



## Dean Madden (adapted from a model by Van R. Potter)

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# Modelling the helix

## A cut-out 3-D model of DNA

### Aim

This inexpensive cut-out model of DNA can be used to learn about the structure of B-DNA.

### Equipment and materials

#### Needed by each person or group

##### Equipment

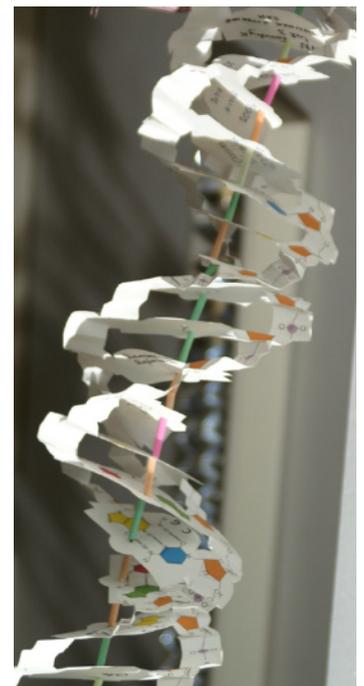
- Scissors
- Bodkin or strong needle, for punching holes through card
- OPTIONAL: Sharp craft knife and cutting board

##### Materials

- Nucleotide templates, copied onto card from the following pages
- Paper glue
- Drinking straws
- Fine string or strong sewing thread
- Crayons (if coloured prints of the following pages are not used)

### Procedure

- 1 Make several copies of the nucleotide templates on card. Ten nucleotide pairs are required for a complete turn of the double helix. To see the major and minor grooves in the double helix clearly, the model needs to have at least 16 nucleotide pairs.
- 2 If colour copies have not been used, colour in the card appropriately. The colours that are often used in sequencing markers for DNA bases are: Cytosine=Blue; Guanine=Yellow; Adenine=Green; Thymine=Red.



- 3 Cut out the nucleotide pairs around the thicker, outer lines. Make two small cuts into the card by the phosphate groups where indicated. OPTIONAL: Use a sharp craft knife to make cuts above the deoxyribose molecules where shown.
- 4 Carefully punch a small hole in each cut-out where shown. This will be the axis of the DNA model through which the string will be threaded. *Do not make these holes too big!*
- 5 Fold the sugar-phosphate 'backbones' where indicated by dotted lines. These folds must be made in the directions shown on the accompanying pages. *Take care not to make left-handed DNA.*
- 6 Cut 25 mm lengths of drinking straw. You will need one less piece of straw than you have nucleotide pairs.
- 7 Glue the phosphate group on one cut-out onto the deoxyribose on the next. Do the same with the opposite sugar-phosphate strand. Remember that the sugar-phosphate chains run in opposite (anti-parallel) directions. The orientation of the letters on the card should help you to assemble the model correctly.
- 8 Hold a piece of drinking straw between the holes in the cut-outs, and thread the string through them.
- 9 Repeat steps 5–8 for as many nucleotide pairs as desired.
- 10 Cut out the genetic code discs, and glue the two sides together onto the string at the bottom of the model. The weight of the discs will help the model to hang vertically.



## Safety

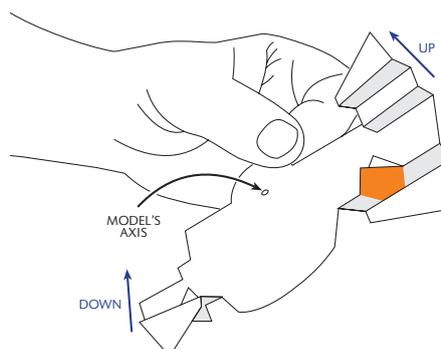
Care is needed when cutting out the model, and especially when punching holes through the cut-out parts.

## Preparation and timing

It will usually take about 90 minutes to assemble a model of 16 nucleotide units. It can be tedious to cut out large numbers of base-pairs, so the task is best shared between members of a class, with each student cutting out one or two base-pairs.

