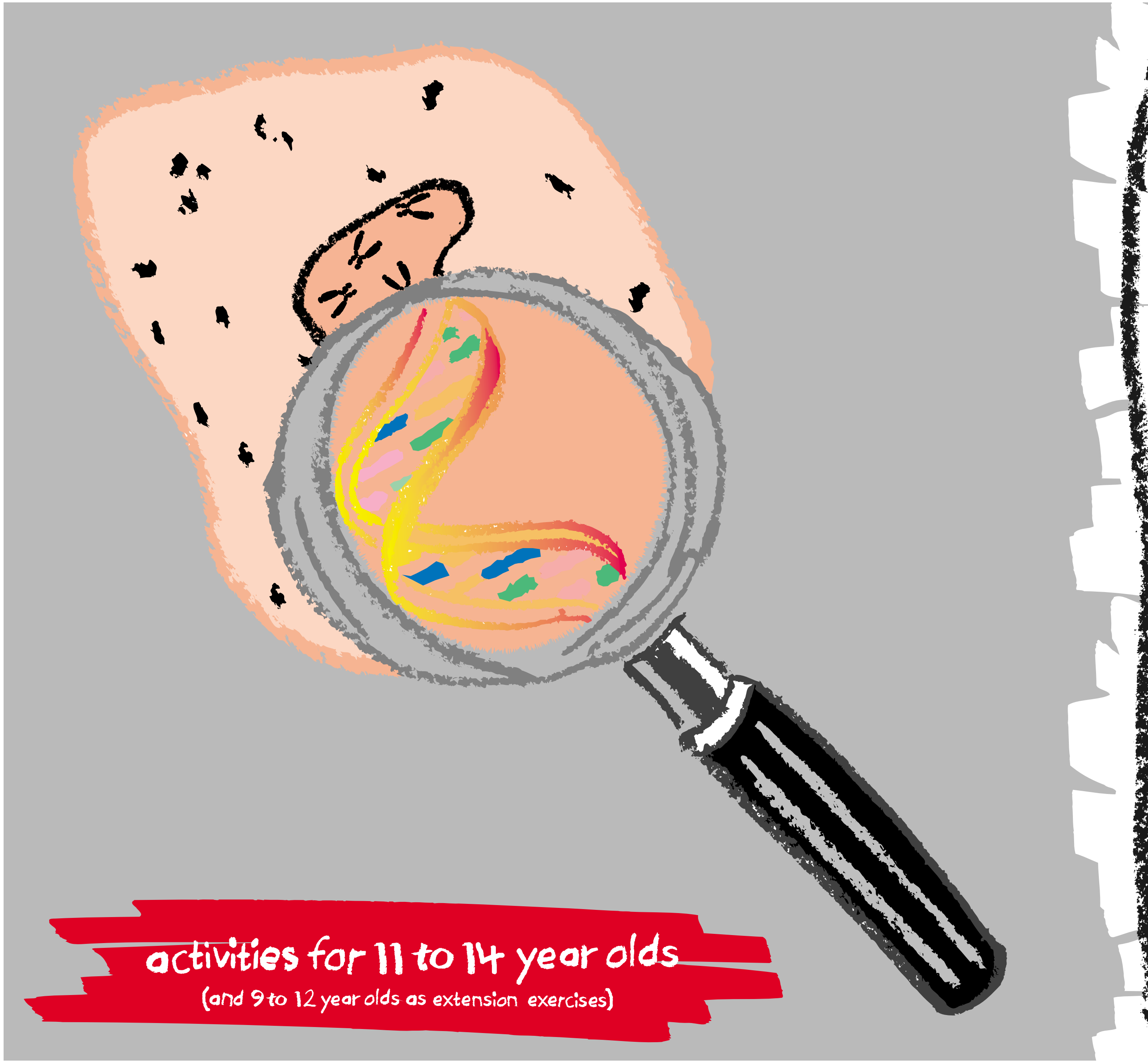


Discovering DNA 'The Recipe for Life'

Created by Dr Sue Assinder of
the University of Wales, Bangor

Prifysgol Cymru · University of Wales
BANGOR

Produced by the BBSRC
Schools' Liaison Service

bbsrc
biotechnology and biological sciences
research council

How the workshop was created

Age range
11 to 14 years
(or 9 to 12 years as curriculum extension exercises).

Total time
Two hours if you choose to run the activities in the form of a workshop.

Group size
The workshop can be run with a class of 25 -35 children or you may choose to work with smaller groups.

Helpers
You will need one helper if the class is split into smaller groups for activities 5 and 6.

In June 1995, Dr Sue Assinder, a scientist working on the molecular genetics of cell division at the University of Wales, Bangor won the first BBSRC *Science Communicator* Award with her idea to introduce primary-aged children to DNA through a series of hands-on activities.

Since it's initial development, some elements of this resource have been amended so that the workshop activities can be made available to 11 to 14 year olds in support of their science education (see *Links to the Curriculum*), and 9 to 12 year olds as curriculum extension exercises.

This pack is the end result. Through the Discovering DNA Workshop children can gain:

> a basic understanding of the role of DNA within the cells of the human body and an appreciation that it is the uniqueness of their DNA "recipes" which makes them all very different people.

Although this pack is written to help a teacher deliver the information in the form of a science workshop, a number of the activities are 'free-standing' and can be fitted into programmes of study as and when the teacher requires.

Acknowledgements

The BBSRC thanks all those who contributed to this pack including the National Centre for Biotechnology Education (NCBE) for their support and advice, the teachers and students of Ysgol Y Borth, Menai Bridge, Ysgol Y Garnedd, Bangor, Ysgol Tregarth, Bangor, Ysgol Llanfairpwllgwyngyll, Llanfair P.G., for helping to pilot the resource, Debbie Evans, Hannah Rees, Michelle Hughes and Sue Whittaker for their help in running the pilot workshops and Sue Dewar for the photography.

Safety First

Methylated spirit (used in activity 5) is an acceptable solvent to use in primary science teaching. However, please note that this substance is highly flammable and should not be put near a naked flame.

Links to the curriculum

This pack can be used in direct support of the curriculum for 12 to 14 year olds. Links are given below.

• **England, Wales and Northern Ireland.** ***Science****. Key stage 3*. **Programme of Study** - 1a and 2a; **Life Processes and Living Things** - 1b, 1c, 4a, 4b and as an introduction to 4e.

• **Scotland.** ***Environmental Studies 5 - 14 Science.*** *Stages P7 - S2.* **Understanding Living Things and the Processes of Life - Variety and characteristic features** (including an introduction to how information is passed from one generation to the next); **The process of life** (including the basic structure and function of plant and animal cells).

This pack can be used to enhance the knowledge of 9 - 12 year olds through a range of curriculum extension activities. These can be linked to curriculum at the following points:

• **England, Wales and Northern Ireland.** ***Science****. Key stage 2*. **Life processes and Living Things** - 1a; **Materials and their Properties** - 2a-c and 3c.

• **Scotland.** ***Environmental Studies 5 - 14 Science.*** *Stages P5 - P8*. **Understanding Living Things and the Processes of Life - Variety and characteristic features** (similarities and differences between plants and animals of the same species).

This pack can be used as a source of *reinforcement* activities for 14 - 16 year olds. ***Science****. Key stage 4*. **Programme of Study** - 1a, 1b and 2a; **Life Processes and Living Things** - 4a, 4b, 4c, 4g and as an introduction to 4d, 4e, 4f and 4h.

The *Discovering DNA* workshop can also be used to support *English* - speaking and listening including opportunities for group discussions and writing to inform; *Maths* - handling data and using measures and *Information Technology* - using a computer to store and retrieve information and to produce graphs.

Contents

A quick guide to the way the workshop works....

15 minutes

1. Making a cake

The children are divided into four groups of about the same size. Each child is given a badge marked with the letter A, T, G or C, and, if possible, they are dressed in T-shirts in four different colours.

The children are then shown (and given a piece of!) a chocolate swiss roll. Each group is given a box containing essential items to make the cake plus “red herrings” and asked to pick out the things they need. To help them, the boxes contain a cookery book with the recipe for a chocolate swiss roll (amongst several other recipes).

In this way you introduce the idea of the importance of having a **recipe** (a set of instructions/information) so that the **exact** product (in this case a cake) can be made.

10 minutes

2. The “Recipe for Life”

The children are shown examples of some of the other cakes from the book and led to the idea that the cakes are *different* because they have been made using *different recipes*.

It is pointed out that it’s not just cakes that can look different – children differ from each other as well. The children are asked to point out the differences between three “volunteers” (eye colour, hair colour etc).

Children learn that each of us contains a “recipe” which controls what we look like – the **“Recipe for Life”**. We all look different because the recipe is different for each person.

There follows a question and answer session on where the recipe might be and what form it might take, with the explanation that the recipe is a “special chemical” called DNA kept in every part of the body.

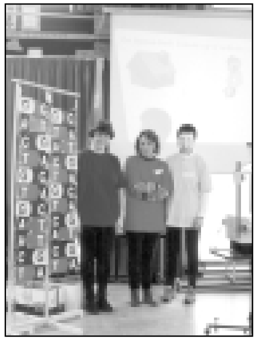
20 minutes

3. An introduction to cells

The children are led to the idea that living things are made of cells, using the analogy of a house made of bricks. A poster and simple models are used to explain that each cell has a special compartment (the nucleus) where the “recipe” (the special chemical called DNA) is stored.

15 minutes

4. DNA - a chemical “recipe”



The structure of DNA is introduced using a large pre-prepared model. The children are asked to spot the important features (i.e. “rules” of AT, GC pairing - see *The DNA Discovery Workshop:Teachers’ Notes*) and the names of the bases are introduced.

Using a second pre-prepared model, the children are asked to spot that the “rules” are the same but the order of bases is *different*. This is used as a link to explain that DNA works like a “recipe” because the *order* of the bases acts as a special code. We all look different because our DNA has a slightly different order of bases, so the “recipe” is slightly changed.

If time allows, the children make their own small DNA models to reinforce these ideas.

25 minutes

5. Exploring DNA: looking at onion DNA

A large flow chart is used to trace the path from the whole onion, to the single cell, to inside the nucleus. This is linked to slides of onion cells set up under a microscope. Children are asked to work out how they would get the DNA out of the cells (i.e. by bursting them open). You then help the children to carry out the *DNA from onions* activity, preparing the necessary solutions and getting the children to help with weighing, measuring and mixing.

25 minutes

6. Exploring DNA: cartoon fun

The activity aims to get over the idea that DNA carries the recipe for all of the features of the human body. Children (in smaller groups of 2-3) are asked to build a cartoon face by cutting noses, eyes etc from “identikit” sheets and sticking them onto a blank template. Each of the features has assigned to it a DNA “recipe” (or genetic code). Having designed the cartoon character, the children are asked to write down the “recipe” and then colour their character and give it a name.

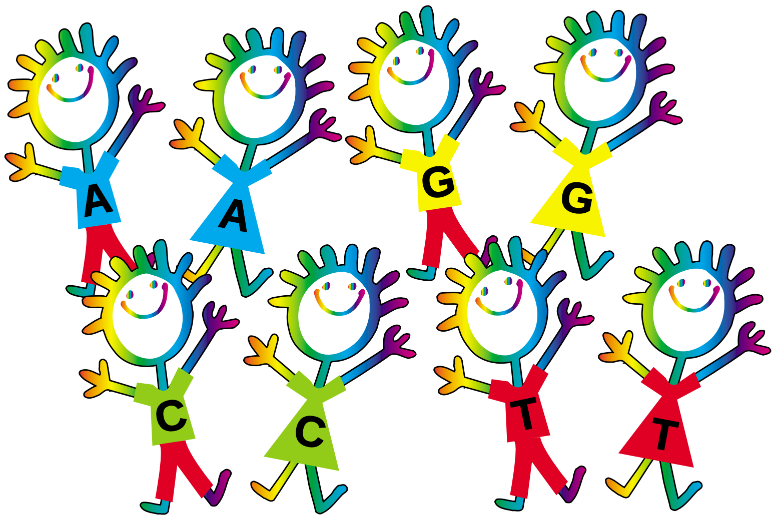
10 minutes

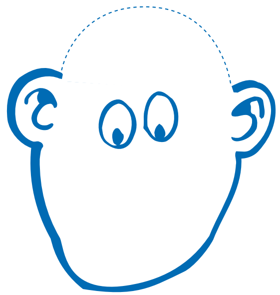
7. The living DNA molecule

Children join up with a “complementary” partner and collect an appropriate pair of model pieces (A, T, G or C) linking them together with a paper fastener. They stand in two lines and the backbone of the model is provided by threading a thin rope through holes cut in the ends of the pieces. In this way, the class finishes with a DNA molecule of its own.

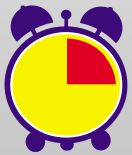
At the end of the workshop it’s a nice idea to provide certificates for each child, stating that he/she has completed a course in DNA biology.

The activities in detail





1. Making a cake



15 minutes

You will need:

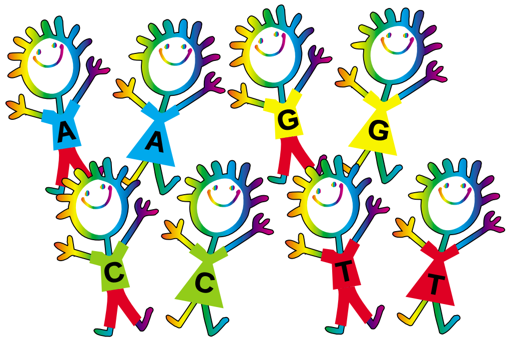
- Four chocolate swiss rolls (cut into sections to give to the children).
- One jam swiss roll.
- Four boxes containing items needed to make the cake plus some 'red herrings'.
- Worksheets 1 (a - b) - the recipe book templates.

Outline of the activity:

- Children are asked to select essential items to make a cake.

Intended message:

- Recipes are important to make sure that an exact product is made.



Step 1

Divide the children into four groups of around the same size. The four groups represent the four bases in DNA *(See Teachers' Notes).* Give each child in the first group a sticky badge with the letter **A** which stands for the base called **A**denine (pronounced ad-en-een). Do the same for the other groups - giving the second group badges with the letter **C** for **C**ytosine (cy-toe-seen); the third group badges with the letter **G** for **G**uanine (gwa-neen) and the fourth group the letter **T** for **T**hymine (thy-meen). There is no need to introduce the children to the actual names of the bases at this stage.

Sue's advice: Ideally each group should wear a different coloured T shirt or sash. This clearly identifies to which group a child belongs - which helps you and the children and gives the children the feeling of being part of a team. It is also useful for the workshop finale (activity 7).

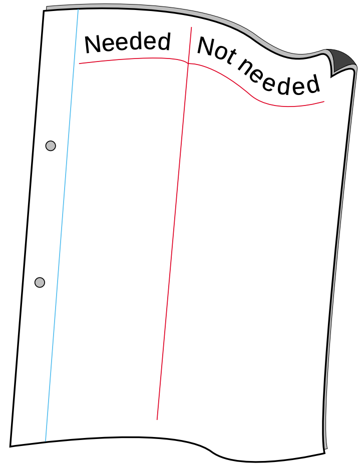
Step 2

Introduce the activity by showing the whole group a chocolate swiss roll. Give each child a slice of the cake.

Sue's advice: chocolate swiss roll is a good choice - it's cheap, readily available and most children like it - but any cake in the recipe book (worksheets1a and b) will do. ➔

1. Making a cake *(continued)*

Step 3
Give each group a box containing all the essential ingredients needed to make a chocolate swiss roll. Include the recipe book (worksheets 1 a and b) and some ‘red herrings’ like tins of beans, bottles of ketchup, chocolate sauce etc.



*Sue’s advice: the box can either include a tub labelled “vanilla butter cream” **or** the ingredients needed to make the filling (margarine, icing sugar and vanilla essence). If you opt for the latter you will need to add to the recipe book an extra recipe for the cream. The children will probably need to be directed to the existence of this separate recipe. The advantage of this is that, later on in the workshop, the children learn that many human characteristics require several recipes, and you can reinforce this by referring back to the fact that **two** recipes were needed to make the chocolate swiss roll.*

Step 4
Ask each group to select the items that they think they need to make a chocolate swiss roll cake **exactly** like the one they have just eaten. Allow each group around 5 minutes to make their choices and then ask them to bring their choices back to the centre of the room. Alternatively children could record all the items they think are needed using the layout suggested above. Compare the choices of the groups.

Sue’s advice: Some groups will think of hunting for the recipe book and referring to the recipe for chocolate swiss roll almost immediately - others will need to be prompted (e.g. “how could you check that you haven’t forgotten anything?”).

Step 5
Congratulate the groups which have selected the correct items and through discussion introduce the importance of having a recipe so that the exact product (in this case the chocolate swiss roll) can be made. Emphasise the point that the groups selected the *correct* ingredients because they referred to the recipe book in their box and that they all have the *same selection* of ingredients because they are all following the same recipe. Use the jam swiss roll to reinforce the point that different recipes make different cakes.

Baking a cake as a lead-in or extension exercise
If time allows, it is nice to let the children **make a cake by following a recipe**. In this case it may be advisable to make individual cakes such as the cherry buns in the recipe book (worksheet 1a and 1b). This can be used as a basis for discussing the importance of recipes and the fact that different recipes are used for different cakes. It is also a useful demonstration of irreversible changes in materials and allows the children to practice weighing, sieving and measuring.

