MAKING MODELS OF DNA – TEACHER NOTES AND HANDY HINTS

This resource is designed to provide an insight into the practical model building methods used by James Watson and Francis Crick to discover the structure of DNA. The activity combines individual tasks and group discussion and will take approximately one hour to complete, but may be extended or reduced depending on the amount of time and resources available and the nature of the students. The activity could also be entirely non-practical, with the teacher leading a discussion and encouraging participation from the students. It is assumed that the students are aware of the discovery of the structure of DNA, and it is recommended that a brief review of the story is given as an introduction to this resource.

Activity sheet – aims and benefits

The aim of this activity is to provide an insight into the practical model building methods used by James Watson and Francis Crick to discover the structure of DNA. The resource can be used to illustrate many of the key features of DNA, including the pairing of bases A-T and C-G, the possibility of different sequences of bases, and self-replication. The activity encourages students to:

a) make careful observations
b) detect patterns in information
c) express their ideas clearly

Throughout the activity the teacher should emphasise that this puzzle is much simpler than that faced by James Watson and Francis Crick. Firstly, there are many fewer pieces in this puzzle than in a single strand of DNA. Secondly, the pieces have much simple shapes than the true components of DNA. Thirdly, this puzzle is two-dimensional, whereas the true structure of DNA is three-dimensional. Finally, we know what the correct answer is! It is relatively easy to do simple calculations in reverse, to show that the observed patterns of simple structures are the same as in a theoretical structure. It is far easier to do this than it was to make the original discovery, just as writing a good detective story is completely different from solving a real case with a limited number of clues.

Hints

1. There is no ‘correct’ sequence of DNA model bases. The activity is designed to illustrate that the DNA bases can fit into the DNA structure in any sequence.

2. Make sure that the students to try several possible sequences of DNA model bases before gluing their final DNA model together.

3. The DNA model bases fit into the DNA model framework ‘up-side down’ as well as ‘right way up’, which can give many more possible sequences of DNA model bases.

4. Extend the activity by asking the students to create their own DNA model framework. The approximate framework dimensions are: 17cm (H) x 15cm (W).

5. Extend the activity by constructing a three-dimensional model of the structure of DNA. For example, try using Dolly Mixture sweets as suggested by Stuart Evans of Chepstow Comprehensive School, Monmouthshire: Evans, S.W. (2003) The Dolly Mixture model of the DNA Double Helix. *School Science Review*, **84**(308), 23.

MAKING MODELS OF DNA – STUDENT NOTES

What is DNA?

DNA is the molecule that carries the genetic code, the 'secret of life'. Every living thing contains DNA, which stores all the information about that living thing in a chemical code. The information stored in human DNA is used to build and operate our bodies. To understand how DNA stores and uses information we need to know more about the DNA molecule.

Question 1: List three things that contain DNA and three things that do not contain DNA.

Things that contain DNA	Things that do not contain DNA
1.	1.
2.	2.
3.	3.

How does DNA store and use information?

DNA is shaped like a twisted ladder. The rungs of the ladder are made from four chemical compounds, known as bases: adenine (A), thymine (T), guanine (G) and cytosine (C). Each rung is made of one pair of bases, and the bases are always found in the same pairs: A-T and G-C. These pairs are exactly the same size, and so they can fit into the structure of a DNA molecule in any order or sequence. The sequence in which the bases occur is a code that contains information. So, DNA stores information in the sequence of bases that form the rungs of its twisted ladder structure.

Figure 1: The twisted ladder structure of DNA. . Each human cell contains about 3 billion DNA bases – this is a lot of information!

How does DNA use information?

DNA bases always form the same pairs: A-T and G-C. This means that if a DNA molecule is split in two along the length of the ladder structure it is a perfect template for making two new DNA molecules that are perfect copies of the original.

MAKING MODELS OF DNA – ACTIVIY SHEET

In this activity you will make a model of the structure of DNA using the same practical model building methods used by James Watson and Francis Crick when they discovered the structure in 1953. James Watson and Francis Crick discovered the structure of DNA at the Cavendish Laboratory in Cambridge. They knew that DNA was made up of four chemical compounds known as bases: adenine (A), thymine (T), guanine (G) and cytosine (C). They also had some clues to the shape and size of the structure from X-ray images of DNA. They discovered the structure of DNA by figuring out how the four DNA bases fit together, just like putting together the pieces of a jigsaw puzzle.