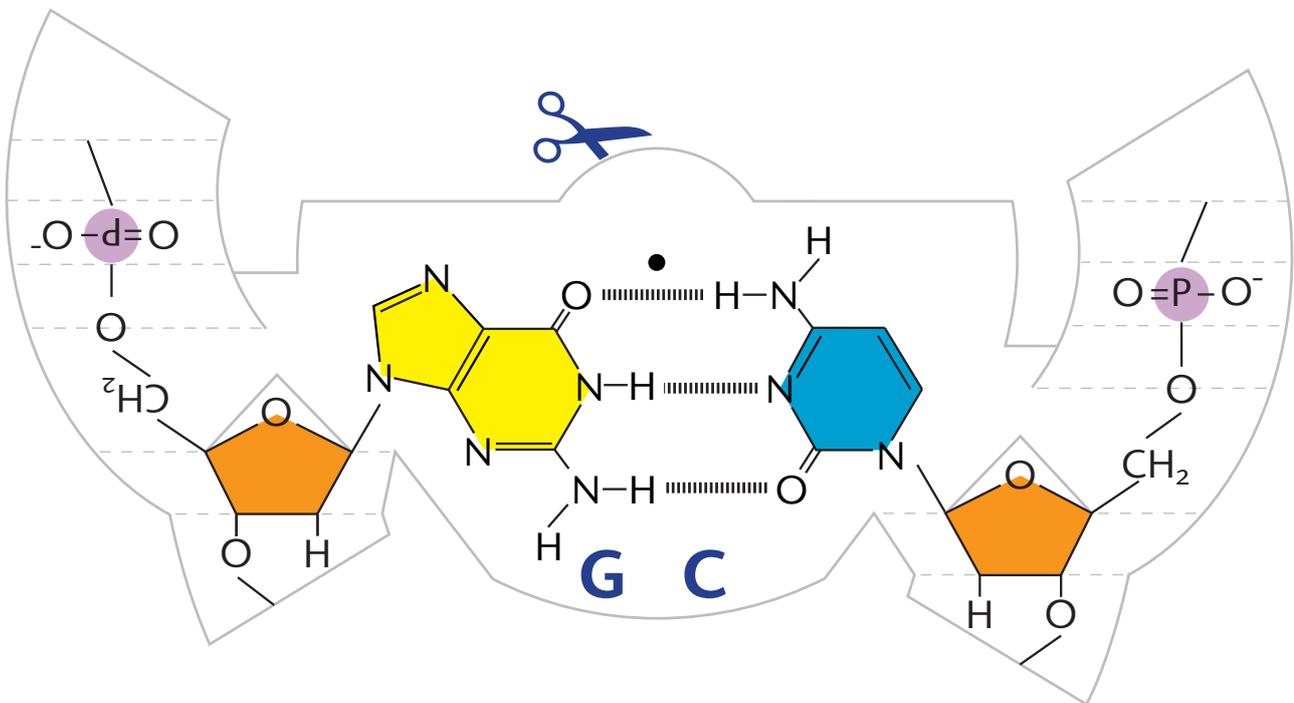
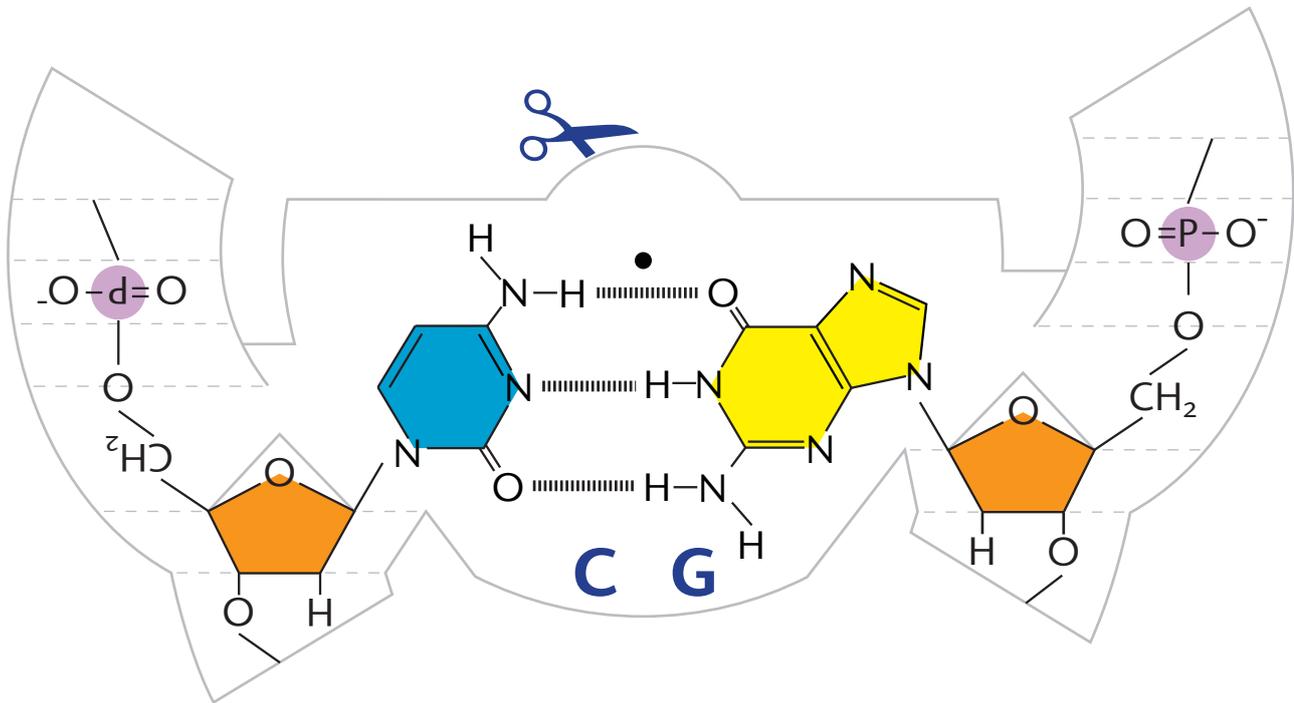
## Troubleshooting