2. The “Recipe for Life”

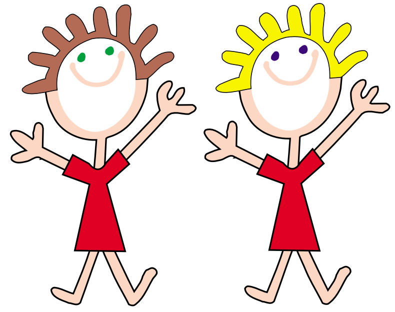
10 minutes

You will need:

- Three volunteer children (all of the same sex).

Outline of the activity:

- Volunteers are used to illustrate differences between individuals.
- The idea is introduced that we contain a “Recipe for Life” - a special chemical called DNA.



Intended message:

- People are different because of their special DNA “recipe”.

Step 1
Repeat the two main points from activity 1:

- You need a recipe to make a cake;
- Different cakes need different recipes.

Now point out that we can also see differences between people, using three children from the group to illustrate your point.

Sue’s advice: I found this easiest to do with three volunteers of the same sex - each with some obvious physical difference such as hair colour. (Although in the heat of the moment I always seemed to manage to pick children who were uncannily alike!)

Step 2
Ask the children to point out the differences they can see between the volunteers. Obvious things are hair colour and eye colour, but there are other fun things like tongue rolling which can only be done by around 50% of the population. Also ask the children to point out similarities like “all the volunteers are girls”; “they are all humans”.

Sue’s advice: I usually needed to steer them away from focusing on what the volunteers were wearing.

Step 3
Repeat the story so far:

- Chocolate swiss rolls, jam swiss rolls, cherry buns etc are all cakes.
  The ‘volunteers’ are all human and all girls (or all boys).
- The cakes are different - (some are chocolate, some contain jam, some contain cherries) and the girls (or boys) are different (some have blonde hair, some have dark hair).
- Different types of cake are made by following different recipes. ➔

2. The “Recipe for Life” *(continued)*

Arrange the children so that they are sitting in a circle to help ensure that they all have a ‘fair’ say and then ask the question:
Do you think people are different from each other because their bodies have been built using different recipes?
Do you think we each have a recipe inside us which says how we will grow and what we will look like?
You might like to use a floor book to record the group discussion which follows.

Sue’s advice: I got a varied response to this question. Here are the tactics I used to deal with the children’s answers.

A: No we haven’t got a recipe inside of us.

About half the groups I worked with said there wasn’t a recipe. I this case I led them round to the idea that there was with the following:

- A recipe does not have to be in the form of a book.
- There is a recipe inside of us but it is a special **chemical** recipe.
- The name of the chemical is **DNA.**
- We can call the DNA recipe the **“Recipe for Life”** *(I wrote this in big letters on the board)*.

A: Yes we must have a recipe inside of us.

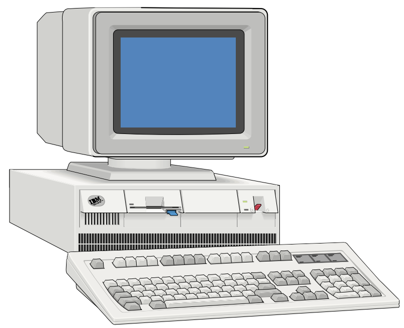
Some groups thought there must be a recipe inside each human but they couldn’t decide how this could be. In this case I would agree with them, say well done and then use the same explanation as for those who answered “no”.

A: Yes and its called DNA .

Some groups had a bright spark who said “yes and it’s called DNA”. In this case I would agree with the child, say well done and lead the whole class to the idea that DNA is a special recipe again by using the same explanation as for those who answered “no”.

Step 4
Ask the question - **“Whereabouts in the body is the DNA recipe?”**
Expect a mixed response. These are the answers Sue got in order of frequency:

A: “everywhere”.
A: “in the heart, brain” etc.
A: “inside cells”.



Take four or five suggestions and then point out that they are **all** correct:
DNA is in every part of the body because it is inside every **cell** in the body.

Extension
There is potential here for a more extensive data collection if time allows - with the children completing a data sheet detailing their own characteristics (hair colour, eye colour etc) and the characteristics of the other members of their group. This data could be used to plot histograms either on paper or using computer programmes such as - the ‘Graph-it’ which runs on the A4000 and ‘Ourfacts’ which runs on the BBC Basic.

3. An introduction to cells

20 minutes

You will need:

- A single OHT of worksheet 2 or overlaying OHT's from worksheets 3 (a-c).
- Photocopies of worksheet 4 (at least one per group).
- Worksheet 5 to make a *sandwich box cell* and a *balloon nucleus*.
  Note: you may wish to prepare these models before starting activity 3.

Outline of the activity:

- The point is made that living things are made of cells using a house/body analogy.
- Pictures and simple models are used to illustrate cell structure.

Intended message:

- Living things are made of cells.
- Cells contain DNA.

Step 1
Using OHT's created from worksheet 2 or worksheets 3 (a-c), explain that living things are made of cells, using the analogy of a house made of bricks.

Sue's advice: I used OHTs from worksheet 3 (adding layers progressively) together with a question and answer session as follows:

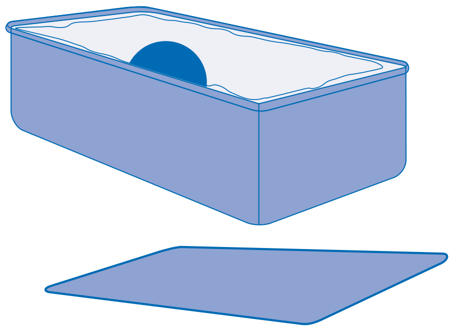
"Your body is a bit like a house".
Q. "What do we see if we look inside a house?"
A: Common answers are: "rooms" (or names of particular rooms) and "furniture" (in which case I led them round to the furniture being in different rooms).
Q: "What do we see if we look inside a human body?" (*use worksheet 3a*)
A: "Blood, heart" etc.
Add worksheet 3b
Q: "What do we see if we look closely at the walls of a house?"
A: "Bricks."
Add worksheet 3c
If we look closely at the body, we see 'cells'. There are thousands of bricks in a house and we do not need any special equipment to see them.
The body has around a million, million cells.
Q: "Can we see cells using just our eyes?"
A: "We need a microscope."

If resources and time allow this would be ideal point at which to let the children work with microscopes (*see activity 5 - step 2*).→

3. An introduction to cells *(continued)*

Step 2
Explain that each of our cells has a special compartment called a **nucleus** where the "Recipe for Life" (DNA) is stored.

Step 3
Focus in on the cell using an OHT from worksheet 4 and the models described in worksheet 5 (the *sandwich box cell* and the *balloon nucleus*).

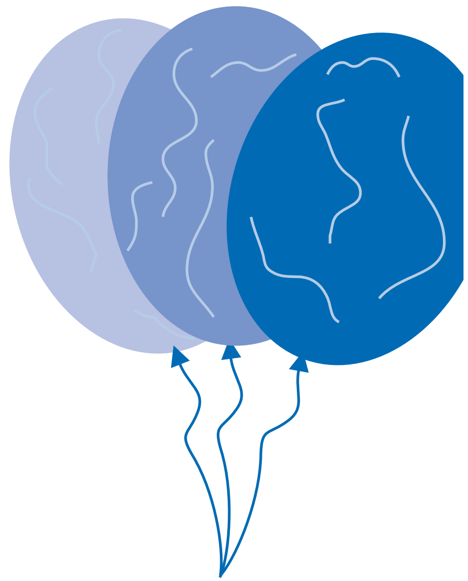


Discuss the various parts of a cell, allowing the children to examine the sandwich box cell (the outside of the box is equivalent to the wall of the cell; the liquid in the box = the cytoplasm, the ball = the nucleus and the clingfilm = the cytoplasmic membrane).

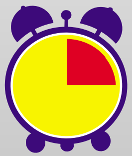
Use the balloon to illustrate that DNA is stored in the nucleus.
Refer to the bits of wool as 'chromosomes' made of 'DNA'. As you identify each of the features, get the groups to draw a line between the picture on worksheet 4 and the appropriate label.

Ask the question:
Q. How we can get the DNA out?
A: By breaking open the cell (like taking the lid off the sandwich box) and bursting the nucleus (balloon). Let whoever gets it right burst the balloon.

This is a useful lead in to activity 5 - exploring DNA.
Taking the lid off the sandwich box and bursting the balloon is equivalent to breaking cells by liquidising and bursting cell membranes with washing-up liquid.



4. DNA - a chemical "recipe"



15 minutes

You will need:

- A DNA 'scroll-type' banner.
- **Two** large DNA models - use worksheets 6 a - 6 f as a template for the small chemicals (the bases). **Note: You should prepare the models before starting activity 4.** Make sure that the sequence of the base pairs in each of the models is *different.*
- Coat stands or wall hooks from which to suspend your DNA models (optional).
- Worksheet 7 (a - c) (optional).
- Worksheets 8 (a - b) The Recipe for Life: Volume 1, recipe book.

Outline of the activity:

- A simple model is used to explain DNA structure.
- The idea of a genetic code is introduced using the "Recipe for Life" book.

Intended message:

- DNA is a large chemical made of four small chemicals (A, T, G, C).
- The order of the small chemicals makes the "Recipe for Life".

Step 1
Explain what DNA stands for.

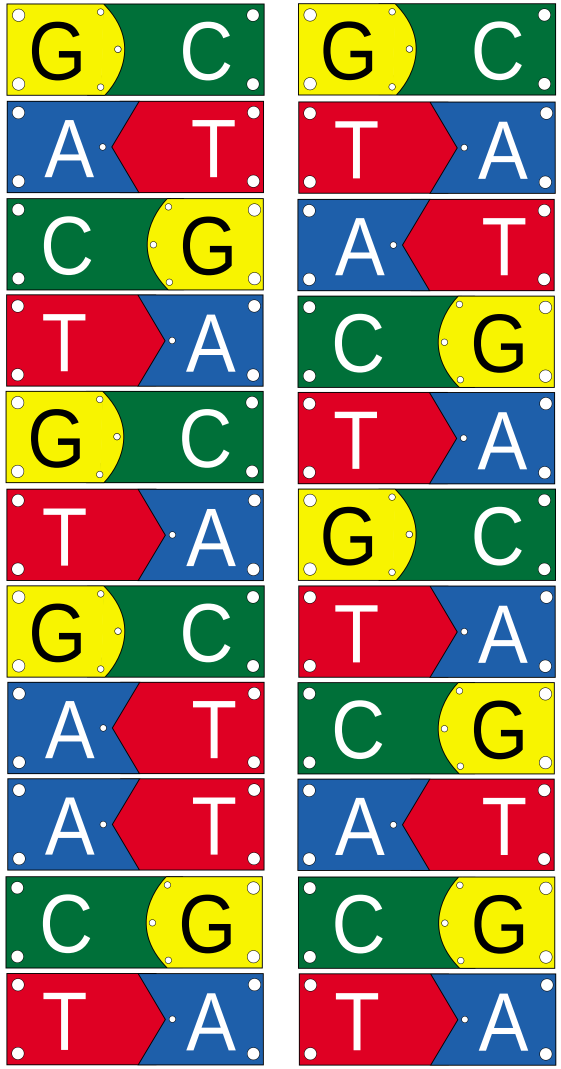
Sue's advice: I did this by preparing a large banner saying ***D****eoxyribo****N****ucleic* ***A****cid - with the letters DNA highlighted in a bright colour. The children unfurled this banner and we all read out the words a few times as a group.*

Step 2
Introduce the structure of DNA using a large paper or card DNA model.

It is best to <u>make up two models before the workshop</u> by photocopying worksheets 6 (a and f) and using these sheets as your templates. Make sure that the sequence of the base pairs is different in each model. The colours of the four bases should correspond to the colours used for the children's T-shirts or sashes. (The diagram on the right gives an example of two sequences that could be followed). Assemble the models following the instructions on Worksheet 7a.

Suspend the first model from a coat stand or a wall hook. Point out to the children that DNA is a large chemical made of four small chemicals joined together according to special "rules". Get the children to work out the DNA "rules" (ie **the pairing** rule of **'A with T'** and **'G with C'**) and introduce the names of the bases.

Sue's advice: It is more important that the children remember the 'A with T' and 'G with C' rule than the names of the bases. ➔



4. DNA - a chemical “recipe” *(continued)*

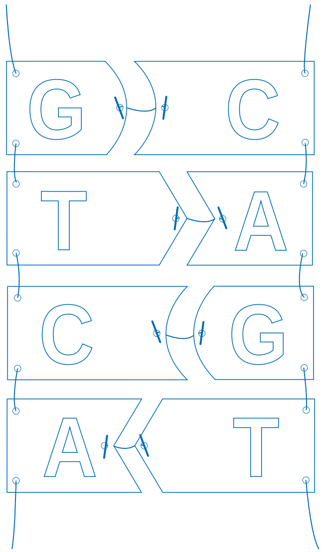
Step 3
Bring out the second large DNA model and get the children to spot that the ‘A with T’ and ‘G with C’ rules are the same but the **order** of the small chemicals is **different.**

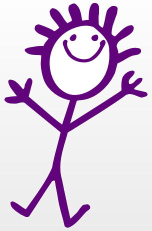
Use this as a link to explain that DNA works like a chemical recipe because the order of the small chemicals acts as a special **code**.

The DNA “recipe” contains instructions to tell the cells in our body what to do.

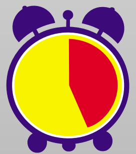
We all look different because we all have slightly different arrangements of the small chemicals inside us so each of our “recipes” is slightly different. Use the DNA recipe booklet (worksheets 8a and 8b) to reinforce this idea. Point out that the recipe for a human being is actually very long and would fill many encyclopedias.

Extension
If time allows, the pairing message (that the four small chemicals only fit together in certain ways) can be reinforced by asking the children to make their own small DNA models using worksheet 7 (a - c) shown below, either individually or in small groups.





5. Exploring DNA: Looking at onion DNA



25 minutes

You will need:

- Worksheet 9 either as individual copies, an OHT or as an enlarged poster.
- Microscopes (3-4 if possible).
- Onion skin mounted on microscope slides.
- Worksheet 10.
- The materials listed on worksheet 10.

Outline of the activity:

- Onion cells are examined microscopically.
- DNA is extracted from onions using washing-up liquid.
- Children gain experience in designing and carrying out a simple experiment.

Intended message:

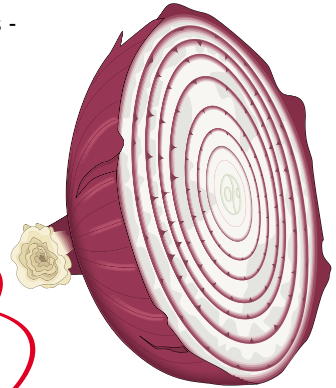
- That DNA is found inside cells (reinforcing activity 3).

Step 1
Use worksheet 9 to trace a path from the whole onion to the single cell, to inside the nucleus of that cell. This reinforces the idea that living things are made up of lots of cells and that the 'Recipe of Life' is inside the nucleus of each cell.

Step 2
Cut an onion into large chunks and show that it is possible to peel off a very thin skin between the onion layers. This skin is one to two cells thick and, if laid flat on a glass slide, it is easy to see the cells under the microscope. (Children can do this themselves if you don't mind them smelling of onions!)

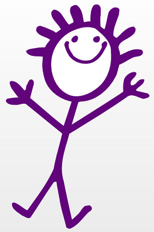
Sue's advice: To prepare the onion cell slide, cover a small piece of onion skin with a cover slip and seal the edges with clear nail varnish. Examine using x10 objective and x10-x40 lens or equivalent, with illumination from underneath. The cells will be clearly visible, and the nucleus should be obvious in some. If you can get hold of red onions, the features are clearer.

It is also possible to see cells by holding up the onion skin to the light and looking through a x10 hand lens - although it can take the children some time to master this.



Step 3
Using the *sandwich box cell* and the *balloon nucleus*, remind the children of the discussion at the end of Activity 3 concerning how to get the DNA out of the cells by breaking them open and bursting the nuclei.

Sue's advice: children usually suggest breaking the cells open with a pin or knife. This can open up a discussion of the problems associated with the small size of the cells and the idea that the blender/liquidiser would be a good way of cutting cells open. Removing the nuclear (and cytoplasmic) membranes requires washing-up liquid to break down the fat. The children should be told this fact but you can then lead them into a discussion about the properties of washing-up liquid for removing fat from dirty plates and relate this to the way in which washing-up liquid will act on the fatty parts of the cells. ➔



5. Exploring DNA: Looking at onion DNA *(continued)*

Step 4

Use worksheet 10 to complete the DNA from onions activity. The basic steps and Sue's advice are given below.

- Blend together the onions and the DNA extraction solution.

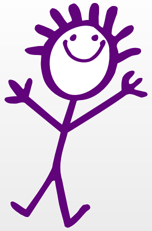
Sue's advice: although I made all of the workshop solutions, there is clearly scope for the children to play a more active role if time allows. Accurate "scientific" equipment is not needed: 100g of onion material can be weighed out on normal kitchen scales, 3g of salt is about half a teaspoon and 10ml of washing-up liquid is two teaspoons. The washing-up liquid must be of the "non-concentrated" type (i.e. cheap). If you are making the extraction solution in advance, it should be stored in the fridge - it will be OK for 2 - 3 days).

