

Get Ready to Crack CSIR-NET 2021 (Most Important Questions On Replication)



1. Following are some statements about chromosomal DNA of eukaryotes:

I. Conserved synteny is the occurrence of the same genes in two evolutionarily distant organisms irrespective of their order on the chromosome.

II. In humans, sex chromosomes in males are the only non-homologous chromosome pairs.

III. Conserved regions represent functionally essential exons and regulatory sequences in a genome.

IV. A linear chromosome must contain a centromere, two telomeres and multiple origins of replication sites.

Which of the above statement(s) is INCORRECT?

A. I and III

B. Only I

C. Only II

D. III and IV

2. In *Staphylococcus aureus*, chromosomal DNA replication starts at

A. Random single locus

B. Random multiple loci

C. One specific locus

D. Multiple specific loci

3. When a DNA sequence is inserted into another without relying on sequence homology, the event is known as:

A. Homologous recombination

B. Transposition

C. Site-specific recombination

D. Recombinatorial repair

4. Lampbrush chromosomes are meiotically paired chromosomes, extensively found in growing amphibian oocytes. Some statements about this unusual structure are given below:

- I. Large chromatin loops emerge out in a series from a linear chromosomal axis.
- II. Most of the newly replicated DNA forms highly condensed loops emerging from the axis.
- III. Each cell contains four copies of each loop.
- IV. Genes present in loops are actively expressed.

Which of the above statement(s) is INCORRECT?

- A. Only II
- B. II and III
- C. Only III
- D. I and IV

5. In *Escherichia coli*, replicon is circular and replication occurs bidirectionally. Some statements made on the biochemistry of *E coli* DNA replication are given below:

- I. Initiation step is facilitated by DnaA, SSB, DnaB, DnaC and DnaG.
- II. Elongation of chain requires DNA polymerase only.
- III. Termination and segregation of daughter strands require terminus binding protein and DNA topoisomerase IV.
- IV. Another name of *E coli* DNA replication is theta replication.

Which of the above statement(s) is INCORRECT?

- A. II and IV
- B. Only IV
- C. Only II
- D. I and III

6. Match the following eukaryotic DNA polymerases with their functions:

- A. a-v, b-i, c-iii, d-vi, e-iv
- B. a-ii, b-i, c-iii, d-v, e-vi
- C. a-v, b-vi, c-ii, d-iv, e-iii
- D. a-ii, b-ii, c-i, d-vi, e-v

7. Dichotomous replication takes place in

- A. Homo sapiens
- B. Escherichia coli
- C. Arabidopsis thaliana
- D. Saccharomyces cerevisiae

8. DnaB helicase is required for the unwinding of DNA at replication fork in *E. coli*. Some statements on the fidelity of DnaB are given below:

- I. Unwinding involves ATP hydrolysis because energy is required to melt DNA
- II. DnaB helicase takes a ring-shaped conformation and dsDNA moves through the hole.
- III. SSB protein inhibits DnaB helicase mediated unwinding if added after DnaB has bound the template.
- IV. DnaB helicase binds to the leading-strand template DNA

Which of the above statement(s) is CORRECT?

- A. I and II
- B. Only III
- C. I and IV
- D. II, III and IV

9. Which of the following enzyme removes the last ribonucleotide of primer after DNA replication in eukaryotes?

- A. RNaseH
- B. Flap endonuclease
- C. DNA helicase
- D. DNA primase

10. Displacement replication occurs in

- A. Yeast
- B. Mammalian nuclear DNA
- C. Prokaryotes
- D. Mammalian mitochondrial DNA

ANSWER

1. B

6. C

2. C

7. B

3. B

8. A

4. A

9. B

5. C

10. D

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Solutions:

1. Conserved syntenicity is occurrence of same genes in two evolutionarily distant organisms in the same order. For example, comparative studies of mouse and human genomes have found many large blocks of genome contains same genes occurring in same order. Second statement is correct as all chromosome pairs except sex chromosomes in males are homologous. In humans, males inherit X chromosome from the mother and Y chromosome from the father, which are non-homologous. Third statement is also correct because exons and regulatory elements are functionally essential part of a gene while introns might vary because they have to be spliced out. Fourth statement stands true for eukaryotic chromosomes, which possesses a centromere for adhering kinetochore, two telomeres for protection of chromosomal ends and multiple replication origins for efficient replication of huge genome.

2. Bacterial chromosomal DNA have single origin of replication, thus replication cycle starts at one specific locus at a time. Eukaryotes have multiple *ori* sites, so replication may start at multiple locus in them. DNA replication does not start at random sites but at specific location known as origin of DNA replication.

3. Transposition is a related to the process of recombination but it allows movement of certain element from one chromosomal location to another without relying on sequence homology. While homologous recombination, as the name suggests, occurs between two homologous DNA molecules and site-specific recombination involves short regions of similar nucleotide sequences. Recombinatorial repair uses homologous single strand DNA from another dsDNA for filling gaps after DNA replication.

4. Lampbrush chromosomes are visible as organized series of large chromatin loops emerging from a linear chromosomal axis. Second statement is incorrect because most of the newly replicated DNA forms highly condensed chromomeres on the axis, and not loops. Also these chromomeres are not

generally expressed. Each of the two chromosomes consists two closely apposed newly replicated chromosomes, thus, each cell contains four copies for each loop. And most of the genes present in DNA loops are actively expressed, therefore, loops are precisely defined and organised structural units of a lampbrush chromosome.

5. Initiation step of replication in *E. coli* is facilitated by a replication initiation factor DnaA, single-stranded DNA binding protein SSB, DNA helicase DnaB, loading factor DnaC and primase DnaG. Second statement is incorrect because elongation not only requires DNA polymerase for chain elongation but also needs SSB for stabilizing unwound single stranded DNA, DNA ligase for joining Okazaki fragments and DNA gyrase to relieve positive supercoiling. While termination step requires terminus binding protein and DNA topoisomerase IV. And *E. coli* DNA replication is also known as theta replication.

6. DNA polymerase β is required for base excision repair, while DNA polymerase γ is involved in mitochondrial DNA replication. DNA polymerase δ synthesizes lagging-strand, while DNA polymerase ϵ synthesizes leading-strand. DNA polymerase κ is required for cohesion attachment.

7. In *Escherichia coli* cell, approximate 40 minutes are required for chromosome replication while the generation time is only 20 minutes. To achieve this doubling time, a second round of replication is initiated before termination of previous one. Thus, almost six replication forks may be active on a single chromosome. This is known as dichotomous replication. While on human, Arabidopsis and budding yeast multiple origin of replication sites are present, multiple replication forks on a single chromosome is a common event.

8. Unwinding is an energy consuming process because hydrogen bonds are kinetic barrier to strand separation, thus, it requires ATP hydrolysis. DnaB helicase forms a ring-shaped structure around DNA strand to ease the movement across replication fork. Third statement is incorrect because SSB protein inhibits DnaB helicase mediated unwinding, if added before DnaB has

bound the template because SSB binds to ssDNA and prevents binding of helicase. And DnaB binds to lagging-strand template DNA, not the leading-strand.

9. In eukaryotes, when primers are removed by RNaseH, the last nucleotide is removed by a specialised enzyme, flap endonuclease. While DNA helicase and primase are required for unwinding and adding primers to facilitate DNA replication, respectively.

10. Replication of circular double stranded mitochondrial DNA starts only in one of the two parental strands and proceeds for a short distance, then displaces the original complementary strand. This generates a displacement loop, hence displacement replication. Yeast, mammalian nuclear DNA and prokaryotes do not form displacement loop during replication.

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