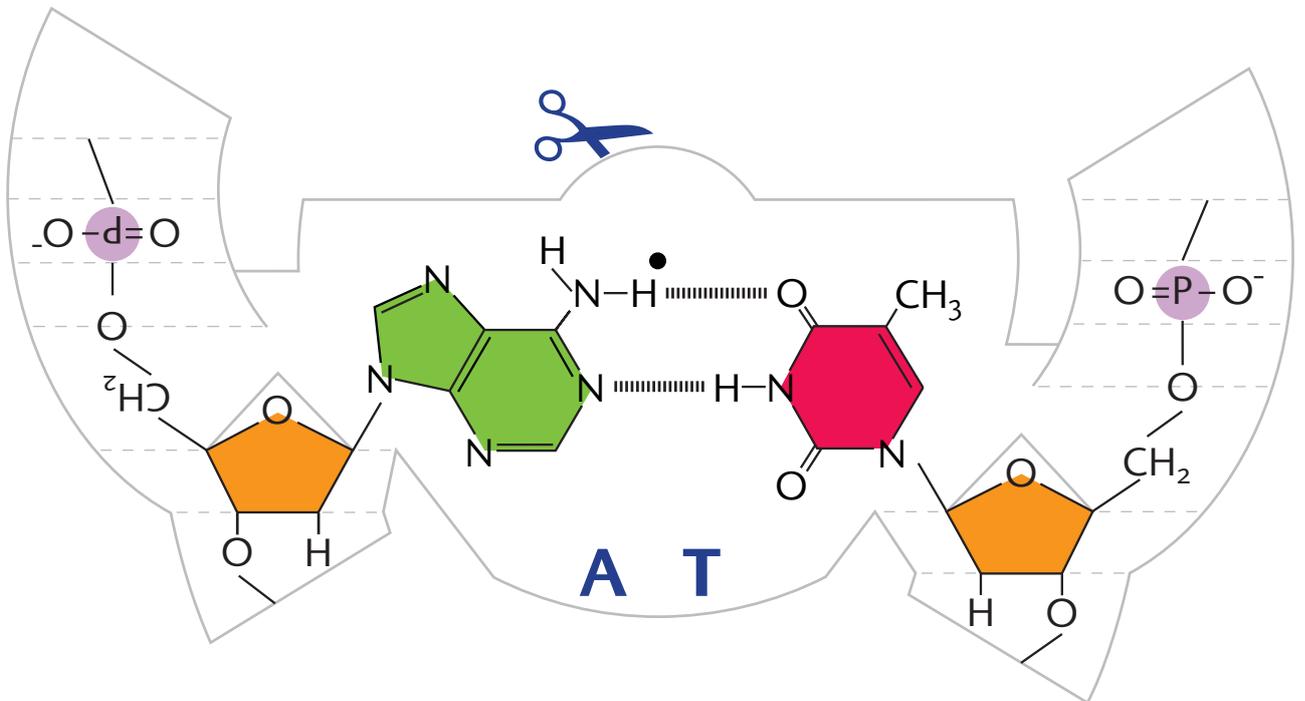
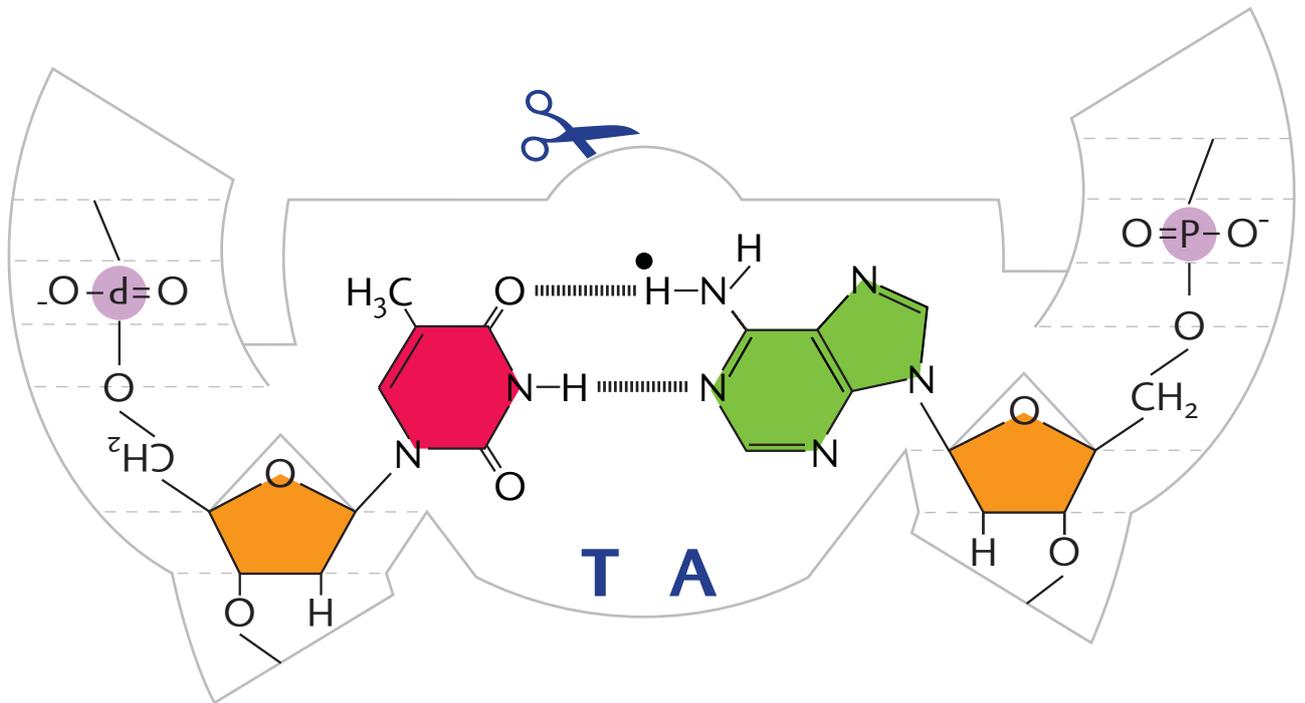
Ensure that you do not make a left-handed helix — fold the pieces as shown in Figure 1.

