# DNA and other naturally occurring polymers

4.7.3.4 · Organic chemistry · revision notes

DNA and the other natural polymers that are important for life (proteins, starch and cellulose), and the monomers they are made from. GCSE Chemistry only. Expect short recall questions, often 1 mark each, and 'describe the structure of DNA'.

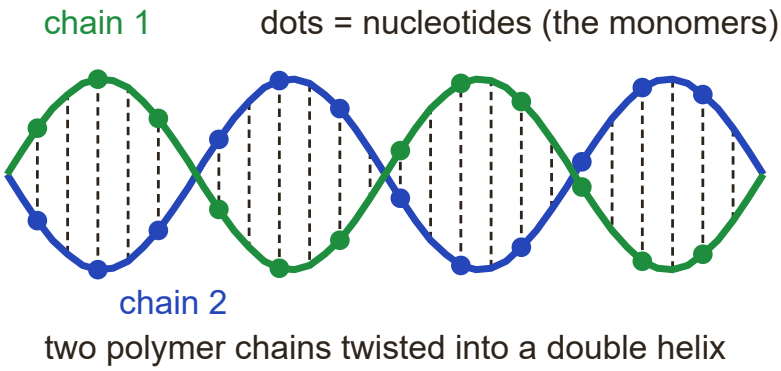
## Key facts

- DNA = deoxyribonucleic acid, a large molecule essential for life
- DNA: two polymer chains, four different nucleotides, double helix
- Proteins are made from amino acids
- Cellulose is made from sugars (glucose)
- DNA encodes genetic instructions for the development and functioning of living organisms and viruses
- DNA is made from nucleotides
- Starch is made from sugars (glucose)
- Grade 7+ only Natural polymers form by condensation: water released as monomers join

## Notes

### DNA

- **DNA** (deoxyribonucleic acid) is a large molecule that is essential for life.
- DNA **encodes the genetic instructions** for the development and functioning of living organisms and viruses.
- Most DNA molecules are **two polymer chains** in the form of a **double helix**.




DNA: two chains of nucleotides twisted into a double helix. The order of the nucleotides is the genetic code.

- The chains are made from **four different monomers** called **nucleotides**.
- The order (sequence) of the nucleotides along the chains carries the genetic instructions. DNA molecules are very long, so they can hold a huge amount of information.

## Other natural polymers

- **Proteins**: the monomers are **amino acids**.
- **Starch**: the monomers are sugars (**glucose**).
- **Cellulose**: the monomers are also sugars (**glucose**). Starch and cellulose are both made by plants.
- Like synthetic polymers such as poly(ethene), natural polymers are very long molecules made from many monomers joined together.
- Proteins, starch and cellulose are condensation polymers: a molecule of water is released each time two monomers join (Higher tier). Grade 7+ only

## How to answer each type of question

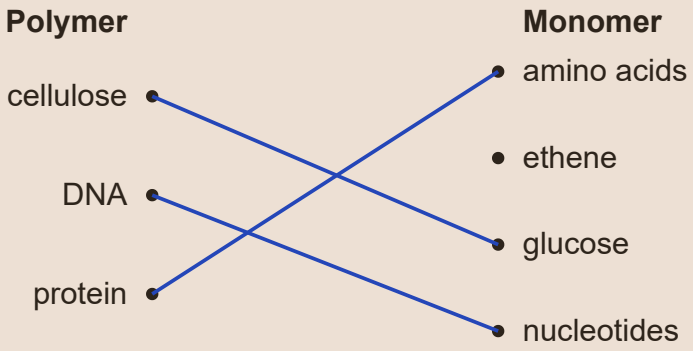
**Match polymers to their monomers** 1 mark each **Grade 4**

1. Learn the four pairs: DNA and nucleotides, proteins and amino acids, starch and sugars, cellulose and sugars.
2. Glucose is the sugar in starch and cellulose, so you can give either word.
3. Draw one straight line from each box, and do not join one box to two others.