- Point out that the liquidised mixture still contains quite large bits of onion - but that you must not liquidise the material any longer than 5 seconds for fear of breaking up the DNA. Discuss how to get rid of the large lumps.

Sue's advice: the children always came up with the answer of sieving/filtering without much prompting. This is 'least messy' using a filter from a coffee machine but a tea-strainer or small plastic sieve would also do the trick.

- Explain that DNA is in the filtered liquid but that it is invisible at the moment because it is *dissolved*. (A useful analogy is that of sugar dissolving in hot tea). In order to see the DNA, we need to make it "undissolve". This is done by adding methylated spirits since DNA does not dissolve in alcohol. This part of the activity will work better if the meths is cold, but this is not essential.

Sue's advice: I explored the idea of 'alcohol' by giving familiar examples like whisky, gin and surgical spirits (children who had had their ears pierced often recognised this name). Many children had actually heard of methylated spirits. ➔



5. Exploring DNA: Looking at onion DNA *(continued)*

- The filtered liquid and the meths are mixed in equal proportions; this can be demonstrated *by you* on a large scale or a small sample can be given to each child in a small plastic vial - which is more fun.

The mixture is shaken to precipitate the DNA.
If the children shake their own mixture, make sure that the lid of their vial is fixed securely in place before they shake it **and** that you collect in the samples after the activity.

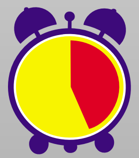
Sue's advice: I dispensed the liquids into small plastic vials and then let the children shake to mix. From a safety point of view, it is best to keep children right away from neat meths, particularly the purple version which is quite noxious. The vigour with which the mixture can be safely shaken seems to vary regionally! In North Wales, even violent shaking still produces beautiful results. I suggest that you test this out using a small portion of the mixture, ***before*** *allowing the children to shake their mixtures.*

- A useful discussion point is the length of the DNA. Point out that DNA is a very long thin chemical (this builds on the information the children have gained from activity 4).

Ask the question: **"**How far would the DNA from one cell stretch?" The answer is approximately 1.5 metres. See if the children remember (from activity 3) that our bodies contain over a million million cells. This means that the DNA from a human body would stretch for over a million million metres (to the moon and back over **800** times). This fact never fails to impress the children, but it is also useful for pointing out that the DNA has to be very long to fit in all of the "recipes" needed to make a very complicated human being.

Extension activity
Children might like to write their own set of instructions about how to extract DNA from onions.

6. Exploring DNA: Cartoon fun



25 Minutes

You will need:

- Worksheets 11 (a - e) - the "identikit" sheets.
- Scissors.
- Child safe glue.
- Coloured pencils.

Outline of the activity:

- Children work out DNA "recipes" for cartoon faces assembled from "identikit" features.

Intended message:

- The characteristics of a living thing are determined by its DNA "recipe" (reinforcing activity 4).

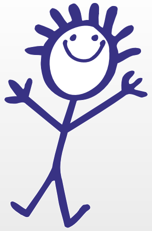
For this activity use worksheets 11 (a - e) - the "identikit" sheets. There is a written introduction which the children should be encouraged to read. You can introduce this section by re-stating the message from activity 4, that:

- **The 'Recipe for Life' is made of four chemical letters (A, T, G, C) in the DNA;**
- **Everybody's DNA has a different order of A, T, G, C - which is why we all look different.**

Step 1
Arrange the children into small groups of two or three.

Step 2
Ask them to build a cartoon face by cutting out noses, eyes, hair and so on from the "identikit" sheets they are given and sticking them onto a blank template. Each of the features has its own DNA recipe.
As the groups build up their cartoon faces, they should also be recording the DNA "recipes" on their sheets.

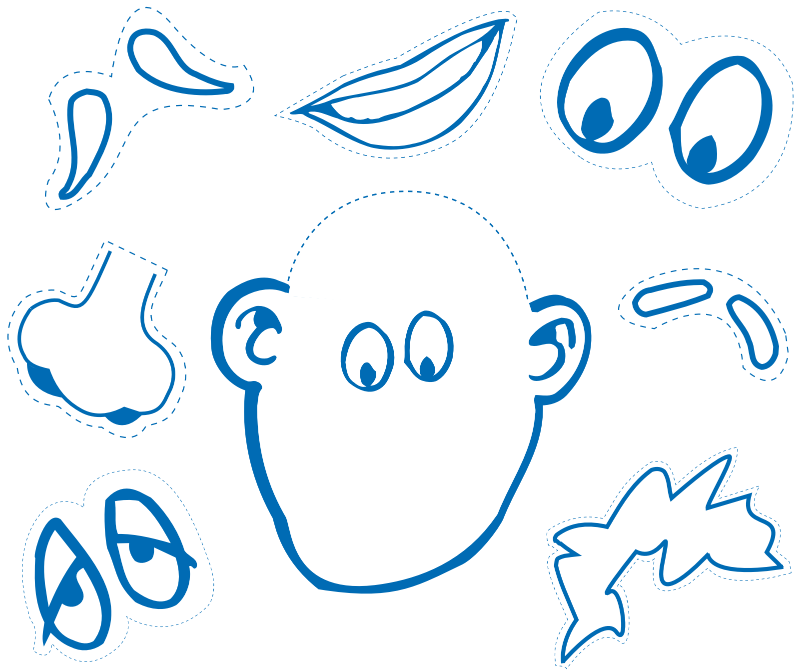
Sue's advice: The children enjoy colouring and naming their faces. Some may want to change the eyes on their cartoon face (which are already on the worksheets) this is OK as long as they change their genetic recipe also. Others might want to add a beard (particularly if they know someone with a beard) - in this case they can make use of the hairstyles by turning them upside down - again provided they remember to add an extra bit to their DNA recipe.→

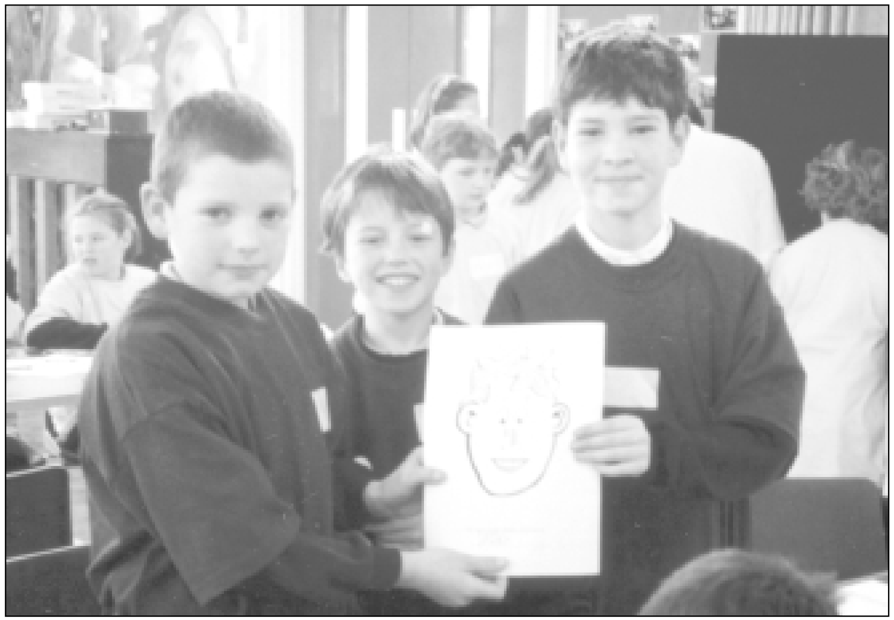


6. Exploring DNA: Cartoon fun *(continued)*

Step 4
Children colour in their character and give it a name. The cartoon faces should be put up around the room with their DNA recipes next to them. The posters can then be used for a whole group discussion about the fact that all the faces (and their recipes) are different.

> *Sue's advice: it's worth stressing the point that human genetic recipes are much longer than those in Cartoonland and that often more than one recipe is needed to create a certain characteristic (e.g. hair colour). You could refer back to the fact that the chocolate swiss roll cake really required two recipes, one for the sponge and one to make the cream filling.*

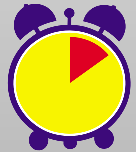




Extension activity
Groups could swap worksheets and build each other's cartoon faces.

With a bright group you might like to compare faces built from the same recipe and show that, although they are made from the same features they do not look *absolutely* identical. This could lead to the idea that although the DNA recipe sets the basic pattern, other things, like the way we live our lives, will affect the way we look (e.g. eating too much, or too little, smoking etc). You can liken these **environmental effects** to the way in which the shape of the baking tin, the heat of the oven and the baking time allowed, will affect the look and the taste of a cake.

7. The living DNA molecule



10 minutes

You will need:

- Enough loose DNA bases for one per child (use worksheet templates 6a and 6f).
- Two lengths of thin rope (approximately 2m each in length).
- Certificates (optional) - worksheet 12.

Outline of the activity:

- Children pair up with a complementary partner (A with T and G with C). They collect an appropriate piece of the DNA model and stand facing one another in two lines. The pieces of the DNA model are threaded together.

Intended message:

- DNA is a large chemical which is made up of four smaller chemicals which pair together according to certain ‘rules’.

Before you begin this activity you will need enough loose DNA base cards for one per child. You might like to make several photocopies of worksheets 6a and 6f. Stick onto thin card and cut out the individual pieces. Ask the children to colour the base cards in agreed colours (e.g. all ‘ A’ cards in blue, ‘T’ cards in red, ‘G’ cards in green and ‘C’ cards in yellow). Make sure you have equal numbers of each of the cards (A, T, G and C). Notice that each of the bases comes in two forms on worksheets 6a and 6f for the left and right hand strands - be sure to include a mixture of both types.

Step 1
Children act as if they are the DNA bases. Remind the children that they are wearing a badge with a base letter on (either A, T, G or C) and possibly a coloured T shirt or sash. This will help them. Ask them to find a partner according to the DNA rules they have learnt **(A with T and G with C).**

Sue’s advice: don’t worry if you have an odd number of children in your group - you (or a helper) can team up with one of the children.

The pair can then collect one card base each (if the child is wearing an **A** badge give them an ***A****denine base* card. This child’s partner should be wearing a **T** badge and should receive a ***T****hymine base* card and so on). The cards belonging to each pair should be joined together using paper fasteners.

Step 2
Ask the pairs of children to face each other **in two long lines** holding their (joined) cards between them.

Sue’s advice: remember it doesn't matter what order the base pairs are in - so long as each ‘child partnership’ is made up of either A with T or G with C. Also, I found that making this a race between the two DNA “strands” increased the appeal of the activity.

Step 3
Children thread a rope through each card base in each of the two lines to form the backbone of the DNA model.

At the end of the workshop it is a nice idea to give each child a certificate. You might like to use worksheet 12.

The DNA Discovery Workshop: Teachers' Notes

Can you give me some basic information about cells?

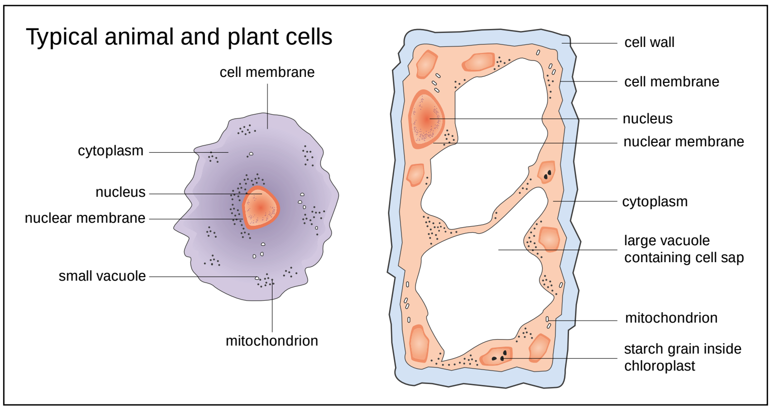
Yes. All living organisms are made from cells, and all cells have some features in common. They all contain a jelly-like watery substance called **cytoplasm**. This tends to form the bulk of the cell.

The cytoplasm is enclosed by a boundary – the **membrane**. This controls the traffic of materials in and out of the cell. The membrane is a bit like the skin of the cell – think of a balloon filled with water.

In plant cells there is another boundary layer outside the membrane – the **cell wall**. This is rigid and contains cellulose. It makes the cell strong – (imagine the water-filled balloon now placed inside a shoe box).

All cells contain **DNA** – this is the genetic material of the cell – it contains all the information for regulating the cell. In plant and animal cells this material is kept in a special compartment in the cytoplasm called the **nucleus** – this is the control centre of the cell. (Note red blood cells are an exception – they do not contain a nucleus or DNA).

Just like a house has different rooms for different activities, plant and animals cells contain different compartments in their cytoplasm that are used for different functions. These include special places that provide the cell with energy – the power stations of the cell. In plants, these are the **chloroplasts**. They contain the green coloured material **chlorophyll** that helps the plant to make its food energy from sunlight. Plant cells also contain large compartments known as **vacuoles**. These are used to store nutrients and waste materials.



Cells are small. There are about ten trillion cells in a human body.

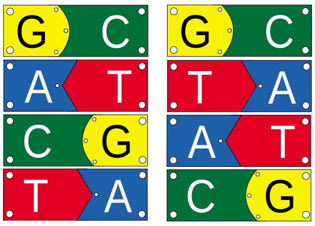
Bacteria: Bacteria are single cell organisms. They contain DNA but it floats freely in the cytoplasm rather than being in a nucleus.

A bacterial cell is about I millionth of a metre long. The volume of a plant or animal cell is typically several hundred times larger.

What is DNA?

DNA stands for **D**eoxyribo**N**ucleic **A**cid. It is a long rope-like molecule. Genes are made of lengths or segments of DNA. Different sets of genes make up the "recipe" for different living things.

Is the structure of DNA important?



Yes. DNA molecules are shaped like spiral staircases. Their sides are made up of chains of sugar and phosphate; their steps are made of pairs of four bases called:

Adenine

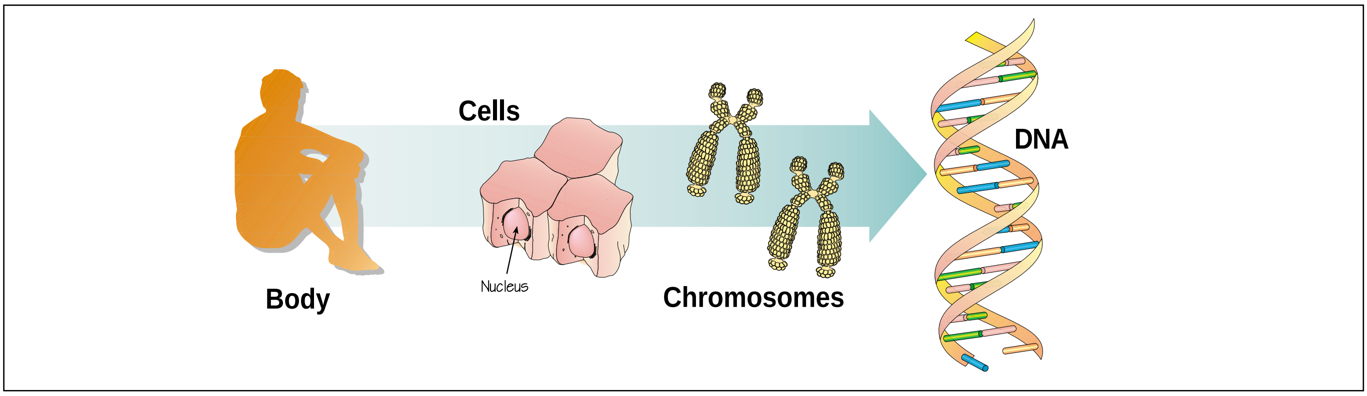
Thymine

Guanine

Cytosine

These bases fit together in specific ways. Adenine always pairs with Thymine while Guanine always pairs with Cytosine. It is the order or **sequence** of these pairs of bases which contains the information of a gene (a bit like the dots and dashes of morse code contain and convey information).

The long DNA molecules are usually held in tightly coiled structures called **chromosomes**. Chromosomes are found in the nucleus of a cell.



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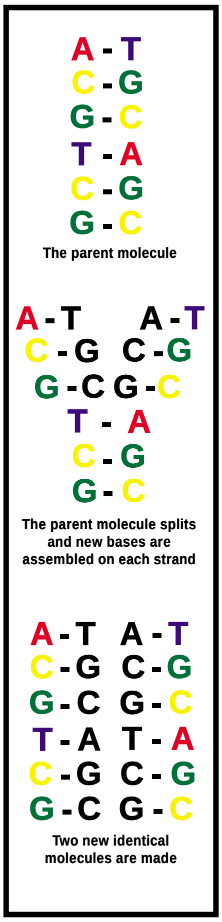
Why is the "base pairing" important?

The structure of DNA allows the molecule to make copies of itself or **replicate** when a cell divides in two. As the diagram on the right shows, the two DNA strands split apart and new bases are added to each strand to make two double stranded molecules which are exact copies of the original.



How does DNA do its job?

DNA directs the growth and activities of a living organism by directing the production of proteins.

All proteins are made up of amino acid building blocks. The order of the bases in DNA (A, T, G and C) dictates the sequence of the amino acids in a protein and, therefore, the type of protein which is to be made.

DNA does not code for proteins directly. It operates through an intermediary called ribonucleic acid or RNA.

The sequence of bases on the DNA molecule acts as a **template** for the production of RNA. RNA binds to the sites in a cell where protein production takes place and directs this production.