Apparatus

DNA Model framework
DNA Model bases
Scissors
Glue
Colouring pencils
(red, blue, green and yellow)

Activity

Cut out the DNA model bases from the activity sheets provided. Try fitting the DNA model bases into the DNA model framework, like a jigsaw puzzle.

Can you fit all of the DNA model bases into the DNA model framework? .....

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Can you fit the DNA model bases into the DNA model framework in a different way, creating a different sequence of bases? …….....

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How many different sequences of DNA bases can you create that fit into the DNA framework? .....

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Decide which sequence of bases you are going to use to complete your model, and glue the bases into the framework. Colour in the bases using a different colour for each of the four different bases as follows: A = Red, T = Blue, G = Green, C = Yellow. *It is important that you use the right colour for each base so that you can compare your completed model with others!*

Does your DNA model have the same sequence of bases as others in your group? .....

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How many DNA models with different sequences of bases have been made in your group? .....

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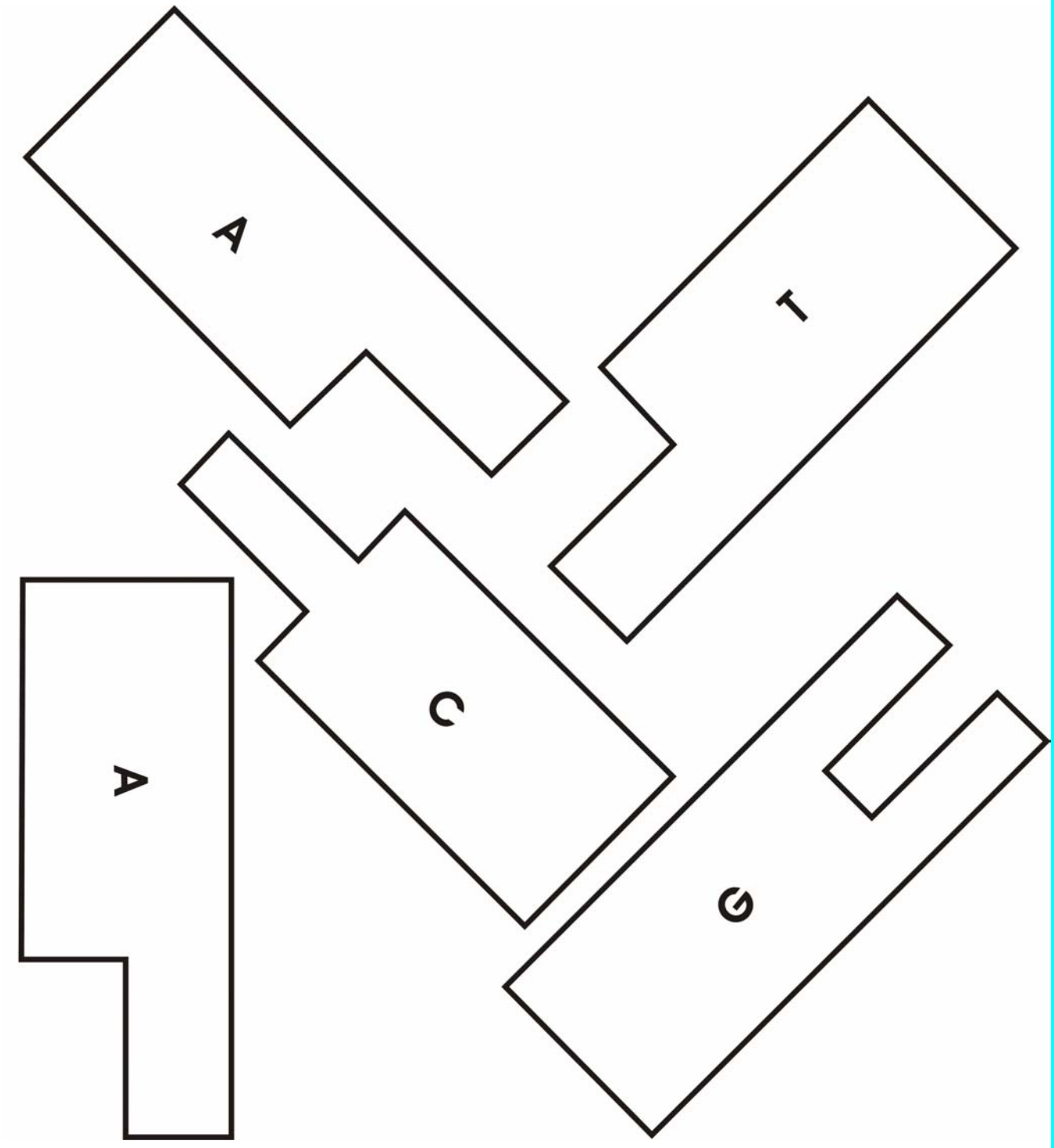
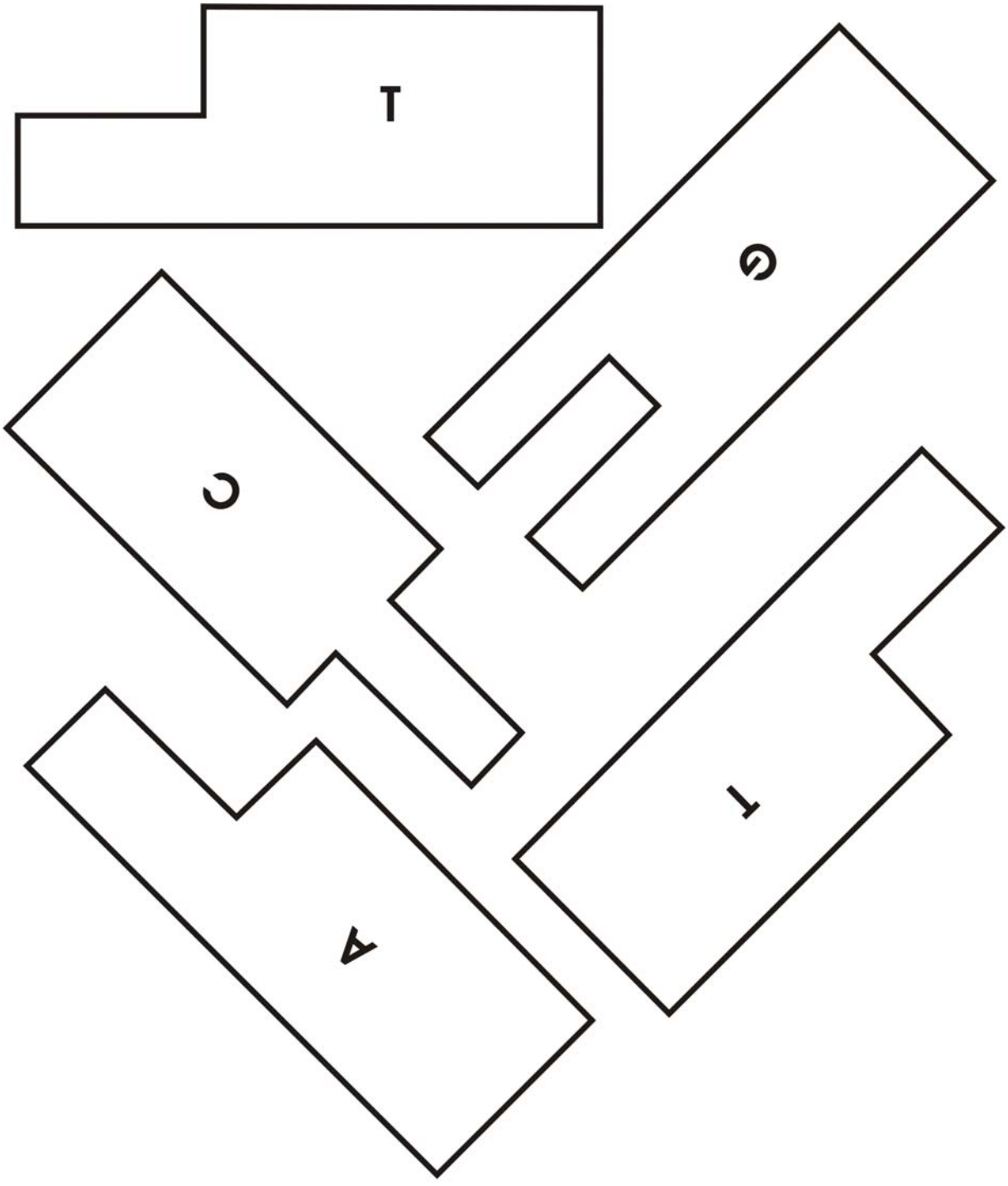
MAKING MODELS OF DNA – ACTIVIY SHEET

