2023 Bi H2 Q1

Section: DNA and the Genome

Topic: Replication of DNA

Question Summary

This question explores DNA replication and the polymerase chain reaction (PCR), testing understanding of enzyme function, strand synthesis, primer use, and DNA amplification.

Worked Solution

(a) Name the enzyme that adds DNA nucleotides to newly synthesised strands

■ DNA polymerase — this enzyme adds complementary nucleotides to the 3′ end of a growing DNA strand during replication.

(b) Strand A is the lagging strand — explain why

In the diagram, strand A is synthesised in short fragments moving away from the replication fork. DNA polymerase can only add nucleotides to the 3′ end, so it must repeatedly start and stop as the fork opens up. ■ This produces Okazaki fragments, typical of the lagging strand.

(c)(i) Why two different primers are used in PCR

The two DNA strands are antiparallel and have different base sequences at their ends. Therefore, two primers are required — one complementary to the start of each strand, ensuring both are copied.

(c)(ii) Temperature at which primers bind

■ Between 50 °C and 65 °C — this allows primers to anneal (bind) to the target DNA before extension by DNA polymerase.

(d) Copies after 9 minutes (one cycle = 3 minutes)

Number of cycles = 9 ÷ 3 = 3 cycles
Each cycle doubles the amount of DNA:
Total copies = original molecules × 2■
= 30 × 2^3 = 30 × 8 = 240
■ Answer: 240 copies

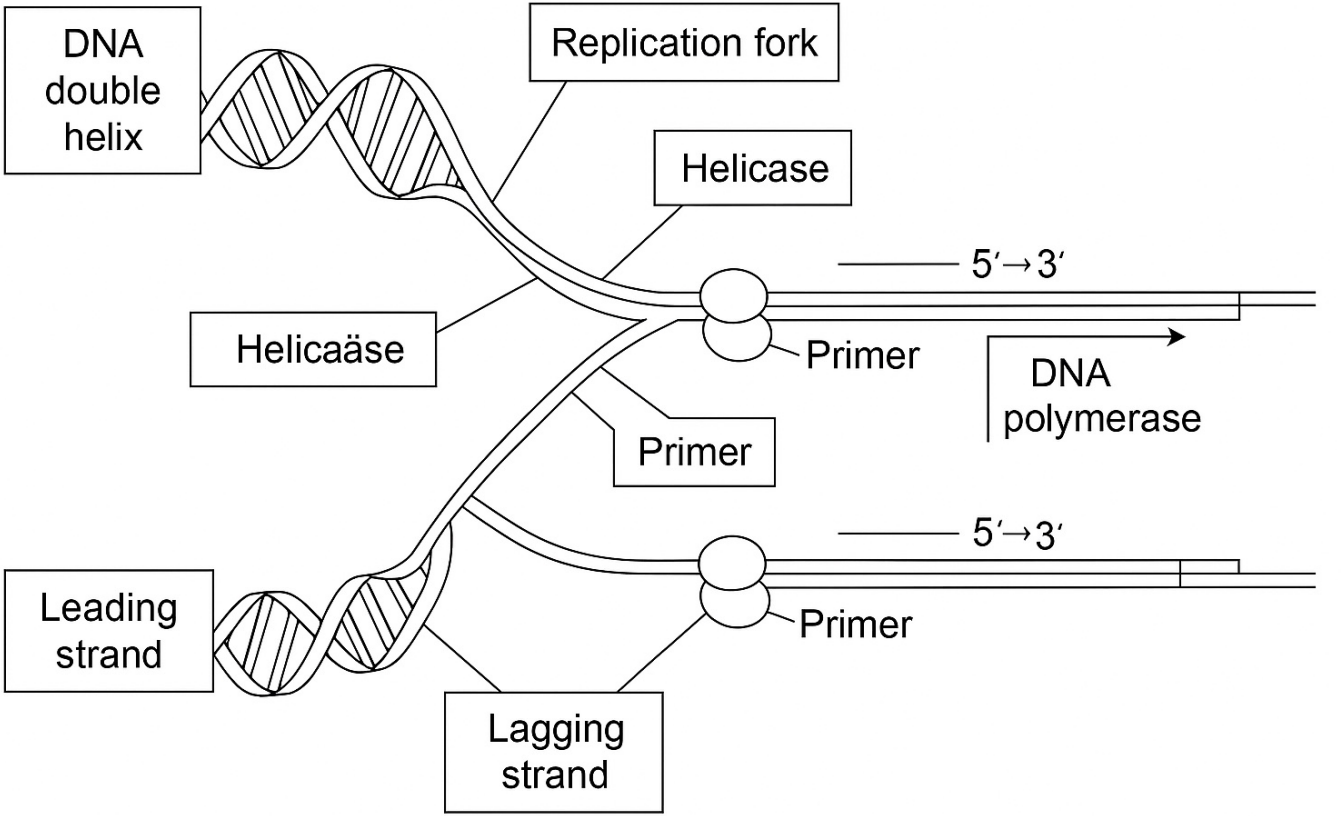
Final Answers

■ (a) DNA polymerase
■ (b) Synthesised in fragments — opposite direction to fork
■ (c)(i) Two primers needed — each strand has different sequence
■ (c)(ii) 50 °C – 65 °C
■ (d) 240 copies

Revision Tips

• Leading strand: continuous synthesis toward fork.
• Lagging strand: discontinuous synthesis away from fork (Okazaki

fragments).
• Enzymes to remember:
– DNA helicase – unwinds double helix
– DNA polymerase – adds nucleotides
– Ligase – joins fragments
• PCR stages:
1. 94–96 °C — DNA separates
2. 50–65 °C — primers anneal
3. 70–75 °C — extension by DNA polymerase
• Each PCR cycle doubles the DNA — exponential amplification.


DNA double helix
Replication fork
Helicase
5′→3′
Helicaäse
Primer
DNA polymerase
Primer
5′→3′
Leading strand
Primer
Lagging strand