What happens during reproduction?

Mitosis

Some single celled organisms produce offspring by dividing into two identical pieces – a process called **mitosis**.

As the threads of genetic material in the nucleus split lengthways, the nucleus itself splits into two. The cytoplasm separates and flows around the two nuclei and new cell membranes form. The result is two identical offspring. The offspring are **clones** of the original, and the original no longer exists.

This kind of reproduction occurs in bacteria and in simple organisms like the *Amoeba*. Mitosis also occurs within more complex organisms during the growth and repair of body tissues and organs.

Meiosis

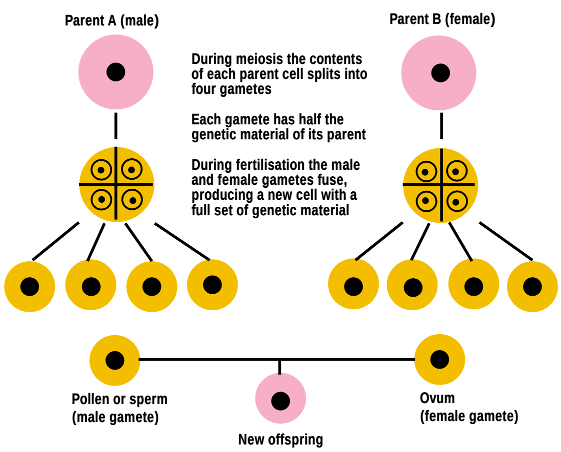
Some organisms carry out a more complicated form of cell replication through *sexual reproduction*, called **meiosis**.

Look at the diagram on the right. You can see that meiosis involves two parents. Each parent produces special *half cells* called **gametes**. The gametes provide half the genetic material required by the offspring.

In plants, pollen containing male gametes is transferred to ovaries containing the female gametes. This process is known as **pollination**. Male and female gametes fuse during **fertilisation** and a cell is formed which develops into a new individual.

In animals, the male gametes are in sperm. Sperm is transferred to an egg in the female ovary where fertilisation takes place.

New offspring formed through sexual reproduction may resemble one of the parents or both of the parents or neither of the parents because *some* of the characteristics of both parents are passed on to the offspring.



Do you have any more information on this subject which I can read before running the workshop?

Yes. For more information about Cells and DNA write to the
BBSRC Schools' Liaison Service, PR, BBSRC, North Star Avenue, Swindon SN2 1UH, or ring 01793 413302 and request the free four-page booklets:

- Science File No2 - an introduction to Genetics
- Science File No3 - an introduction to Genetic Modification

I have also included a "Parents Notes" factsheet which you may choose to distribute through the children before running the workshop.

I hope you and your students enjoy the DNA Discovery Pack.

The Schools' Liaison Officer
Biotechnology and Biological Sciences Research Council

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The DNA Discovery Workshop: Parents' Notes

What is the workshop all about?

This workshop has been designed by Dr Sue Assinder, a scientist working on the molecular genetics of cell division at the University of Wales, Bangor, on behalf of the Biotechnology and Biological Sciences Research Council.

Dr Assinder worked with a team of primary teachers from North Wales to develop interesting and enjoyable ways to introduce children to the biology of cells and to the "Recipe for Life" DNA.

What will my child gain through this workshop?

We hope that your child will learn that our bodies are made up of individual "building blocks" called cells and that in each cell there is a molecule called DNA, which holds a genetic code (i.e. set of instructions which during the workshop we call the "Recipe for Life"). These instructions tell a living organism how to grow and function. Your child should gain a basic understanding of the role of DNA within the cells of the human body and appreciate that it is the uniqueness of their DNA "recipes" which makes them all different (and thus very special) people.

What sort of activities might my child participate in?

The box below gives you an overview of the workshop. Your child's teacher may choose to do all or just some of the suggested activities either as a one day workshop or spread out over a term.

A quick guide to the way the workshop works

1. Making a cake

The children are divided into four groups of about the same size. Each child is given a badge marked with the letter A, T, G or C, and, if possible they are dressed in T shirts in four different colours.

The children are then shown (and given a piece of!) a chocolate swiss roll. Each group is given a box containing essential items to make the cake plus "red herrings" and asked to pick out the things they need. To help them, the boxes contain a cookery book with the recipe for a chocolate swiss roll (amongst several other recipes).

In this way we introduce the idea of the importance of having a **recipe** (a set of instructions/information) so that the **exact** product (in this case a cake) can be made.

2. The "Recipe for Life"

The children are shown examples of some of the other cakes from the book and led to the idea that the cakes are *different* because they have been made using *different recipes*.

It is pointed out that it's not just cakes that can look different – children differ from each other as well. The children are asked to point out the differences between three "volunteers" (eye colour, hair colour etc).

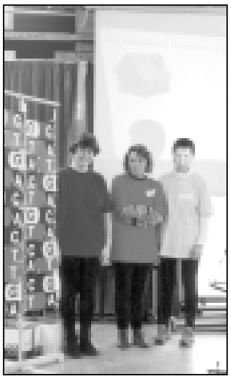
Children learn that each of us contains a "recipe" which controls what we look like – the **"Recipe for Life"**. We all look different because the recipe is different for each person.

There follows a question and answer session on where the recipe might be and what form it might take, with the explanation that the recipe is a "special chemical" called DNA kept in every part of the body.

3. An introduction to cells

The children are led to the idea that living things are made of cells, using the analogy of a house made of bricks. A poster and simple models are used to explain that each cell has a special compartment (the nucleus) where the "recipe" (the special chemical called DNA) is stored.

4. DNA - a chemical "recipe"



The structure of DNA is introduced using a large pre-prepared model. The children are asked to spot the important features and the names of the bases are introduced.

Using a second pre-prepared model, the children are asked to spot that the "rules" are the same but the order of bases is *different*. This is used as a link to explain that DNA works like a "recipe" because the *order* of the bases acts as a special code. We all look different because our DNA has a slightly different order of bases, so the "recipe" is slightly changed.

If time allows, the children make their own small DNA models to reinforce these ideas.

5. Exploring DNA: looking at onion DNA

A large flow chart is used to trace the path from the whole onion, to the single cell, to inside the nucleus. This is linked to slides of onion cells set up under a microscope. Children are asked to work out how they would get the DNA out of the cells (i.e. by bursting them open). The teacher then helps the children to carry out the *DNA from onions* activity, preparing the necessary solutions and getting the children to help with weighing, measuring and mixing.

Your child's teacher will be happy to give you details of this practical activity. This activity requires the use of everyday materials including salt, onions and non concentrated washing up liquid. It also requires a small amount of methylated spirits which will be strictly controlled and used **only** by the teacher.

6. Exploring DNA: Cartoon fun

The activity aims to get over the idea that DNA carries the recipe for all of the features of the human body. Children (in smaller groups of 2-3) are asked to build a cartoon face by cutting noses, eyes etc from "identikit" sheets and sticking them onto a blank template. Each of the features has assigned to it a DNA "recipe". Having designed the cartoon character, the children are asked to write down the "recipe" and then colour their character and give it a name.

7. The living DNA molecule

Children join up with a "complementary" partner and collect an appropriate pair of model pieces (A, T, G or C) linking them together with a paper fastener. They stand in two lines and the backbone of the model is provided by threading a thin rope through holes cut in the ends of the pieces. In this way, the class finishes with a DNA molecule of its own.

At the end of the workshop your child may receive a certificate stating that he/she has completed a course in DNA biology.

We very much hope your child enjoys the workshop.

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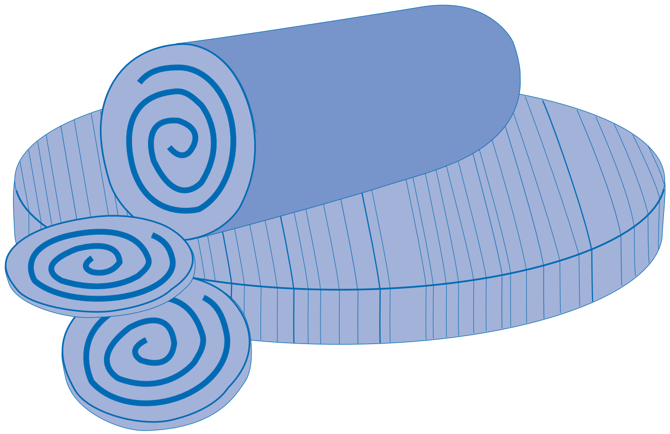
Jam Swiss Roll



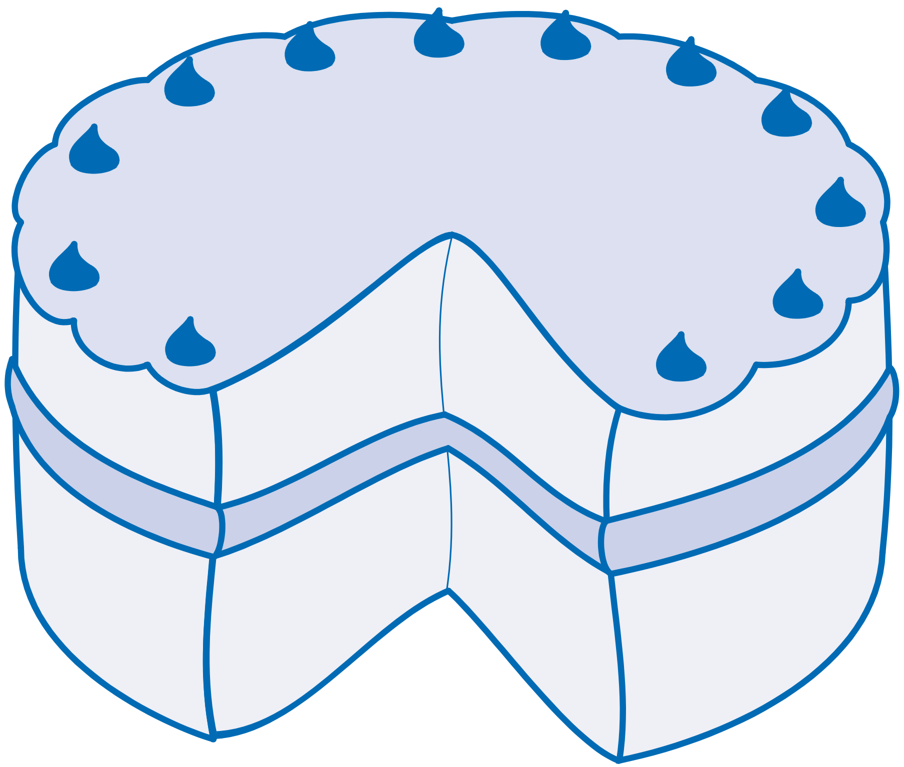
Ingredients

75g caster sugar
75g self-raising flour
2 eggs
Jam

Instructions

1. Break eggs into a mixing bowl, whisk lightly, add sugar and whisk well until thick and creamy and almost white in colour.
2. Lightly fold flour into the mixture.
3. Line a Swiss roll tin with greased paper and pour in the mixture.
4. Bake in a hot oven (220 C, 445 F, Gas mark 7 for 7-8 minutes). Do not over bake or it will crack when rolled.
5. Turn out on to sugared grease proof paper, remove lining paper and trim the edges of the sponge.
6. Spread quickly with slightly warm jam.
7. Working from the narrow end first, make the first roll with your fingers, then continue by drawing the paper away from you over the sponge.
8. Leave to cool, resting on the seam then sprinkle with caster sugar.

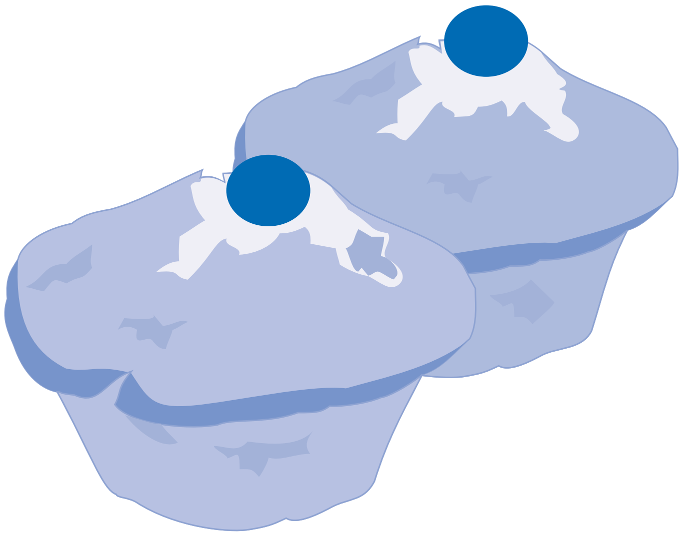
Recipe Book



Delicious recipes
for all sorts of cakes

Worksheet 1a

Cherry Buns



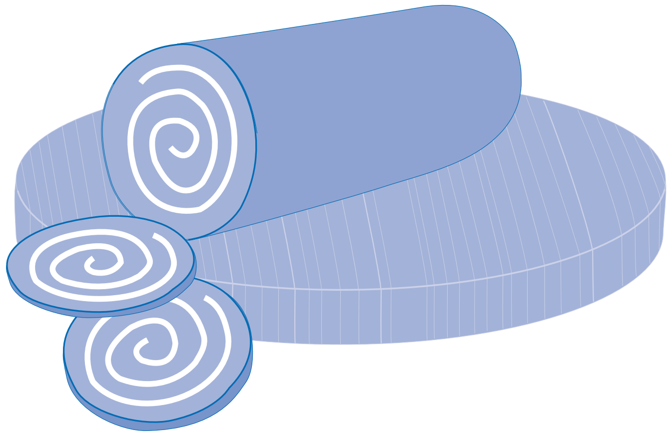
Ingredients

100g margarine
100g caster sugar
100g self-raising flour
2 eggs
50g chopped glacé cherries

Instructions

1. Cream the margarine and sugar until light and fluffy.
2. Beat in the eggs, one at a time, adding a little flour with each. Add chopped cherries.
3. Half fill paper cases or greased party tins with the mixture.
4. Bake at 190 C, 375 F, Gas mark 5 for 20-25 minutes until firm.

Chocolate Swiss Roll



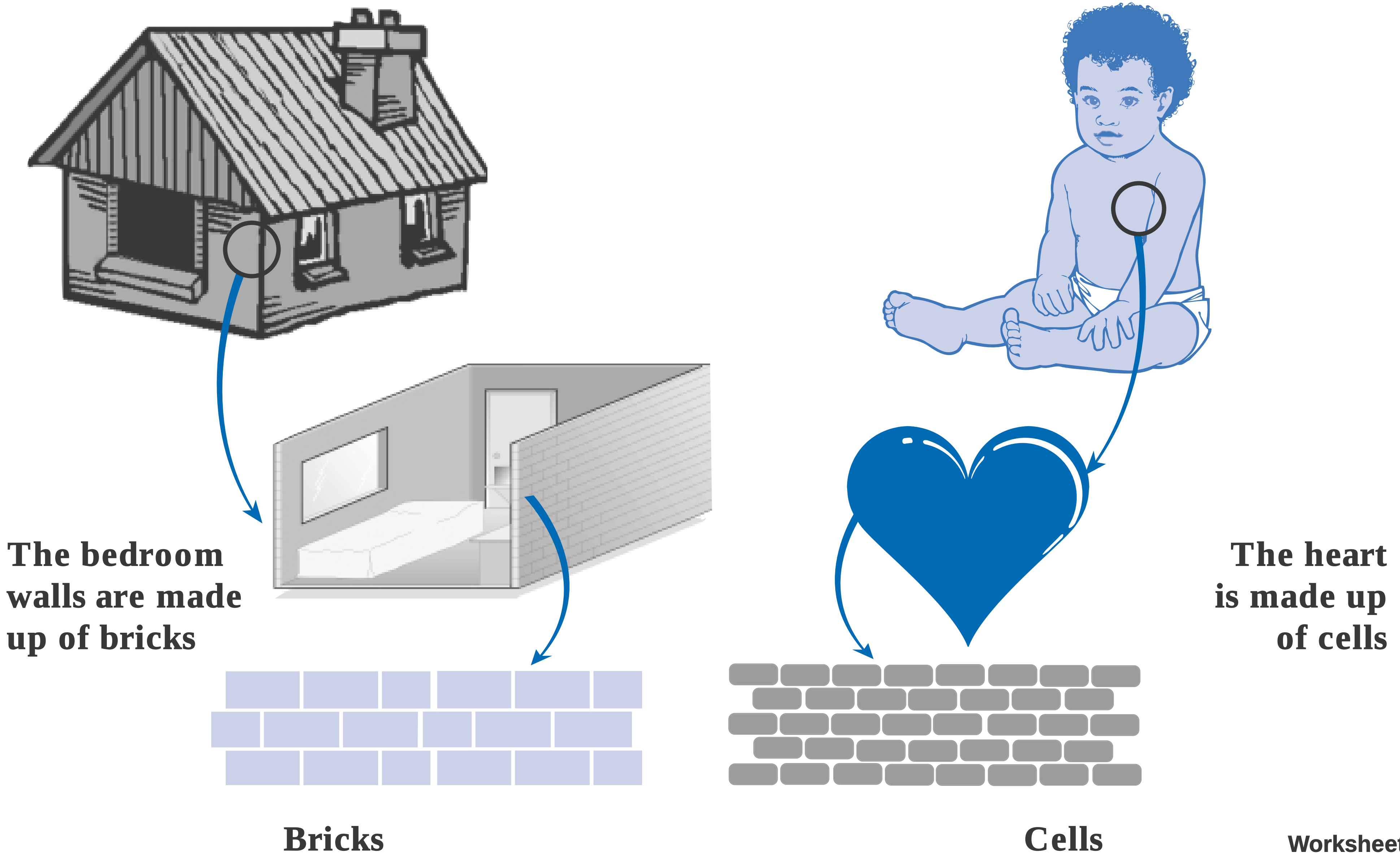
Ingredients

75g caster sugar
50g self-raising flour
25g cocoa powder
2 eggs
One tub of
Vanilla Butter Cream