DNA MODEL BASES 1



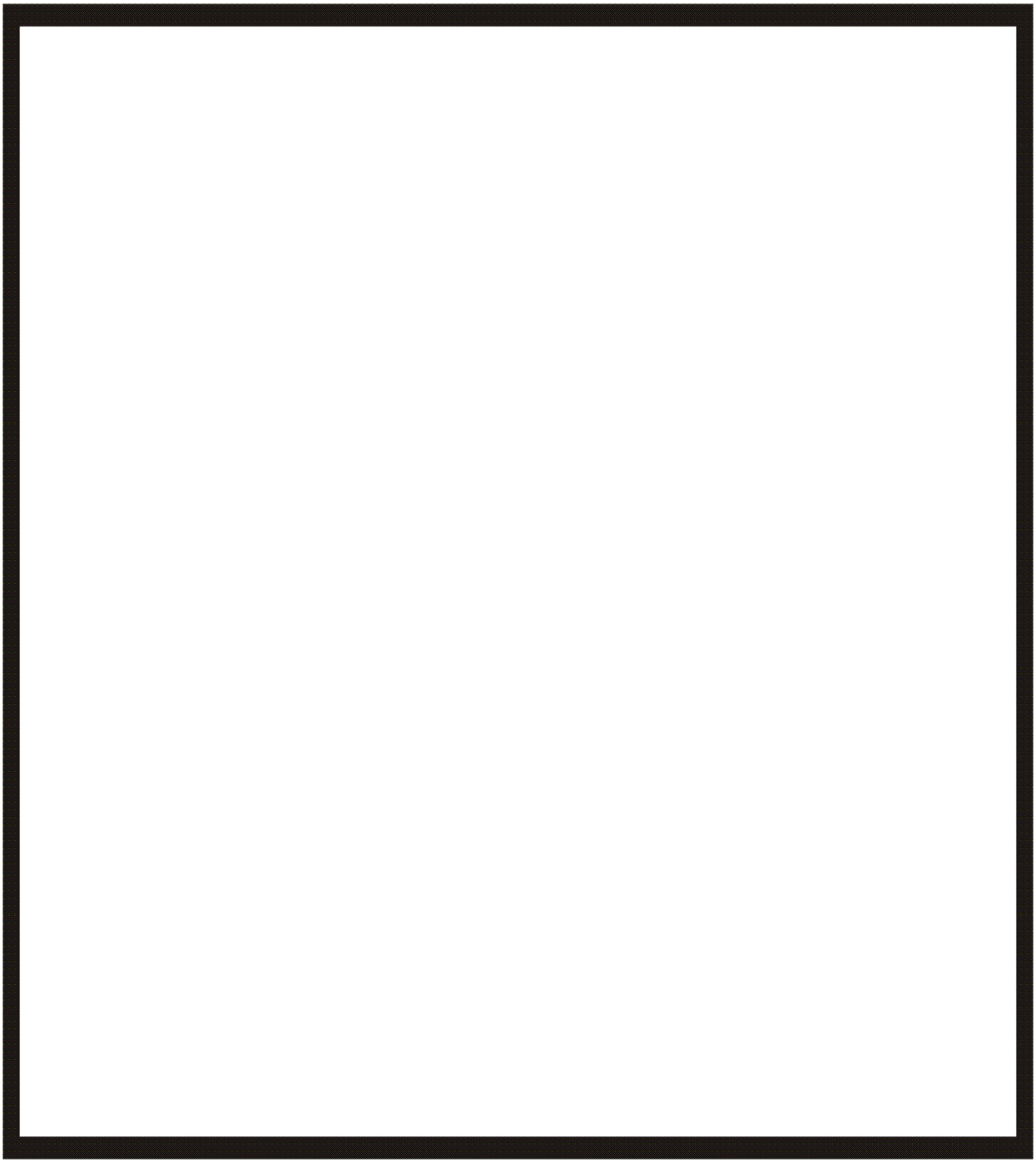
MAKING MODELS OF DNA – ACTIVIY SHEET

DNA MODEL BASES 2



MAKING MODELS OF DNA – ACTIVIY SHEET

DNA MODEL FRAMEWORK



In this activity you have made a two-dimensional (2-D) model of the structure of DNA. The true three-dimensional (3-D) structure of DNA is a double helix, which looks like a twisted ladder. How could you make a 3-D model of the structure of DNA? .....

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