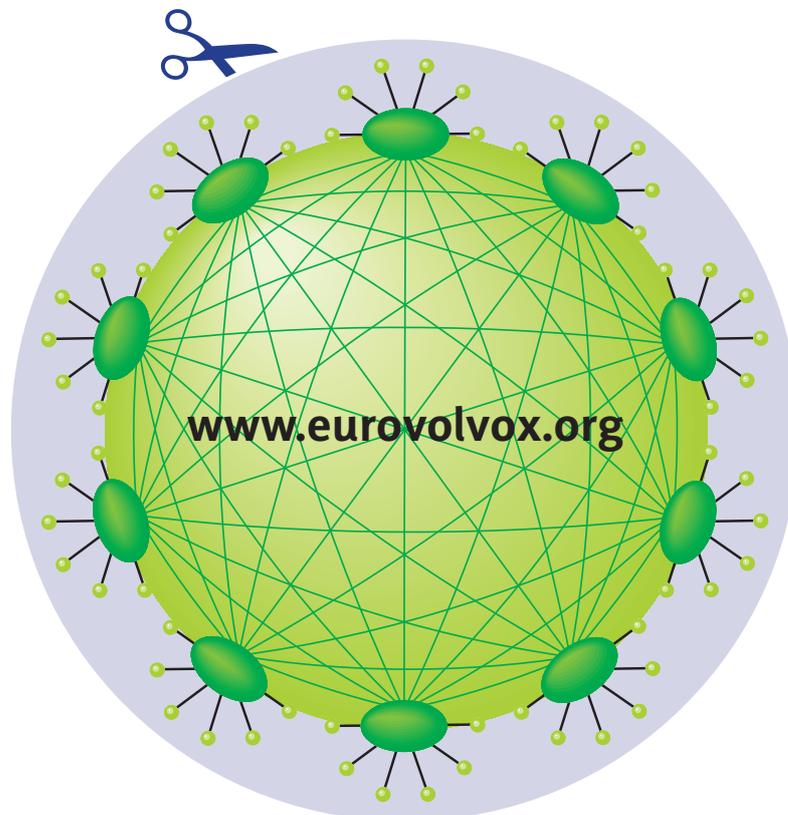
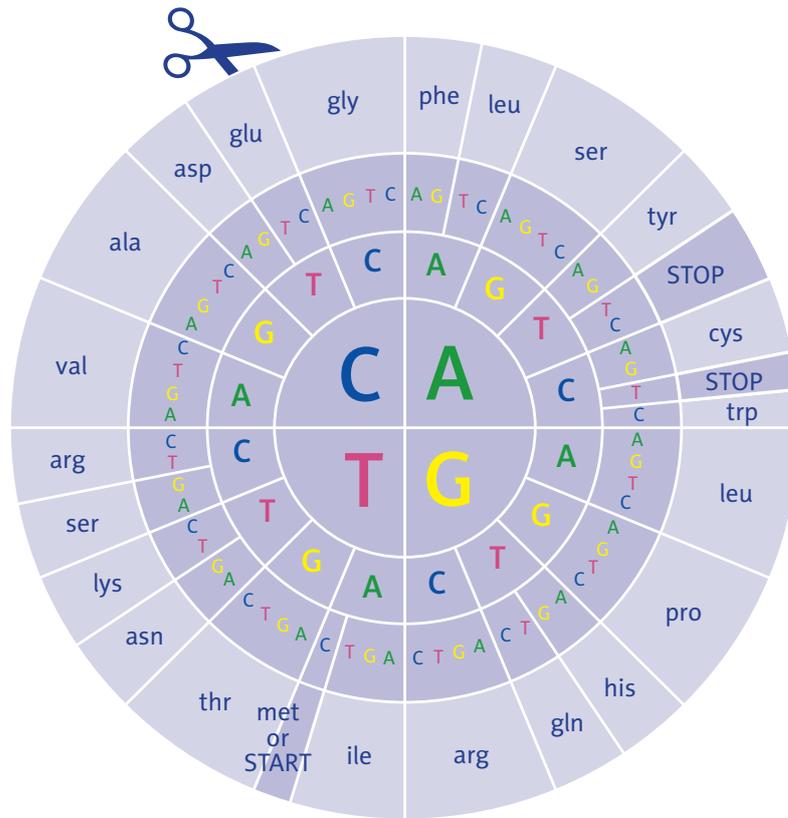


