

### Thinking questions

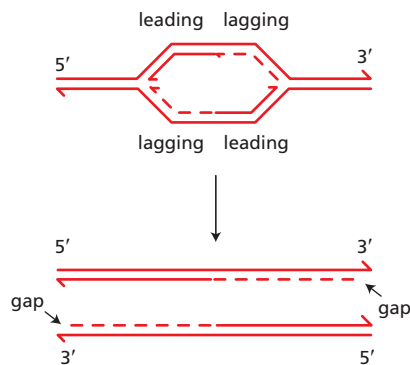
1. Which one of the following statements about the newly synthesized strand of a human chromosome is correct?
  - a. It was synthesized from a single origin solely by continuous DNA synthesis.
  - b. It was synthesized from a single origin solely by discontinuous DNA synthesis.
  - c. It was synthesized from a single origin by a mixture of continuous and discontinuous DNA synthesis.
  - d. It was synthesized from multiple origins solely by continuous DNA synthesis.
  - e. It was synthesized from multiple origins solely by discontinuous DNA synthesis.
  - f. It was synthesized from multiple origins by a mixture of continuous and discontinuous DNA synthesis.
  - g. It was synthesized from multiple origins by either continuous or discontinuous DNA synthesis, depending on which specific daughter chromosome is being examined.

**The correct answer is F. Each newly synthesized strand in a daughter duplex was synthesized by a mixture of continuous and discontinuous DNA synthesis from multiple origins. Consider a single replication origin. The fork moving in one direction synthesizes a daughter strand continuously as part of leading-strand synthesis. The fork moving in the opposite direction synthesizes a portion of the same daughter strand discontinuously as part of lagging-strand synthesis.**

2. The mechanism of DNA replication gives rise to the “end-replication problem” for linear chromosomes (=shortening of telomeres). Over time, this problem leads to loss of DNA from the ends of chromosomes. In cells such as yeast, loss of nucleotides during replication is balanced by addition of nucleotides by telomerase. In humans, however, telomerase is turned off in most somatic cells early in development, so that chromosomes become shorter with increasing rounds of replication. Consider one round of replication in a human somatic cell. Which one of the following statements correctly describes the status of the two daughter chromosomes relative to the parent chromosome?
  - a. One daughter chromosome will be shorter at one end; the other daughter chromosome will be normal at both ends.
  - b. One daughter chromosome will be shorter at both ends; the other daughter chromosome will be normal at both ends.
  - c. One daughter chromosome will be shorter at both ends; the other daughter chromosome will be shorter at only one end.
  - d. Both daughter chromosomes will be shorter at one end, which is the same end in the two chromosomes.
  - e. Both daughter chromosomes will be shorter at one end, which is the opposite end in the two chromosomes.

- f. Both daughter chromosomes will be shorter at both ends.

**The correct answer is E. The two daughter chromosomes will be shorter at opposite ends. This outcome is illustrated below, which shows replication from a single origin to the ends of the chromosome. (Multiple origins make no difference to the outcome.) The leading strand can continue all the way to the end of the chromosome, but the lagging strand cannot. The very last RNA primer cannot be replaced by DNA because there is no upstream primer for DNA polymerase to extend.**



### **Multiple Choice Questions**

- Which of the following enzymes removes supercoiling in replicating DNA ahead of the replication fork?
  - DNA polymerases
  - Helicases
  - Primases
  - Topoisomerases

**The correct answer is D**

- The NHEJ pathway is used to rectify \_\_\_\_\_ in the DNA.
  - nucleotide substitutions
  - double-strand breaks
  - single-strand breaks
  - mismatched base pairs

**The correct answer is B**

- Which of the following mechanisms will remove uracil and incorporate the correct base?
  - Direct repair
  - Base excision repair
  - Mismatch repair
  - Nucleotide excision repair

**The correct answer is B**

4. Which of the following statements is correct about telomeres?
- Telomeres exist in all DNA in eukaryotes, including that of mitochondria
  - The shortening of telomeres caused by DNA replication is accountable for ageing of cells
  - Telomerase activity is usually decreased in cancer cells
  - Telomeres contain RNA as their indispensable component
  - Telomerase is capable of transcribing DNA into RNA

**The correct answers are A, C, D and E**

5. Site-specific recombination can serve as a powerful tool in molecular biology, such as Cre/LoxP system. Which of the following statements is incorrect?
- Cre/LoxP system enables tissue-specific knockout of the gene of interest
  - Only one LoxP site on either side of the gene of interest would be enough
  - In cells in which Cre is expressed, there will be no expression of the gene of interest, if it is surrounded by loxP sequences
  - It is important to integrate the gene of Cre recombinase downstream of specific promoters to ensure tissue-specific express of Cre

**The answer is B**

6. Pyrimidine dimers represent molecular lesions originating from thymine or cytosine bases within DNA, resulting from photochemical reactions such as UV radiation. Which DNA repair system is involved in repairing this kind of lesion?
- Base excision repair
  - Nucleotide excision repair
  - NHEJ pathway
  - Homologous recombination

**The correct answer is B**

7. Which of the following statements is INCORRECT about DNA replication?
- DNA replication in prokaryotes can initiate anywhere because they typically have one circular chromosome
  - Eukaryotes have a lot of origins to initiate DNA replication, but different cells in the same organism may use different origins
  - Nucleosomes need to be disassembled so that the replication fork can move forward
  - Both new DNA and new histones are majorly synthesized during the S-phase of the cell cycle

**The answer is A**

**TRUE or FALSE**

1. Multiple enzymes are involved in nucleotide excision repair, including DNA polymerase and helicase.

**TRUE or FALSE**

2. In bacteria the origin of replication usually has CG-rich DNA sequence.

**TRUE or FALSE**

3. DNA methylation is very important to control the reinitiation of DNA replication of prokaryotes.

**TRUE or FALSE**

4. Telomerase contains a small DNA sequence as the template for DNA synthesis.

**TRUE or FALSE**

5. Aberrancy in one kind of DNA repair system does not cause serious outcomes because cells have other DNA repair systems.

**TRUE or FALSE**

6. Non-homologous end joining is generally not so accurate and can introduce mutations.

**TRUE or FALSE**

7. During meiosis, homologous recombination always leads to chromosomal cross-overs

**TRUE or FALSE**