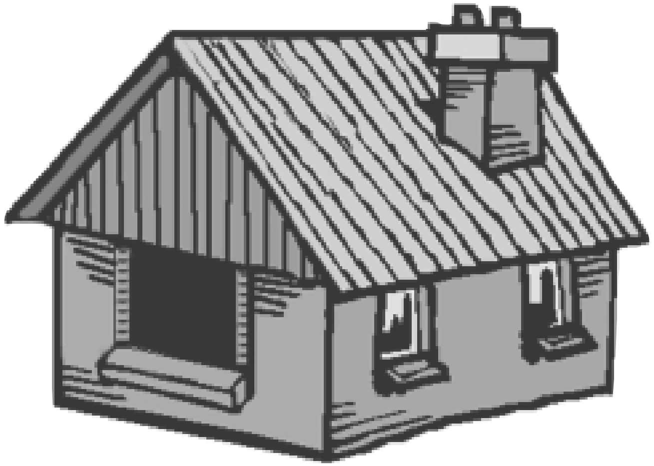
Instructions

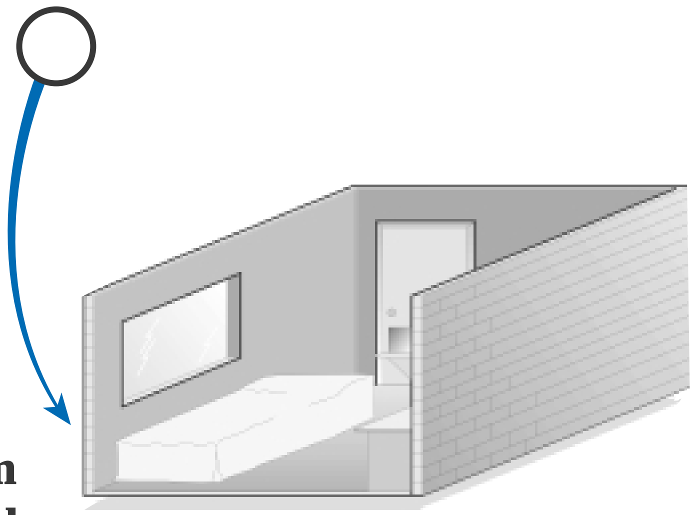
1. Break eggs into a mixing bowl, whisk lightly, add sugar and whisk well until thick and creamy and almost white in colour.
2. Lightly fold flour and cocoa powder into the mixture.
3. Line a Swiss roll tin with grease proof paper and pour in the mixture.
4. Bake in a hot oven 220 C, 425 F, Gas mark 7 for 7-8 minutes. Do not over bake or it will crack when rolled.
5. Turn out on to sugared grease proof paper, remove lining paper and trim the edges of the sponge.
6. Roll up with a piece of grease proof paper working from the narrow end first, make the first roll with your fingers, then continue by drawing the paper away from you over the sponge.
7. Leave to cool, gently unroll, remove paper and spread with Vanilla Butter Cream, then re-roll.

The human body is made up of millions of CELLS

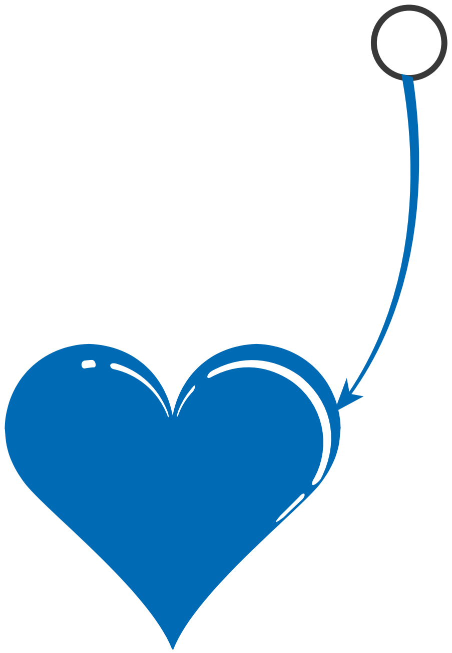


The human body is made up of millions of CELLS

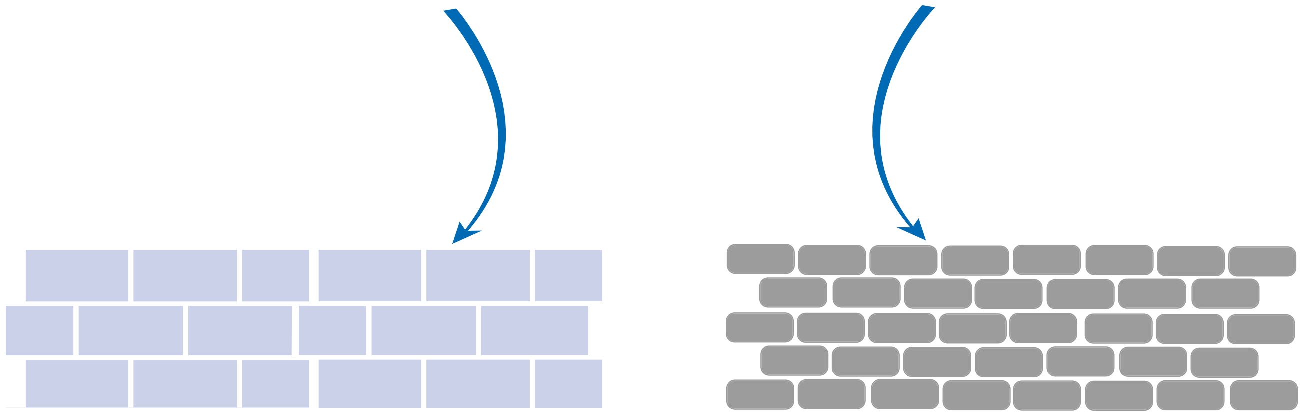




The bedroom walls are made up of bricks



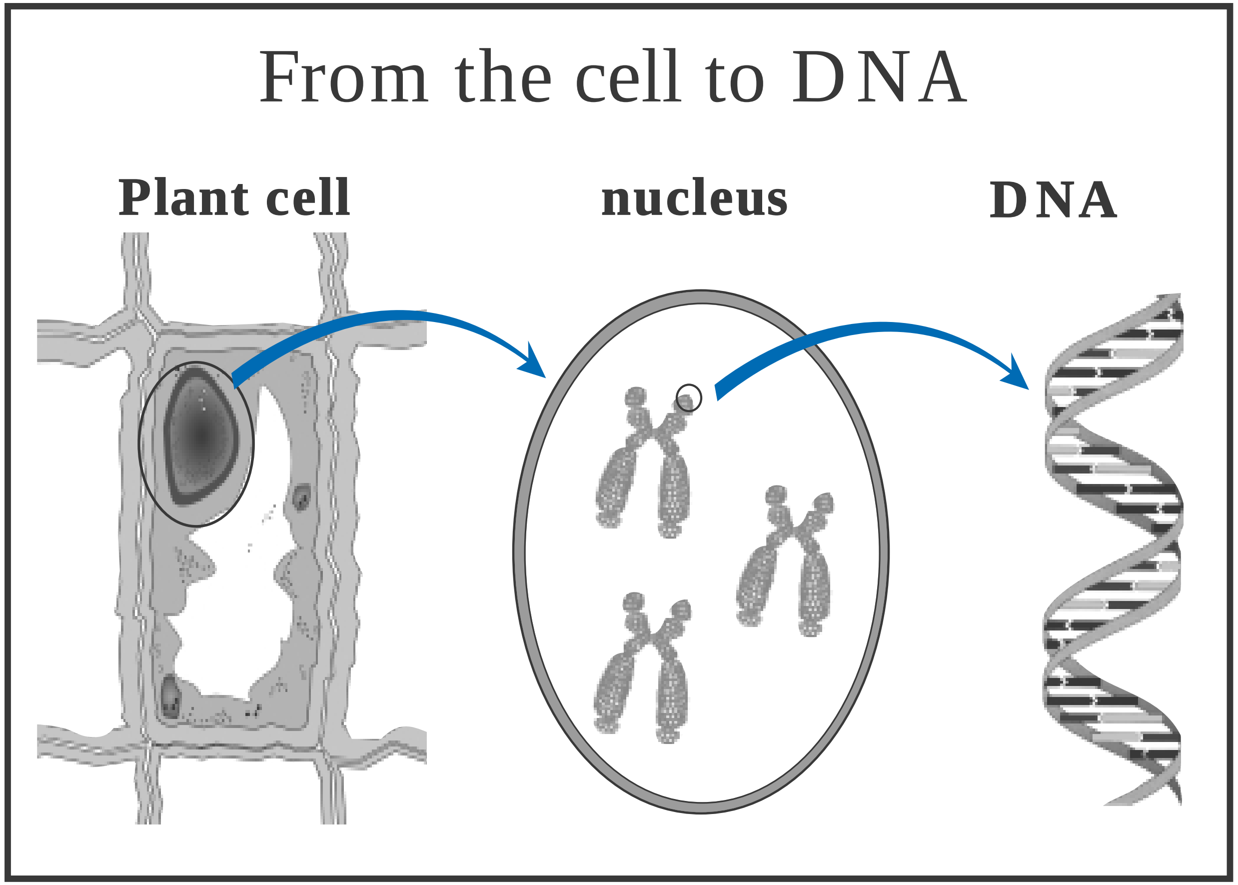
The heart is made up of cells



Bricks

Cells

Draw lines to link the words below with the pictures in the box.



nucleus

cell wall

cytoplasm

DNA

vacuole

chromosome

Making a *sandwich box cell* and a *balloon nucleus*

The *sandwich box cell*

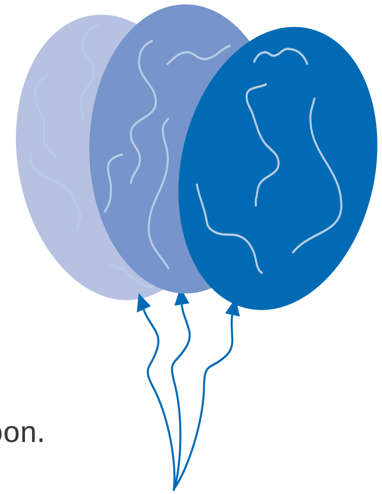
Materials:

- Rectangular plastic lunch box.
- Medium-sized plastic bag (the sort with “ears” are good because they are easier to tie).
- A small ball, approximately 1” - 1.5” radius, ideally solid so it doesn’t float too much (a large ball bearing painted red would be ideal).
- Red food colouring/powder paint.
- Clingfilm.
- Sticky tape.

Instructions:

1. Half-fill a plastic bag with water and add a few drops of food colouring/paint to get a pale pink “cytoplasm”.
2. Add a “ball” nucleus.
3. Tie a tight knot in the end of the bag. Try to exclude most of the air but don’t worry about air bubbles because these make good “vacuoles”.
4. Place the bag in a lunch box, tucking the knot underneath out of sight.
5. Cover the open box with clingfilm, securing underneath the box with sticky tape. This can be the cell “membrane” if you want - but is useful mostly to restrain leaks.
6. Label the lid of the box with the word “cell” in large letters.

The *balloon nucleus*

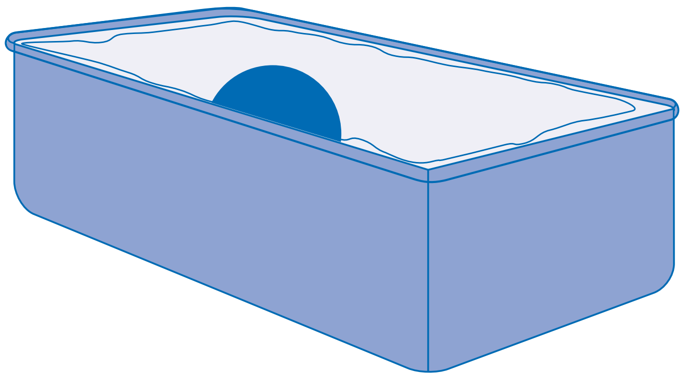


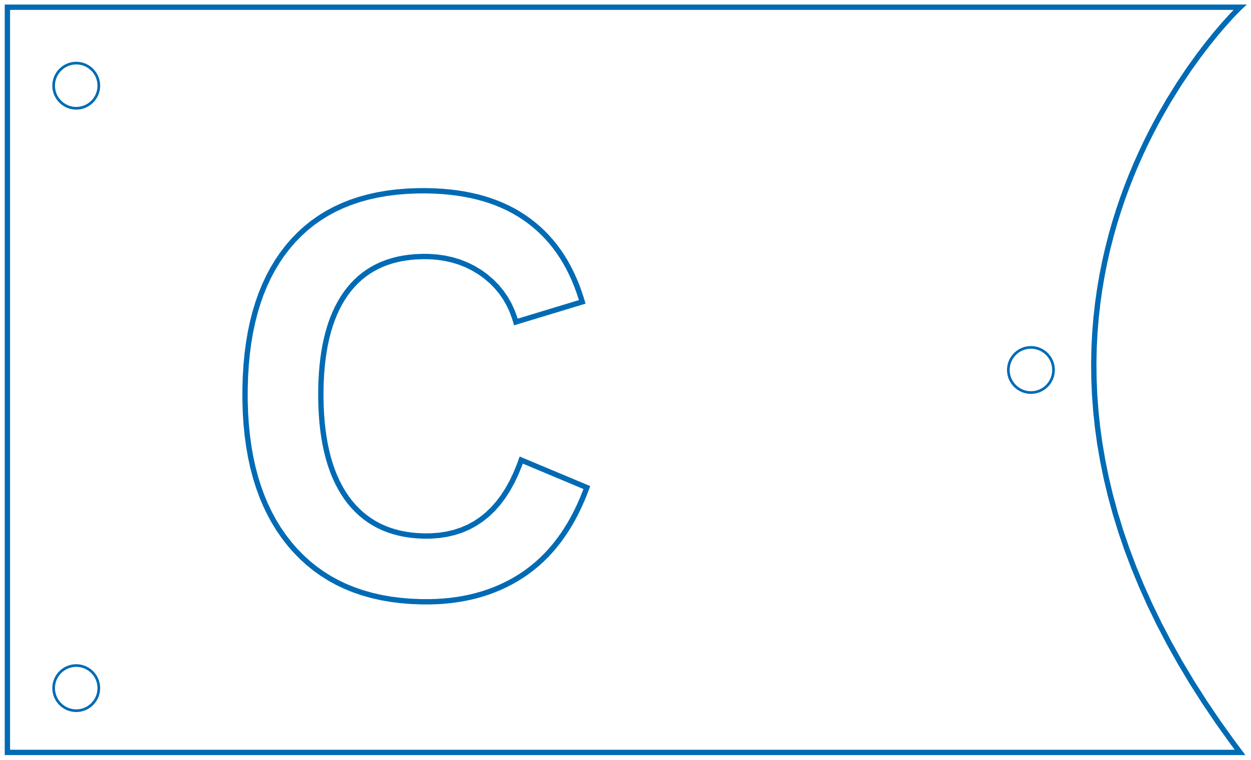
Materials:

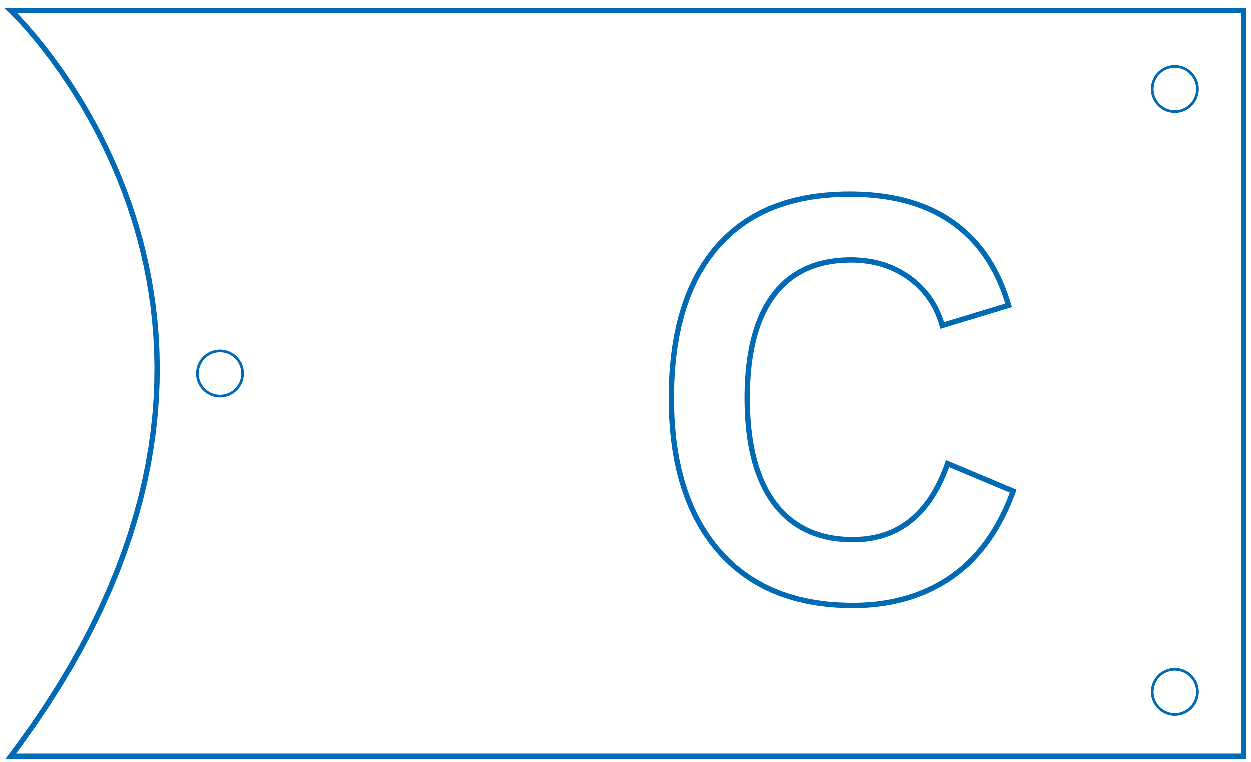
- 1 balloon (the same colour as ball in model cell would be ideal).
- 3-4 bits of wool, approximately 4” in length.
- A pair of good lungs!

