

Exercise walk-through

29.1

DNA replication: retain one strand in each daughter molecule

International Baccalaureate · IB Diploma · Biology · HL

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. Supported HL concept preparation; original classroom practice, not an official IB paper or assessed learner work.

1 Key knowledge and worked examples

■ What would explain this observation?

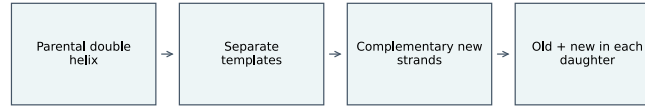
- After DNA replication, each daughter double helix contains one pre-existing strand and one newly synthesized strand. Copying a molecule is different from expressing its information.
- Start with a prediction. State the quantities or features you would compare, then

decide what evidence could distinguish two explanations.

■ 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** 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 synthe-

sizes DNA using a template.



■ **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.
- 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**

- State the known values and their units. Choose the relation because its assumptions fit this case, then rearrange before substitution.
- 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 $2/4=50\%$.

Example:

One labelled double helix replicates for three complete rounds in unlabelled nucleotides. What percentage of the eight molecules contain an original strand? Use the same sequence: known quantities → model → relation → substitution → unit and interpretation.

■ 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.
- Return to the original observation. Explain what the result supports, which conditions it assumes, and one way to test a competing explanation.

Warn:

DNA replication and transcription both produce the same type of nucleic-acid product. This claim is false: 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.

Key:

DNA replication: retain one strand in each daughter molecule: 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.

Exercises 2.1·2.3

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: DNA replication and transcription both produce the same type of nucleic-acid product.

[2]

Exercises 2.1-2.3

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]

2.1 A New DNA is synthesized in the 5' to 3' direction. In a simplified fork model, one

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]

2.2 After 3 complete rounds there are $2^3 = 8$ molecules. Two retain original strands; $2/8 \times 100 =$

2.3 Decide whether this claim is true and justify: DNA replication and transcription both produce the same type of nucleic-acid product.

[2]

2.3 False. 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.

Exercises 2.4·3.1

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

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]

Exercises 2.4·3.1

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

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

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]

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.