**Figure 1**

Phosphate groups on the left side fold **DOWN**, phosphates on the right fold **UP**.







## Further activities

Photocopy or print the nucleotide pairs into overhead transparency sheets instead of card. These can be assembled to make a particularly attractive model.

Our colleague Fernand Schroeder of the Lycée de Garçons, Esch/Alzette (Luxemborg) has devised a 'Genetic code computer' which is available from the *Volvox* web site.

The *Volvox* site also includes several interactive DNA animations devised by Tago Sarapuu and his colleagues from the Science Didactics Department, University of Tartu (Estonia).

## Further reading

*The double helix. A personal account of the discovery of the structure of DNA* by James D. Watson [Gunther Stent, Ed.] (1980) New York: W. W. Norton and Company. ISBN: 0 393 95075 1.

*What mad pursuit. A personal view of scientific discovery* by Francis Crick (1988) New York: Basic Books. ISBN: 0 465 09138 5.

*Rosalind Franklin: The Dark Lady of DNA* by Brenda Maddox (2003) London: HarperCollins. ISBN: 978 000652116.

*Maurice Wilkins — The third man of the double helix* by Maurice Wilkins (2005) Oxford: Oxford University Press. ISBN: 978 0192806673.

*Francis Crick: Discoverer of the genetic code* by Matt Ridley (2008) London: HarperPerennial. ISBN: 978 0007213313.

## Acknowledgements

The model upon which this one is based was brought to the John Schollar's attention by Dr Cheong Kam Khoo of the Singapore Science Centre. It was devised by Van Rensselaer Potter in 1958 and appeared the following year in his book *Nucleic Acid Outlines*. Sadly, Dr Potter, a bioethicist and oncologist at the University of Wisconsin-Madison, died in 2001 before we learnt that he had devised the original model. Many thanks to Kevin Fraser for alerting us to the origin of the model.

This article is adapted from one by the same author which first appeared in the on-line journal *Bioscience Explained*: [www.bioscience-explained.org](http://www.bioscience-explained.org).

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