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## DNA Replication & S Phase

**Exam — DNA Replication**

Comprehensive Pre-med style questions on DNA replication, S phase, enzymes, directionality, and regulation

**30 items — Printable Exam**

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**1 Which event defines the S phase of the eukaryotic cell cycle?**



- A** Separation of sister chromatids
- B** Synthesis and complete replication of the nuclear DNA
- C** Rapid cell growth without DNA synthesis
- D** Formation of the mitotic spindle
- E** Partition of cytoplasm during cytokinesis

**2 DNA replication in cells is described as 'semi-conservative'. What does this mean?**



- A** Each daughter DNA molecule contains two newly synthesised strands
- B** Each daughter DNA molecule contains two parental (old) strands
- C** Each daughter DNA molecule contains one parental strand and one newly synthesised strand
- D** Only half of the genome is replicated in each cell cycle
- E** Only some bases are copied accurately

**3 During DNA replication, in which direction are new DNA strands synthesised by DNA polymerases?**



- A** 5' → 3' only
- B** 3' → 5' only
- C** Either 5' → 3' or 3' → 5', depending on the strand
- D** Randomly in both directions
- E** Direction is not relevant for DNA synthesis





4 Which statement about DNA polymerase is CORRECT?



- A It can initiate DNA synthesis de novo without a primer
- B It requires a free 3' OH group to extend a pre-existing strand
- C It synthesises RNA primers for DNA replication
- D It unwinds the DNA double helix ahead of the replication fork
- E It forms phosphodiester bonds only between ribonucleotides

5 What is the main role of DNA helicase at the replication fork?



- A Relieving torsional strain by cutting and rejoining DNA
- B Synthesising short RNA primers
- C Unwinding the parental double helix by breaking hydrogen bonds between base pairs
- D Sealing nicks between Okazaki fragments
- E Holding single-stranded DNA in an extended conformation

6 Single-strand DNA-binding proteins (SSBs) are essential during replication because they:



- A Cut and rejoin DNA to relieve supercoiling
- B Stabilise unwound DNA strands and prevent them from reannealing or forming secondary structures
- C Create RNA primers for DNA polymerase
- D Proofread newly synthesised DNA and remove mismatches
- E Ligate Okazaki fragments together





**7** Which enzyme synthesises the short RNA stretches that provide 3' ends for DNA polymerase to begin replication?



- A** DNA polymerase III
- B** DNA ligase
- C** Primase
- D** Topoisomerase
- E** Helicase

**8** What is the role of DNA ligase in replication?



- A** Extending RNA primers with DNA
- B** Joining Okazaki fragments by forming phosphodiester bonds between adjacent DNA fragments
- C** Removing RNA primers from lagging strands
- D** Unwinding the DNA helix
- E** Adding methyl groups to newly synthesised DNA

**9** Topoisomerases are crucial for DNA replication primarily because they:



- A** Add nucleotides to the growing DNA strand
- B** Cut one or both DNA strands to relieve supercoiling ahead of the replication fork
- C** Create RNA primers at the origin of replication
- D** Protect single-stranded DNA from nucleases





- E Initiate transcription at promoters

**10** Which statement correctly distinguishes leading and lagging strand synthesis at a replication fork?



- A The leading strand is synthesised  $3' \rightarrow 5'$ , the lagging strand  $5' \rightarrow 3'$
- B The leading strand is synthesised continuously towards the replication fork; the lagging strand is synthesised discontinuously away from the fork
- C Both leading and lagging strands are synthesised continuously
- D Both leading and lagging strands require only one RNA primer
- E The leading strand does not need a primer, but the lagging strand does

**11** Okazaki fragments are:



- A Short RNA pieces made on the leading strand
- B Short DNA fragments synthesised on the lagging strand
- C Regions of DNA enriched in guanine and cytosine
- D Sections of DNA that are not replicated in S phase
- E Short RNA-DNA hybrids found only in prokaryotes

**12** Why are multiple RNA primers required specifically on the lagging strand during replication?



- A The lagging strand DNA polymerase is unable to bind DNA directly





- B The lagging strand is synthesised discontinuously, so each Okazaki fragment must be initiated by its own primer
- C The lagging strand is synthesised 3' → 5', requiring primers at both ends
- D Primers on the lagging strand are not later removed
- E Primers on the leading strand are unnecessary because synthesis starts at a telomere

**13** In bacteria (e.g. *E. coli*), which DNA polymerase is primarily responsible for bulk synthesis of new DNA on both leading and lagging strands?