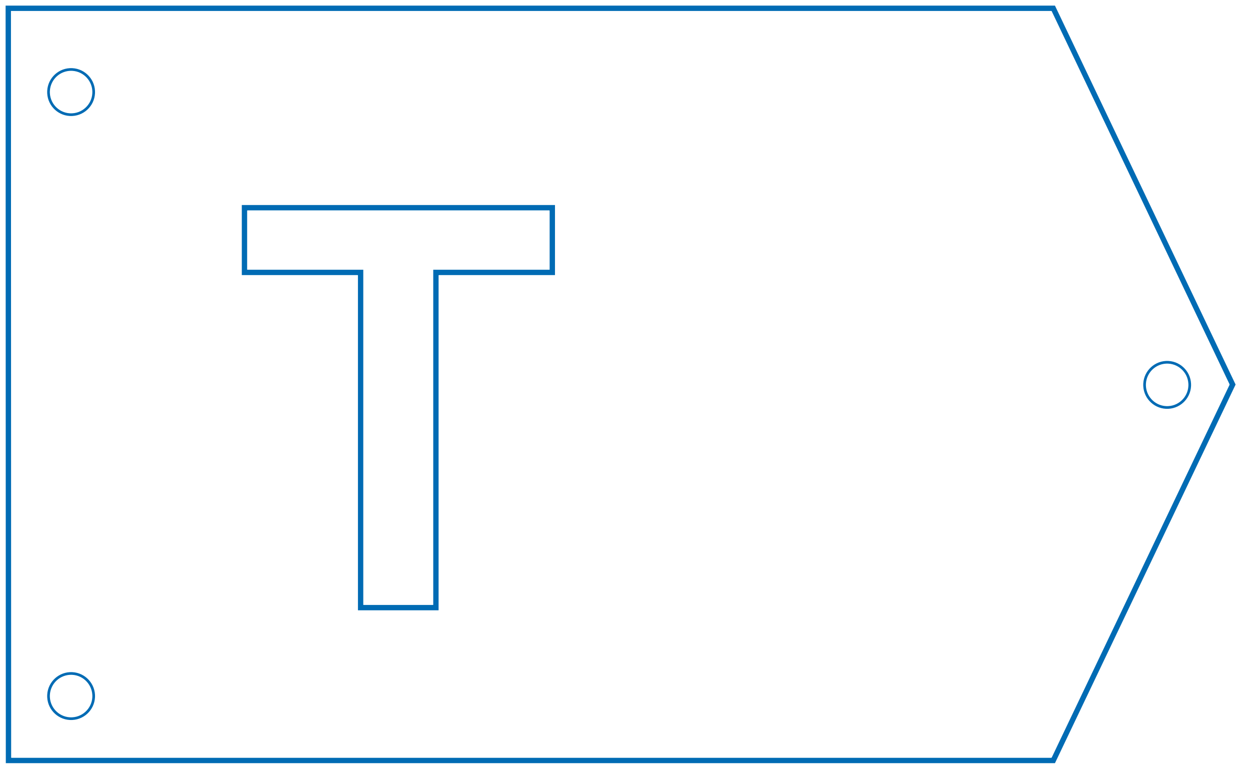
Instructions

1. Stuff the bits of wool into the uninflated balloon.
2. Inflate (taking care not to swallow wool!).
3. Write “nucleus” in large letters on balloon or put on a sticky label.




C


C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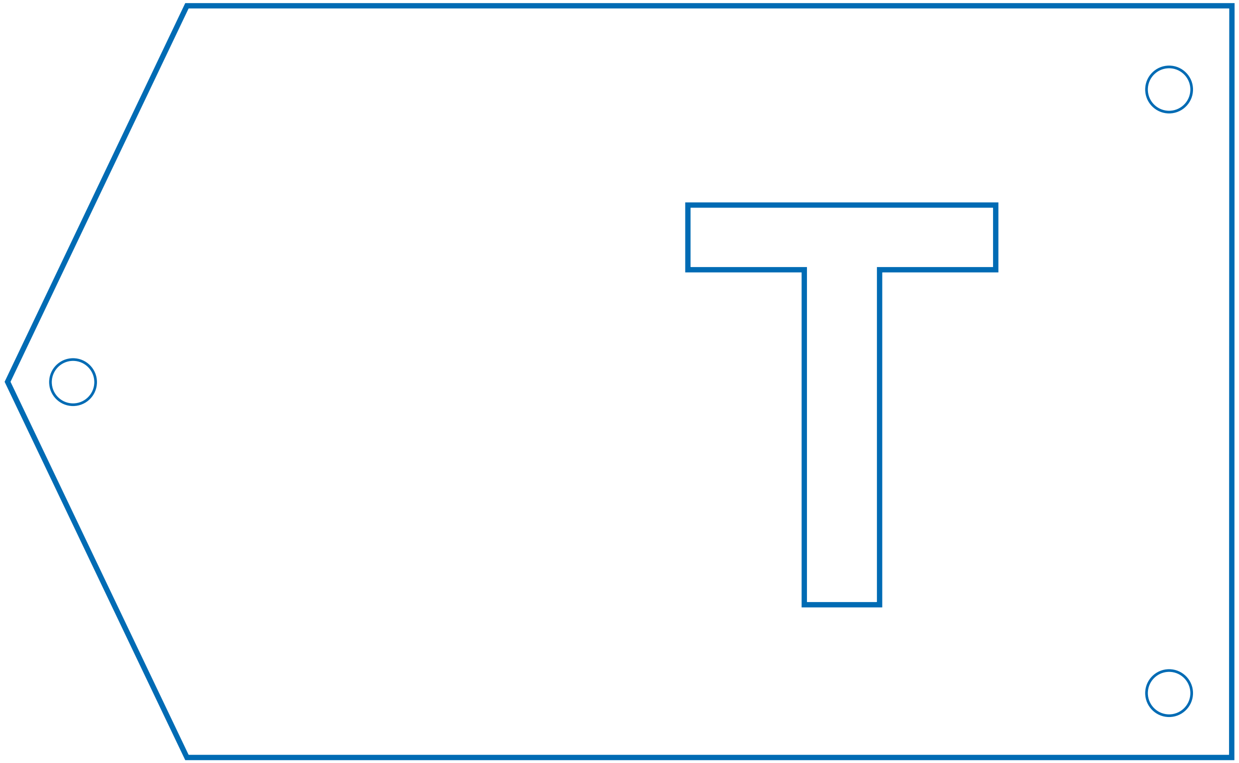
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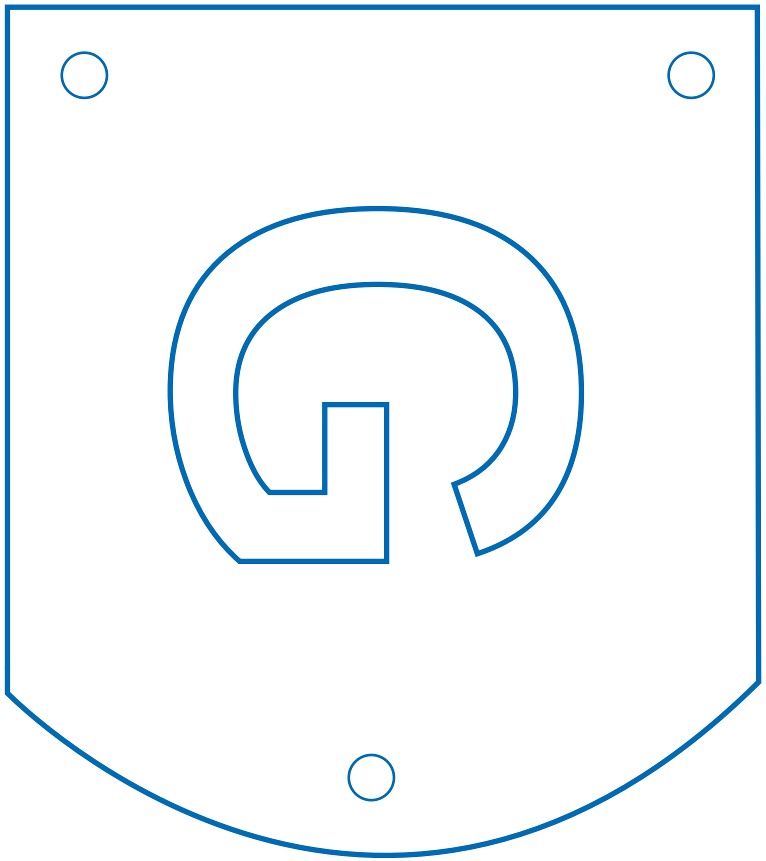
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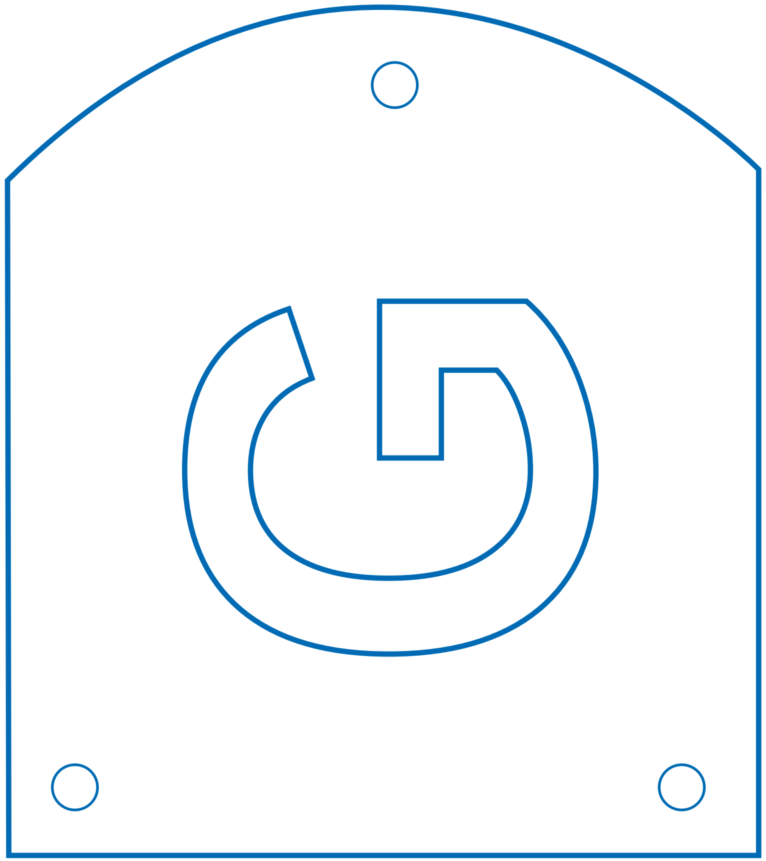
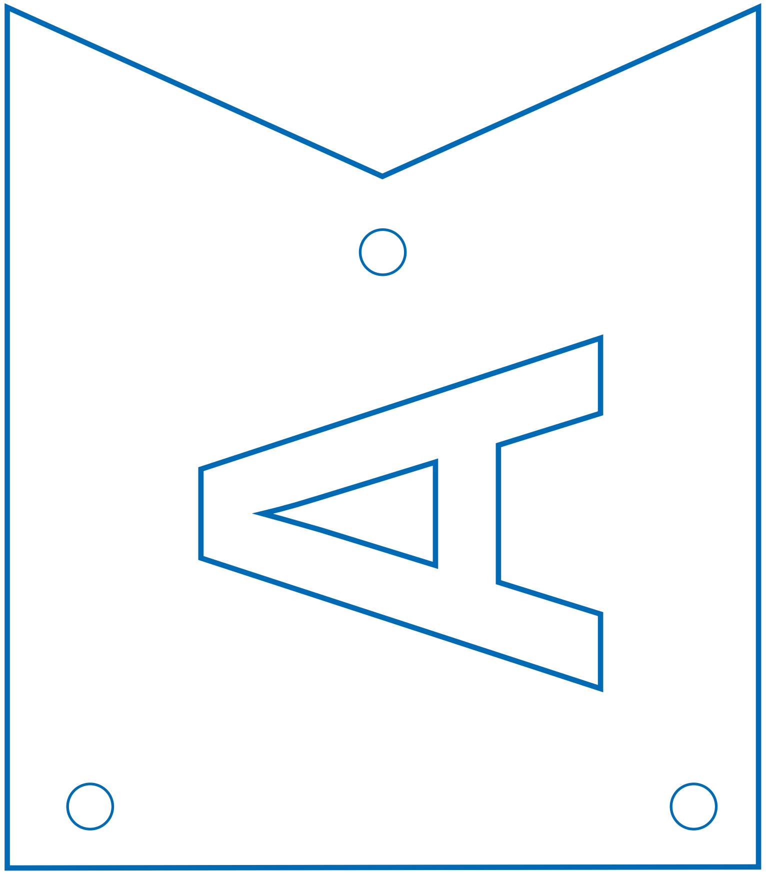
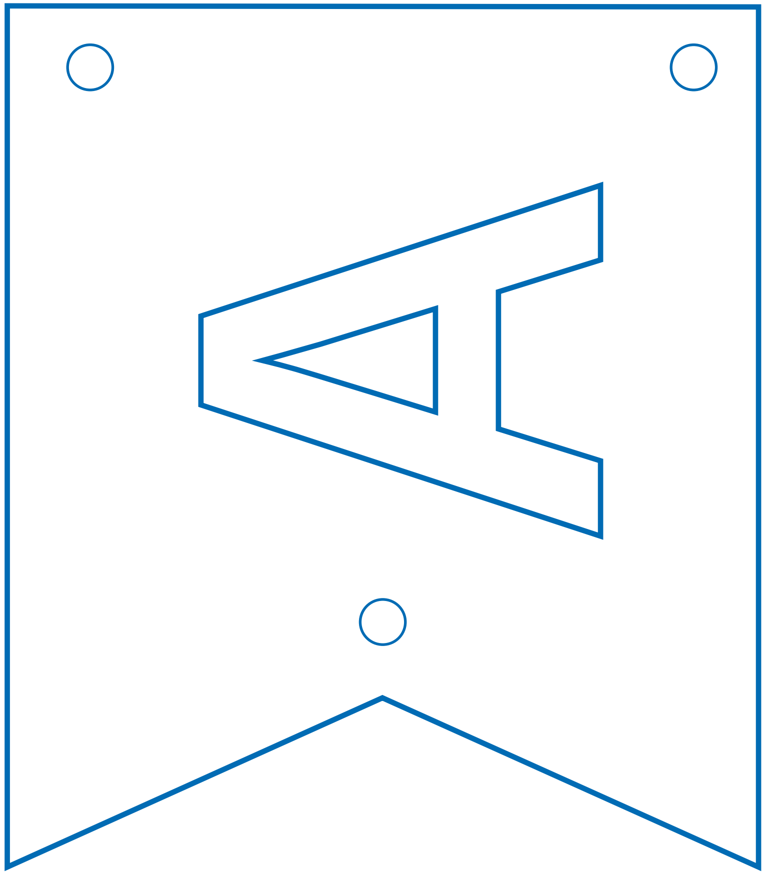



A


A

Creating DNA Models

You can make your own DNA model using the pieces below. The picture in the circle is there to help you.

- First, make around 10 copies of the A, T, G and C shapes on each sheet.

- We suggest you colour each of the 4 base shapes in a different colour.