**Example.** Draw one line from each polymer to the monomer it is made from.
Polymers: cellulose, DNA, protein
Monomers: amino acids, ethene, glucose, nucleotides

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**Model answer.**




Cellulose to glucose (1)
DNA to nucleotides (1)
Protein to amino acids (1)

### Describe the structure of DNA

2 to 3 marks | Grade 5

1. Say that it is made of two polymer chains.
2. Say that the monomers are four different nucleotides.
3. Say that the chains form a double helix.

**Example.** A student writes: 'DNA is a single polymer chain made from one type of monomer.'
Give **two** ways in which the student's description is wrong, and name the shape of a DNA molecule.

**Model answer.** DNA is (usually) two polymer chains, not one (1). It is made from four different monomers (nucleotides), not one type (1). The shape is a double helix (1).

### Explain the variety of natural polymers

2 marks | Grade 6

1. Say how many different monomers each polymer is made from.
2. Link variety to the number of different monomers and the order they are joined in.

**Example.** Starch is made from only one type of monomer, but there are thousands of different proteins.
Explain why there can be so many different proteins.

**Model answer.** Proteins are made from many different amino acids (1). These can be joined in different orders (sequences), giving many different proteins (1).

### Calculate: monomer units in a natural polymer

2 marks | Grade 7

1. Find the relative formula mass of one unit in the chain: the monomer's $M_r$ minus 18 for the water lost.
2. Divide the polymer's relative formula mass by the unit's relative formula mass.

**Example.** Cellulose is made from glucose, $C_6H_{12}O_6$ ($M_r$ = 180). One molecule of water ($M_r$ = 18) is released for each glucose unit added to the chain.
(a) Show that the relative formula mass of each glucose unit in the chain is 162.
(b) A cellulose molecule has a relative formula mass of 486 000. Calculate the number of glucose units in it.

**Model answer.**

(a) 180 − 18 = 162 (1)
(b) 486 000 ÷ 162 = 3000 (1)

## Don’t lose marks

- Saying DNA is made from amino acids. DNA is made from nucleotides; proteins are made from amino acids.

- Writing 'double helix' but not saying that there are two polymer chains made from four different nucleotides.
- Saying starch and cellulose are made from different monomers. Both are made from glucose (a sugar).
- Saying DNA only carries instructions for humans or animals. It does so for all living organisms and for viruses.

## More tips

### Memory tricks

- Two S's: Starch and cellulose are both made of Sugar (glucose).
- P and A: Proteins are made of Amino acids.
- DNA in numbers: 2 chains, 4 different nucleotides, 1 double helix.
- Natural polymers are nature's plastics: long chains of repeating monomers.

### Exam technique

- Most questions here are 1-mark recall: learn the exact key words, such as 'nucleotides', 'double helix' and 'genetic instructions'.
- 'Describe the structure of DNA' is usually 3 marks: two polymer chains, four different nucleotides, double helix.
- In matching questions, one line from each box. Two lines from the same box lose the mark.

## What each grade needs

What you need to be able to do, from the first marks up to the top grade.

**Grade 3** — **Name natural polymers that are important for life**
DNA, proteins, starch and cellulose.

**Grade 4** — **Name the monomers of each natural polymer**
DNA: nucleotides. Proteins: amino acids. Starch and cellulose: sugars (glucose).

**Grade 4** — **State what DNA does**
DNA encodes the genetic instructions for the development and functioning of living organisms and viruses.

**Grade 5** — **Describe the structure of DNA**
Two polymer chains, made from four different nucleotides, in the form of a double helix.

**Grade 6** — **Explain why proteins are so varied**
They are made from many different amino acids, which can be joined in different orders.

**Grade 7** — **Link natural polymers to condensation polymerisation**
Proteins, starch and cellulose form by condensation: water is released each time two monomers join.

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