- A DNA polymerase I
- B DNA polymerase III
- C DNA polymerase
- D DNA polymerase
- E Reverse transcriptase

**14** Which is the primary function of bacterial DNA polymerase I during DNA replication?



- A Initiating DNA synthesis at replication origins
- B Removing RNA primers with its 5' → 3' exonuclease activity and replacing them with DNA
- C Synthesising the leading strand continuously
- D Unwinding DNA at the replication fork
- E Joining Okazaki fragments with phosphodiester bonds





**15** In eukaryotes, which combination of DNA polymerases is most closely associated with replication of nuclear DNA on the leading and lagging strands?



- A Pol  $\alpha$  for both strands
- B Pol  $\alpha$  as the main replicative polymerase and Pol  $\delta$  as primase
- C Pol  $\delta$ –primase to start synthesis, then Pol  $\alpha$  mainly on the leading strand and Pol  $\delta$  mainly on the lagging strand
- D Pol  $\alpha$  on both strands in the nucleus
- E Pol  $\delta$  for mitochondrial DNA and Pol  $\alpha$  for nuclear DNA

**16** What is the function of the sliding clamp ( clamp in bacteria, PCNA in eukaryotes) in DNA replication?



- A It unwinds the DNA double helix
- B It loads RNA primers onto the DNA template
- C It holds DNA polymerase tightly to DNA, greatly increasing processivity
- D It seals nicks between DNA fragments
- E It cuts and rejoins DNA to relieve supercoiling

**17** Many replicative DNA polymerases possess a 3'  $\rightarrow$  5' exonuclease activity. What is its main role?



- A Removing RNA primers from Okazaki fragments
- B Proofreading: removing incorrectly paired nucleotides from the 3' end of the growing strand
- C Extending the DNA chain beyond the 3' end
- D Repairing double-strand breaks
- E Adding telomeric repeats to chromosome ends





**18** Telomerase helps solve which specific problem in DNA replication?



- A** Replication of circular bacterial chromosomes
- B** Replication of the very ends of linear chromosomes on the lagging strand
- C** Removal of RNA primers from Okazaki fragments
- D** Unwinding of the double helix
- E** Random introduction of mutations into telomeric DNA

**19** Which cells typically show the highest telomerase activity in humans under normal physiological conditions?



- A** Most differentiated somatic cells (e.g. neurons)
- B** Germ-line cells and many stem cells
- C** Red blood cells
- D** All cells in G0 phase only
- E** Only cancer cells

**20** Which statement correctly compares DNA replication origins in prokaryotes and eukaryotes?



- A** Both typically have a single origin per chromosome
- B** Prokaryotic chromosomes have many origins; eukaryotic chromosomes have only one
- C** Circular bacterial chromosomes usually have one main origin, whereas linear eukaryotic chromosomes have many origins
- D** Only eukaryotes use origins; prokaryotic replication starts randomly





- E** Origins are required only for lagging-strand synthesis

**21** In a eukaryotic cell, how is it ensured that each origin of replication fires (is used) only once per cell cycle?



- A** By continuous synthesis of new origins during S phase
- B** By licensing origins with specific proteins in G1, then preventing relicensing once S-phase CDK activity rises
- C** By destroying all replication enzymes at the end of S phase
- D** By limiting the availability of dNTPs to a single replication round
- E** By allowing replication only at telomeres

**22** A diploid human cell ( $2n$ ) in G1 has a DNA content of  $2C$ . Immediately after S phase, but before mitosis begins, what are its ploidy and DNA content?