A stands for Adenine (ad-en-een) - Blue
C stands for Cytosine (cy-toe-seen) - Yellow
G stands for Guanine (gwa-neen) - Green
T stands for Thymine (thy-meen) - Red

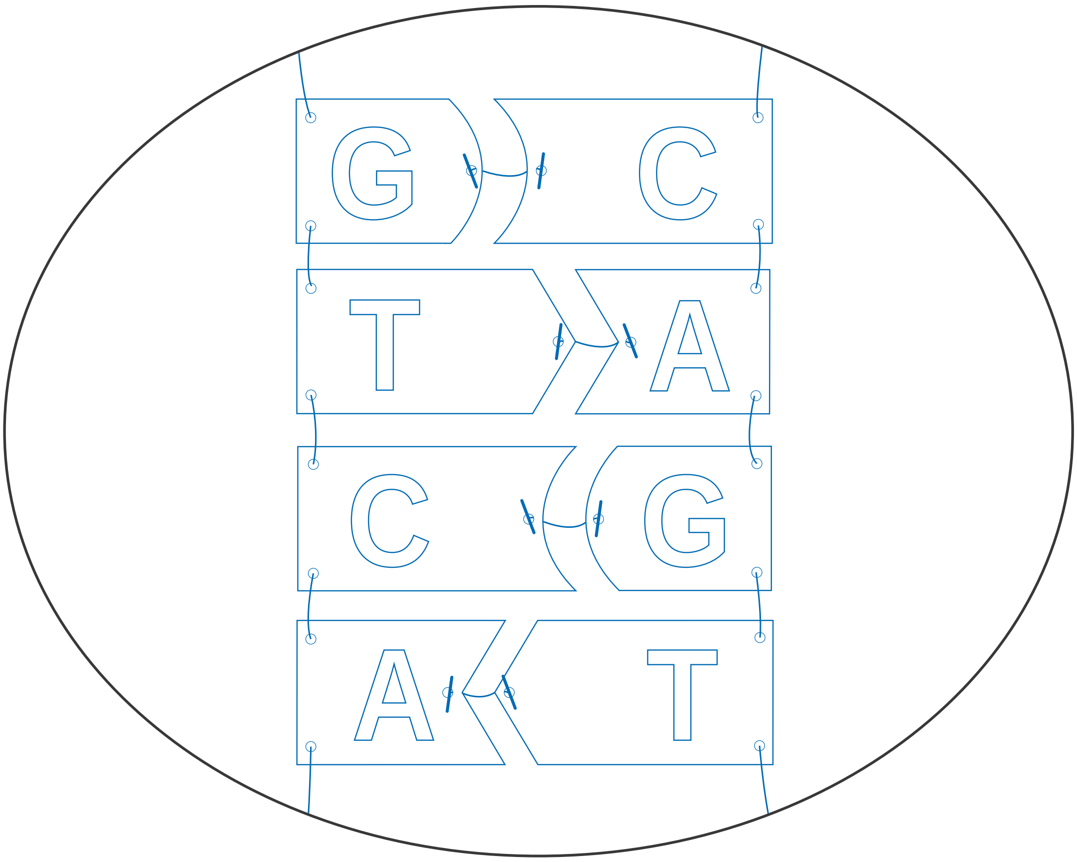
- Cut out the shapes and use a hole punch to make the holes at the ends.

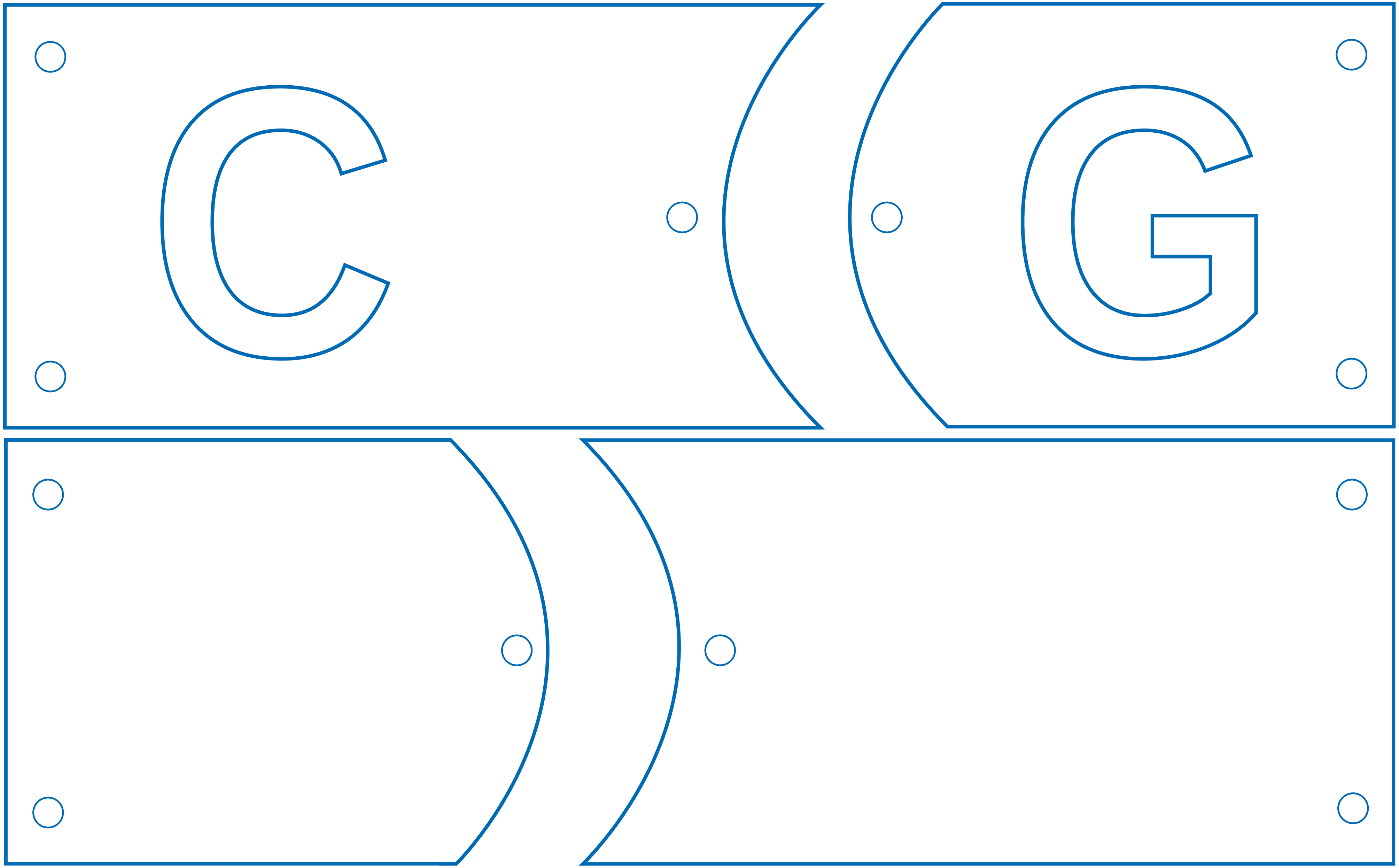
- Fasten pairs of shapes together using paper fasteners or string.

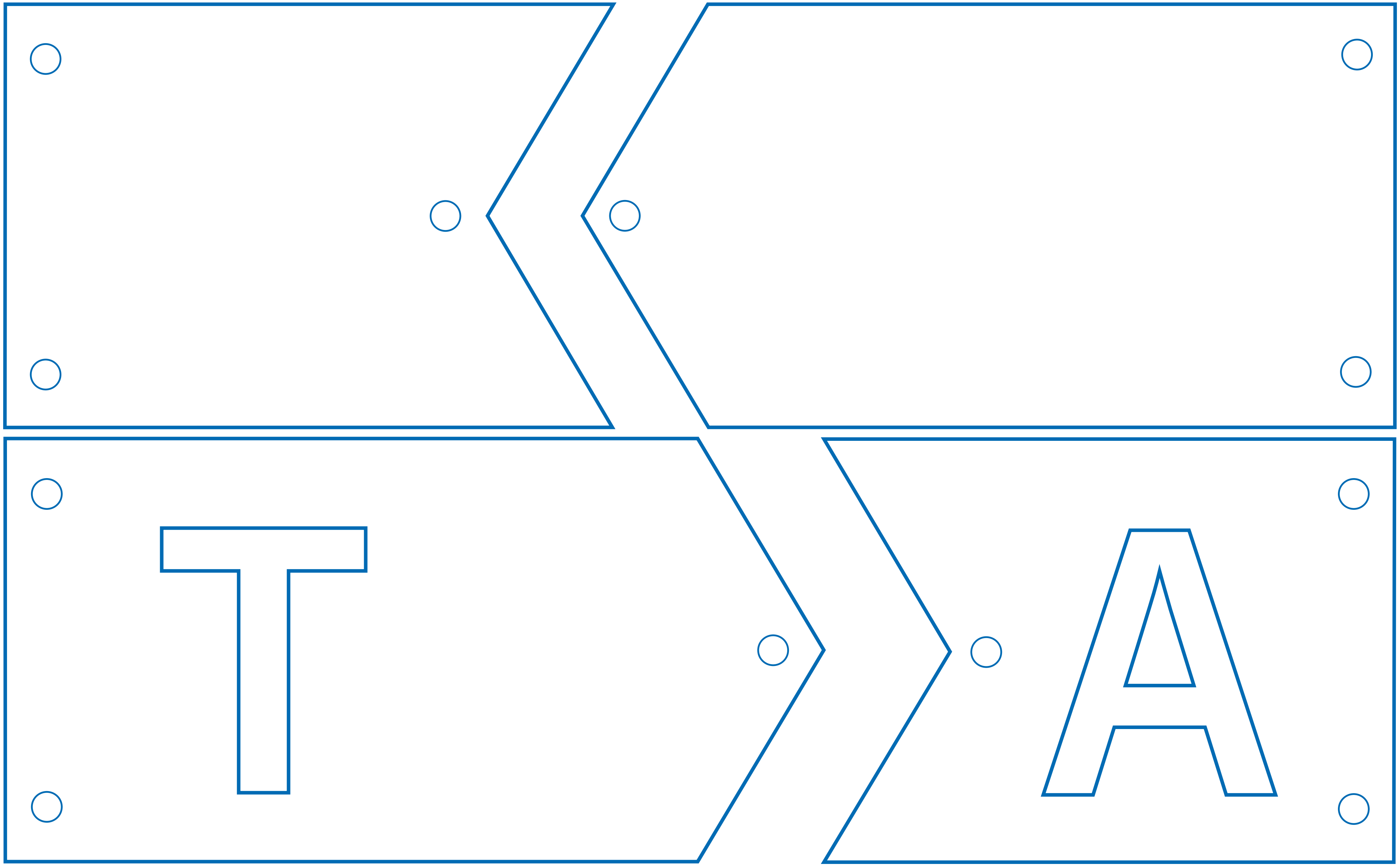
- To make your model, thread two pieces of cord through the holes (don't forget to tie a knot at one end!).

Remember the DNA rules:

C always goes with G   A always goes with T




C
G


T
A

“Recipe for Life” Book

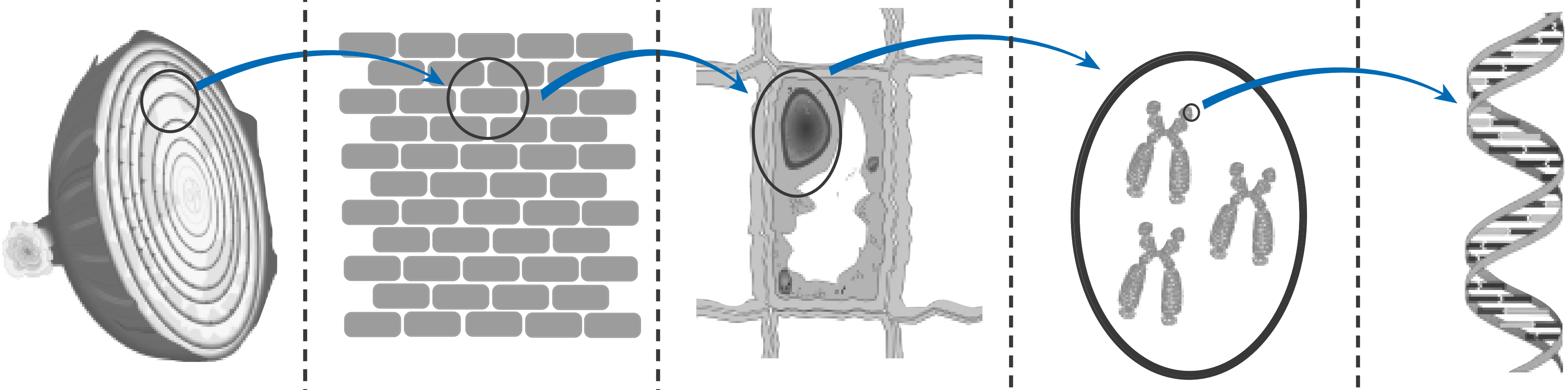
Volume 1.

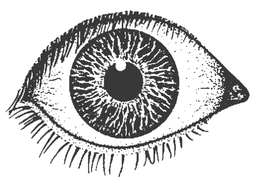
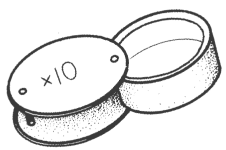
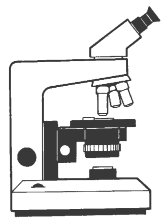
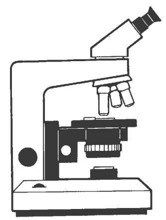
Worksheet 8a

ATCGATGTACTGCATGACTATGTCATACGTAGCTGATCG
ATGCATGACGTACTGCATGTACTGCATGACTACTGCAT
GATGTCATACGTAGCTGATCGATCGATGTACTGCATGA
CTACATCGATGTACTGCATGTATGTCATACGTAGCTACG
TATCATCTAGCTAGATCGTACTAGCTGTACTGCATGTAT
GTAGCTAGATCGATGTACTGCATGACTATGATGTACTAC
TGCATGCTCATCGATGTACTGCATGACTATGTCATACGT
AGCTGATCGATGCATGACGTACTGCATGTACTGCATGA
CTACTGCATGATGTCATACGTAGCTGATCGATCGATGTA
CTGCATGACTACATCGATGTACTGCATGTATGTCATACG
TAGCTACGTATCATCTAGCTAGATCGTACTAGCTATCGAT
GTACTGCATGACTATGTCATACGTAGCTGATCGATGCAT
GACGTACTGCATGTACTGCATGACTACTGCATATGTCAT
ACGTAGCTGATCGATGCATGACGTACTGCATGTACTGC
ATGACTACTGCATGATGTCATACGTAGCTGATCGATCGA
TGTACTGCATGACTACATCGATGTACTGCATGTATGTCA
TACGTAGCTACGTATCATCTAGCTAGATCGTACTAGCTG
TACTGCATGTATGTAGCTAGATCGATGTACTGCATGACT
ATGATGTACTACTGCATGCTCATCGATGTACTGCATGAC
TATGTCATACGTAGCTGATCGATGCATGACGTACTGCAT
GTACTGCATGACTACTGCATGATGTCATACGTAGCTGA
TCGATCGATGTACTGCATGACTATGCATGACGTACTGC
ATGTACTGCATGACTACTGCATGATGTCATACGTAGCT
GATCGATCGATGTACTGCATGACTACATCGATGTACTGC
ATGTATGTCATACGTAGCTACGTATCATCTAGCTAGATCG
TACTAGCTGTACTGCATGTATGTAGCTAGATCGATGTAC

TGCATGACTATGATGTACTACTGCATGCTCATCGATGTA
CTGCATGACTATGTCATACGTAGCTGATCGATGCATGA
CGTACTGCATGTACTGCATGACTACTGCATGATGTCAT
ACGTAGCTGATCGATCGATGTACTGCATGACTATGCAT
GACGTACTGCATGTACTGCATGACTACTGCATGA
TGTCATACGTAGCTGATCGATCGATGTACTGCATGACT
ACATCGATGTACTGCATGTATGTCATACGTAGCTACGTA
TCATCTAGCTAGATCGTACTAGCTGTACTGCATGTATGT
AGCTAGATCGATGTACTGCATGACTATGATGTACTACT
GCATGCTCATCGATGTACTGCATGACTATGTCATACGTA
GCTGATCGATGCATGACGTACTGCATGTACTGCATGAC
TACTGCATGATGTCATACGTAGCTGATCGATCGATGTAC
TGCATGACTATGCATGACGTACTGCATGTACTGCATGA
CTACTGCATGATGTCATACGTAGCTGATCGATCGATGT
ACTGCATGACTACATCGATGTACTGCATGTATGTCATAC
GTAGCTACGTATCATCTAGCTAGATCGTACTAGCTGTAC
TGCATGTATGTAGCTAGATCGATGTACTGCATGACTAT
GATGTACTACTGCATGCTCATCGATGTACTGCATGACT
ATGTCATACGTAGCTGATCGATGCATGACGTACTGCAT
GTACTGCATGACTACTGCATGATGTCATACGTAGCTGA
TCGATCGATGTACTGCATGACTATGCATGACGTACTGC
ATGTACTGCATGACTACTGCATGATGTCATACGTAGCT
GATCGATCGATGTACTGCATGACTACATCGATGTACTG
CATGTATGTCATACGTAGCTACGTATCATCTAGCTAGAT
CGTACTAGCTGTACTGCATGTATGTAGCTAGATCGATG
TACTGCGTACTGCATGACTATGTCATACGTAGCTGATC

From an onion to an onion cell's DNA, the 'Recipe for Life' is found inside cells.



