Exercise session: DNA technologies

1. Which of the following is not a correct statement about third-generation sequencing?

a) A single DNA molecule is sequenced on its own.
b) Different bases interrupt an electric current for a particular length of time.
c) DNA moves through a small nanopore.
d) DNA must be cut into fragments or amplified.

2. Place the steps in a cycle of PCR (polymerase chain reaction) in the correct order:

1. Annealing—Cool to allow primers to form hydrogen bonds with ends of target sequence.
2. Extension—DNA polymerase adds nucleotides to the 3′ end of each primer.
3. Denaturation—Heat briefly to separate DNA strands.

a) 3, 1, 2
b) 3, 2, 1
c) 1, 2, 3
d) 2, 3, 1
e) 1, 3, 2

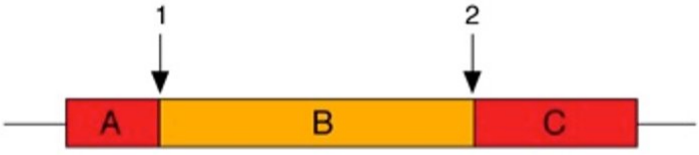
3. This segment of DNA is cut at restriction sites 1 and 2, which creates restriction fragments A, B, and C. Which of the following electrophoretic gels represents the separation of these fragments?

a

b

c

d



4. Which of the following tools and/or techniques would not be suitable as part of the molecular cloning of a particular gene?

a) restriction enzyme
b) plasmid
c) CRISPR-Cas9
d) PCR
e) DNA ligase

5. Which of the following techniques would not be directly suitable for determining the presence of a specific mRNA in a tissue sample?

a) RT-PCR
b) Cloning
c) RNA-seq
d) microarray

6. The coding strand of the human cancer gene BRCA1 contains the sequence 5′ ATG GAT TTA TCT GCT. What would be a suitable probe sequence to detect its mRNA expression via hybridization?

a) 5′ ATG GAT TTA TCT GCT
b) 3′ ATG GAT TTA TCT GCT
c) 5′ AGC AGA TAA ATC CAT
d) 3′ AGC AGA TAA ATC CAT
e) any of the above

7. In order for PCR to work, what must be true about the orientation of the two primers relative to the template DNA

a) The primers must be complementary to each other and to the template.
b) The primers' 5′ → 3′ orientations must go in the same direction when bound to the template.
c) The primers' 5′ → 3′ orientations must point toward each other when bound to the template.
d) The primers' 5′ → 3′ orientations must point away from each other when bound to the template.

8. During the synthesis of cDNA, what is the order of the molecules that are used and/or created (ss = single stranded; ds = double stranded)?

a) ssmRNA → RNA:DNA hybrid → ssDNA → dsDNA
b) dsDNA → RNA:DNA hybrid → ssDNA → ssmRNA
c) ssmRNA → ssDNA → RNA:DNA hybrid → dsDNA
d) ssmRNA → RNA:DNA hybrid → dsDNA → ssDNA
e) ssDNA → dsDNA → RNA:DNA hybrid → ssmRNA

9. The CRISPR-Cas9 system can be used for which of the following?

a) disable a normal gene in an organism
b) repair an abnormal gene in an organism
c) both a and b
d) neither a nor b

10. What is the most logical sequence of steps for splicing foreign DNA into a plasmid and inserting the plasmid into a bacterium?

I. Transform bacteria with a recombinant DNA molecule.
II. Cut the plasmid DNA using restriction enzymes (endonucleases).
III. Extract plasmid DNA from bacterial cells.
IV. Hydrogen-bond the plasmid DNA to non-plasmid DNA fragments.
V. Use ligase to seal plasmid DNA to non-plasmid DNA.

a) II, III, V, IV, I
b) III, II, IV, V, I
c) III, IV, V, I, II
d) IV, V, I, II, III

11. A principal problem with inserting an unmodified mammalian gene into a plasmid and then getting that gene expressed in bacteria is that _____.

a. prokaryotes use a different genetic code from that of eukaryotes
b. bacteria translate only mRNAs that have multiple messages
c. bacteria cannot remove eukaryotic introns
d. bacterial RNA polymerase cannot make RNA complementary to mammalian DNA

12. Which of the following methods would be most successful in attempting to introduce a particular piece of DNA into an animal cell?

a. electroporation followed by recombination
b. introducing a plasmid into the cell
c. infecting the mouse cell with a Ti plasmid
d. transcription and translation

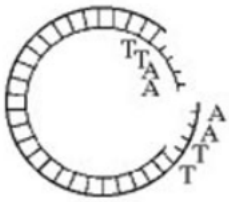
13. Why is it so important to be able to amplify DNA fragments when studying genes?

a) Before amplification, DNA fragments are likely to bind to RNA and would no longer be able to be analyzed.
b) A gene may represent only a millionth of the cell's DNA and have extremely low abundance in an environmental sample.
c) Restriction enzymes (endonucleases) cut DNA into fragments that are too small.
d) A clone requires multiple copies of each gene per clone.

14. Which of the following characteristics of Taq polymerase make it useful in the PCR process?

a) It is heat stable and can withstand the heating step of PCR.
b) Only minute amounts are needed for each cycle of PCR.
c) It binds more readily than other polymerases to the primers.
d) It has regions that are complementary to the primers.

15. Use the figure to answer the following question. Which of the following enzymes was used to produce the molecule of DNA in the figure?



a) ligase
b) a restriction enzyme (endonuclease)
c) RNA polymerase
d) DNA polymerase

16. Many identical copies of genes cloned in bacteria are produced as a result of which of the following processes?

a) plasmid replication
b) bacterial cell reproduction
c) transformation
d) plasmid and bacterial cell reproduction

17. Which of the following sequences is most likely to be cut by a restriction enzyme?

a) 5′-AATTCT 3′ and 3′-TTAAGA-5′
b) 5′-AATATT-3′ and 3′-TTATAA-5′
c) 5′-AAAATT-3′ and 3′-TTTTAA-5′
d) 5′-ACTACT-3′ and 3′-TGATGA-5′

18. Which of the following processes uses labeled probes to visualize the expression of genes in whole tissues and organisms?

a) RT-PCR
b) in situ hybridization
c) DNA microarrays
d) RNA interference