- A**  $n$  and  $2C$
- B**  $2n$  and  $2C$
- C**  $4n$  and  $4C$
- D**  $2n$  and  $4C$
- E**  $n$  and  $4C$

**23** A drug blocks topoisomerase activity but leaves helicase and DNA polymerase intact. Which immediate effect on replication is most likely?



- A** RNA primer synthesis is abolished





- B Supercoiling ahead of the fork increases, causing replication forks to stall and DNA breaks to accumulate
- C DNA ligase cannot seal Okazaki fragments
- D DNA polymerase begins synthesising DNA in the 3' → 5' direction
- E Origins of replication cannot be recognised by initiator proteins

**24** A nucleotide analogue used in chemotherapy lacks a 3' OH group on its deoxyribose. When incorporated into DNA by a polymerase, what is the most direct consequence?



- A DNA becomes resistant to nuclease digestion
- B DNA synthesis continues normally with increased speed
- C DNA synthesis stops because no further nucleotides can be added to that chain (chain termination)
- D The DNA strand is rapidly proofread and repaired
- E The analogue is removed by primase before ligation

**25** If DNA ligase activity is inhibited in a replicating eukaryotic cell, which outcome is most likely on the lagging strand?



- A Okazaki fragments remain unjoined, leaving many nicks in the sugar–phosphate backbone
- B RNA primers cannot be synthesised
- C Helicase cannot unwind double-stranded DNA
- D Leading-strand synthesis stops, but the lagging strand is unaffected
- E Supercoils cannot be relaxed ahead of the replication fork





**26** Replication forks originate at an origin of replication and move in which way along a typical eukaryotic chromosome?



- A** In a single direction, producing a single replication fork per origin
- B** Bidirectionally, producing two replication forks that move away from the origin in opposite directions
- C** Randomly jumping between chromosomes
- D** Only towards the telomeres
- E** Only towards the centromere

**27** Which statement best distinguishes DNA replication from transcription in eukaryotic cells?



- A** Replication uses ribonucleotides, while transcription uses deoxyribonucleotides
- B** Replication requires RNA primers and copies the entire genome; transcription does not need a primer and copies specific genes
- C** Replication occurs only in the nucleus; transcription occurs only in the cytosol
- D** Replication synthesises RNA; transcription synthesises DNA
- E** Replication proceeds only  $3' \rightarrow 5'$ ; transcription only  $5' \rightarrow 3'$

**28** During DNA replication, the template strand is read in which direction by DNA polymerase?



- A**  $5' \rightarrow 3'$ , the same direction in which the new strand is synthesised
- B**  $3' \rightarrow 5'$ , opposite the direction of new strand synthesis
- C** Randomly in both directions
- D** Direction is irrelevant, as nucleotides are added independently
- E**  $5' \rightarrow 5'$





**29** Which statement about DNA replication in bacteria is CORRECT?



- A** Replication starts from multiple origins on the circular chromosome
- B** Replication initiates at a single origin, and two replication forks progress in opposite directions around the chromosome
- C** Replication proceeds only in one direction around the chromosome
- D** Replication is independent of helicase activity
- E** Replication requires telomerase to complete the ends of the chromosome

**30** A mutation abolishes the 3' → 5' exonuclease (proofreading) activity of a DNA polymerase but leaves its polymerisation activity intact. Which consequence is most likely?



- A** Replication speed increases with no change in accuracy
- B** Replication cannot initiate at origins of replication
- C** Replication continues, but the mutation rate during DNA synthesis increases
- D** Replication is impossible because primers cannot be removed
- E** The direction of DNA synthesis reverses to 3' → 5'





#	Ans	Answer Text
	B	
2	C	Each daughter DNA molecule contains one parental strand and one newly sy...
	A	
4	B	It requires a free 3' OH group to extend a pre-existing strand
	C	
6	B	Stabilise unwound DNA strands and prevent them from reannealing or formi...
	C	
8	B	Joining Okazaki fragments by forming phosphodiester bonds between adja...
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18	B	Replication of the very ends of linear chromosomes on the lagging strand
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20	C	Circular bacterial chromosomes usually have one main origin, whereas lin...
	B	
22	D	2n and 4C
	B	
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	A	
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	B	
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	B	
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