An onion	Onion cells	One onion cell	The nucleus of an onion cell	DNA
Onions are made up of thousands of cells. Most cells are too tiny for the human eye to see.	We have to use a magnifying lens to see cells. The magnifying lens makes cells look larger.	The more you magnify a cell, the more detail you can see.	By using a very powerful microscope, scientists can see the **chromosomes** inside the **nucleus** of a cell.	The nucleus holds a 'recipe' or set of instructions in a chemical called **DNA**.
Magnification 				We cannot see DNA under a microscope, but we know from using special equipment that it looks a bit like a spiral staircase or twisted ladder.
x 1	**x 10**	**x 400**	**x 40,000 +**	**x 100,000 +**

DNA from onions

Teacher guidelines

1. Make the “DNA extraction mix” as follows:

    - 10 ml washing-up liquid - it must be of the cheap type and not “concentrated”.
    - 3g salt.
    - 100ml water.

2. Add the salty washing-up liquid solution to 100g of chopped onion. Place in a household blender and liquidise for 5 seconds. (If it does not work first time, use the liquidiser for a few seconds extra).

3. Strain the mixture through a coffee filter into a cup or beaker to separate the chopped-up onion from the clear liquid.

4. Using a squeezy pipette, transfer a sample (a few drops) of the clear liquid into a clean tube and add an equal volume of alcohol (e.g. methylated spirits). If you can, use industrial methylated spirits which is clear and does not have a powerful odour. Your local secondary school may be able to supply this or some ‘de-colourised’ methylated spirits (it is normally purple). Don’t worry if you only have access to purple methylated spirits, the demonstration will still work but the meths is rather more noxious to work with.

5. Gently invert the tube a few times and the DNA should appear as a “fluffy” white solid.

Cartoon Fun

REMEMBER: Nobody else in the whole world has a DNA recipe quite like yours – you are a very special person!

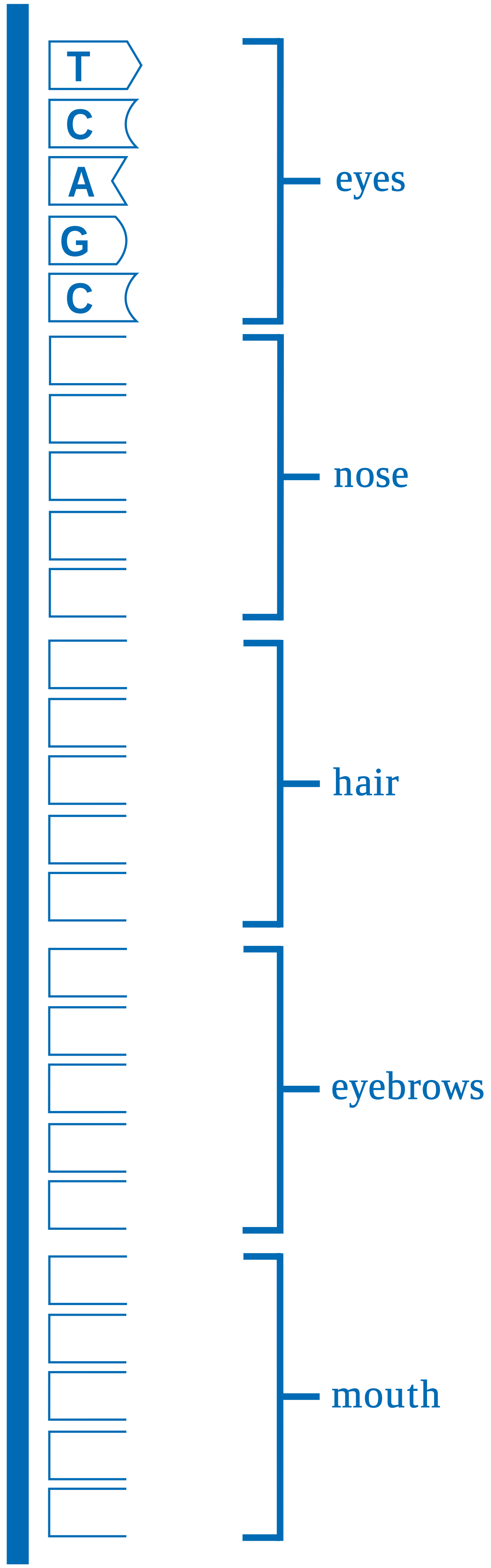
The human “recipe for life” is very large. Nobody fully understands how all of the ingredients work together to make a human being because the rules are so complicated. To make a human eye, you need several very long recipes taken from different chromosomes.

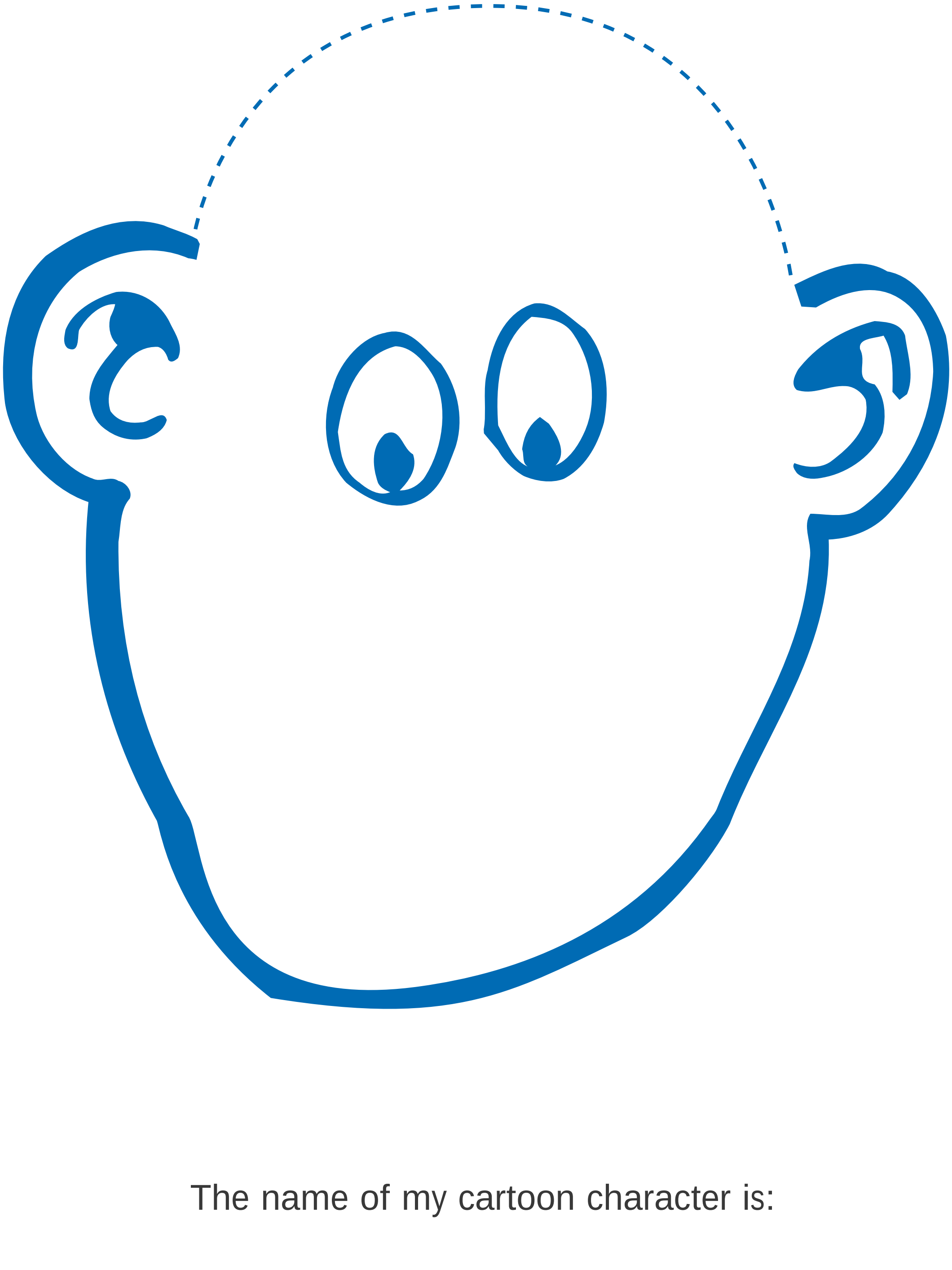
But in Cartoonland we have made the rules much easier for you to understand. We have made up some short simple DNA recipes to build cartoon faces. So why don’t you use our rules to build your own cartoon character.

What to do

- Choose the features which you like from the sheets, cut them out carefully along the dotted lines and stick them on the cartoon face. Don’t forget to give your character a name!
- Write down the DNA recipes for your characters by filling in the boxes on this page. To make it easier, we have only shown you one strand of the DNA. We have already filled in the recipe for the eyes to get you started.
- If there is time, give your worksheet to another group so that they can have a go at building your character. Would you expect the character they build to be exactly the same as yours?

The DNA of my cartoon character is:

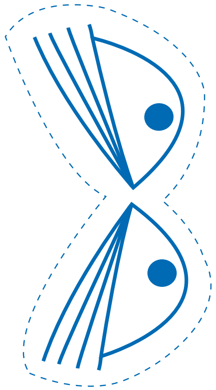




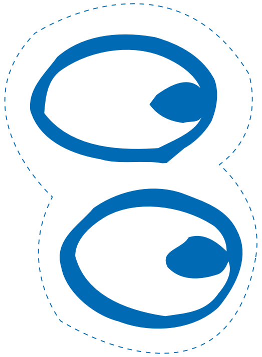
The name of my cartoon character is:

____

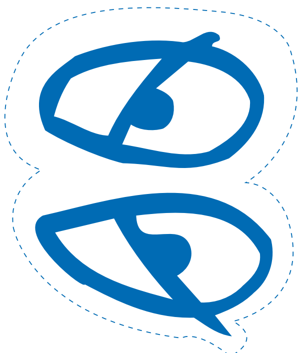
DNA "recipes" for eyes



G T G C A

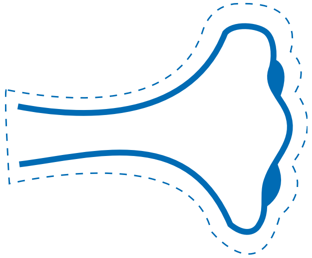


T C A G C

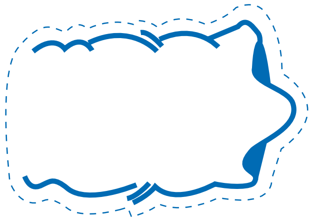


G T C G A

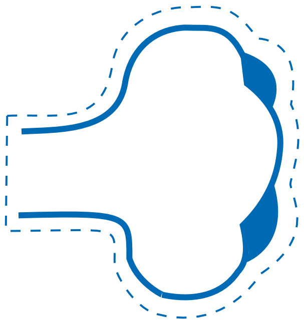
DNA "recipes" for noses



G C G A T

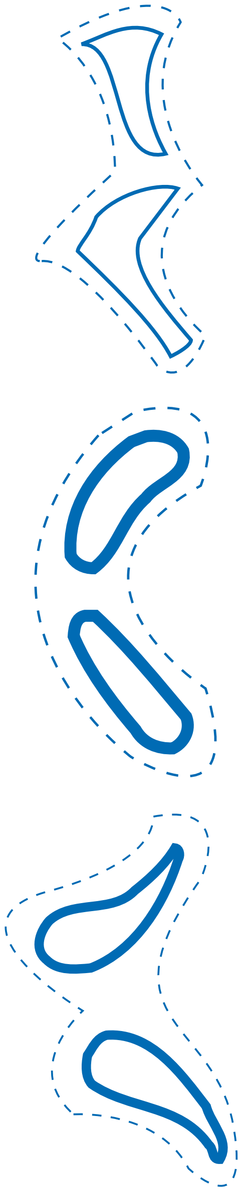


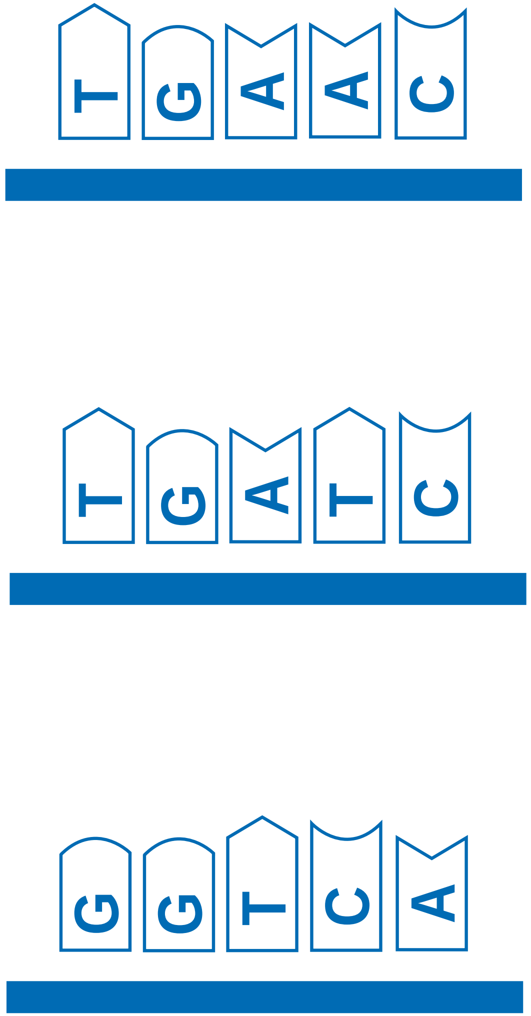
A G A G T



T G T A C

DNA “recipes” for eyebrows

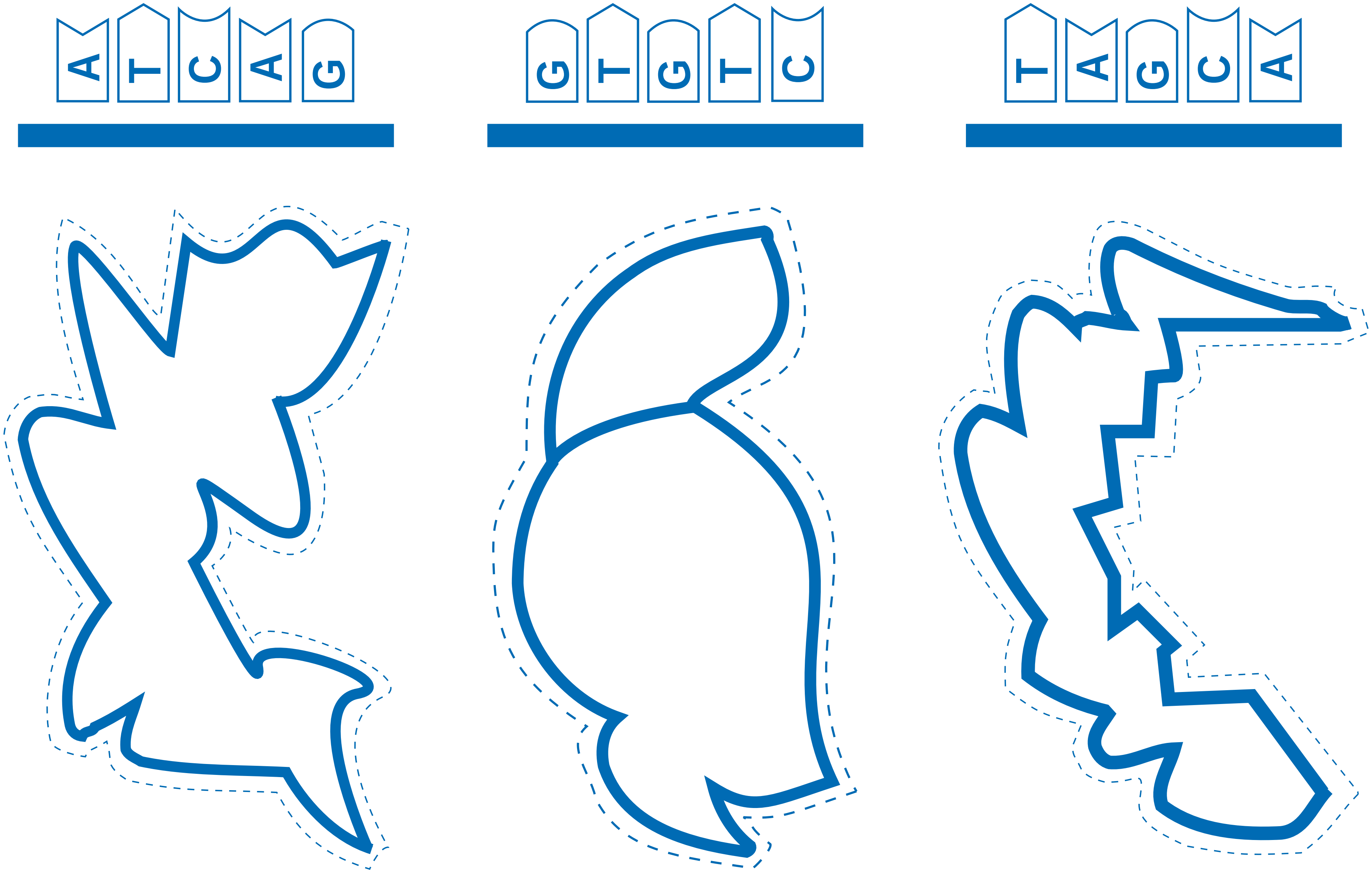




DNA “recipes” for mouths

Worksheet 11d

DNA “recipes” for hair



Worksheet 11e

Certificate

This is to certify that

....

has completed the

DNA Discovery Workshop