

DNA replication

International Baccalaureate · IB Diploma · Biology · HL

Scope and prerequisites

This handout covers selected HL topics for the course first assessed in 2025; it is not the whole syllabus.

Prerequisites: read the stated quantities and units, and use arithmetic and the model conditions below.

The examples are original and fictional: they are not real measurements or real student investigations.

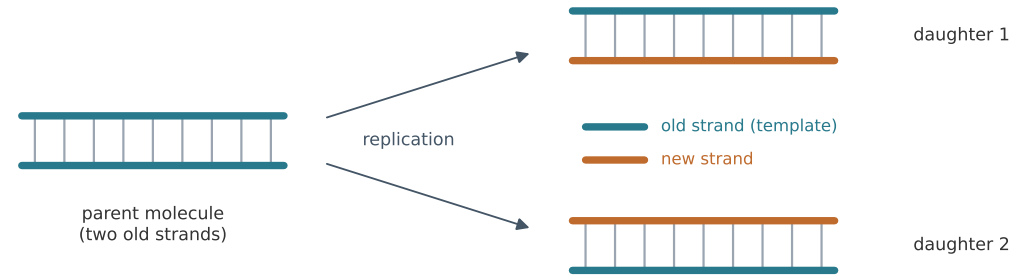
DNA replication: retain one strand in each daughter molecule

■ What would explain this observation?

- After DNA replication, each daughter double helix contains one pre-existing strand and one newly synthesized strand. Copying a molecule is different from expressing its information.

■ Build the model

- DNA replication is semi-conservative.
- Complementary base pairing supports copying of the base sequence: adenine pairs with thymine and cytosine with guanine.
- The strands have opposite orientations.
- Helicase separates paired strands, while **DNA polymerase** DNA builds new DNA using a template and available nucleotides.
- **semi-conservative replication** : DNA copying in which each daughter double helix retains one parental strand.
- DNA polymerase: An enzyme that synthesizes DNA using a template.



Each daughter keeps one old strand and gains one new strand: semi-conservative

Each daughter molecule keeps one old strand and gains one new strand

■ Choose evidence that can test it

- New DNA is synthesized in the 5' to 3' direction.
- In a simplified fork model, one new strand can be synthesized continuously while the other is produced in fragments that are joined.
- Distinguish these molecular mechanisms from the later separation of chromosomes during cell division.
- Copying errors can occur despite proofreading and repair.

In the lab: Use labelled strand models or an attributed experimental diagram. Mark old and new material with both labels and colours so the meaning survives monochrome viewing. Track successive rounds using a stated starting population and assumptions. A classroom model illustrates predictions; it is not direct evidence about enzyme activity or a substitute for experimental results.

■ Work from known quantities

- Known: one double-stranded molecule contains two labelled original strands.
- After one complete round in unlabelled nucleotides, two molecules each contain one labelled strand.
- After two rounds, four molecules exist: two retain one labelled original strand and two contain only unlabelled strands.
- The fraction containing an original strand is $2/4=50\%$.

Your turn: One labelled double helix replicates for three complete rounds in unlabelled nucleotides. What percentage of the eight molecules contain an original strand?

■ **Check the conclusion and its limits**

- Replication uses DNA as a template to make DNA; transcription uses a DNA template to make RNA.
- A predicted label distribution assumes complete rounds and no degradation or exchange of the labelled material.

Not true: DNA replication and transcription both produce the same type of nucleic-acid product. Replication copies DNA into DNA; transcription copies a DNA template into RNA. The products are different nucleic acids with different roles.

Key:

- DNA replication is semi-conservative.
- New DNA is synthesized in the 5' to 3' direction.
- Watch for: replication uses DNA as a template to make DNA; transcription uses a DNA template to make RNA.

■ **Write from 2 labelled molecules out of 32**

- One labelled double helix replicates for 5 complete rounds in unlabelled nucleotides.
- Say how many of the 32 molecules still contain an original strand.

■ **Write from 3 rounds and 8 molecules**

- The same labelling runs for 3 complete rounds instead, giving 8 molecules.
- Say how many molecules retain an original strand, and what fraction of all 16 single strands is original.