29.1 DNA replication: retain one strand in each daughter molecule

Name: _____ Class: _____ Date: _____ **Total: 10 marks**

KEY WORDS DNA polymerase DNA • semi-conservative replication

Objective

DNA replication: retain one strand in each daughter molecule. Original classroom practice for IB HL; not an official IB paper.

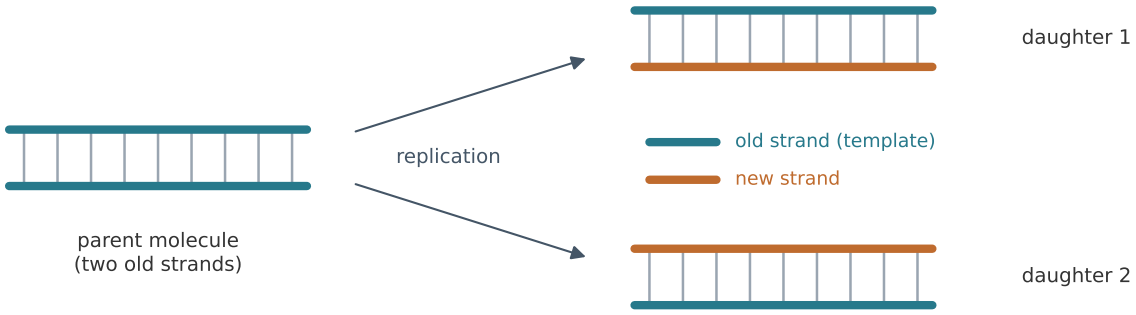
1 Key knowledge and worked examples

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

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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.

2 Practice

2.1 What does each daughter double helix retain after one ideal replication round? Choose one answer.

- **A** One parental strand
- **B** Both parental strands together in every molecule
- **C** No parental material [1]

2.2 One labelled double helix replicates for three complete rounds in unlabelled nucleotides. What percentage of the eight molecules contain an original strand? Show the relation, substitution and units. [2]

2.3 Decide whether this claim is true and justify: Replication copies DNA into DNA; transcription copies a DNA template into RNA. [2]

2.4 DNA copying in which each daughter double helix retains one parental strand: write the technical term. [1]

3 Exam-style questions

3.1 One fully labelled double helix undergoes 4 complete rounds in unlabelled nucleotides. Find the fraction of molecules with any original strand and explain why original strands do not multiply. [4]

Solutions

2.1 A Replication is semi-conservative: each daughter double helix keeps one parental strand paired with one new strand. Keeping both parental strands together in every molecule, or none, contradicts the labelling evidence.

2.2 After 3 complete rounds there are 2^3=8 molecules. Two retain original strands;2/8×100=25%.

2.3 True. True. Replication copies DNA into DNA; transcription copies a DNA template into RNA. The products are different nucleic acids with different roles.

2.4 semi-conservative replication. semi-conservative replication means DNA copying in which each daughter double helix retains one parental strand.

3.1 Two original strands persist among 16 molecules:1/8=12.5%. Templates are retained while new strands are synthesized; assume no degradation or strand exchange. This does not require unsupported SL fork detail.