Please write ALL your answers in the answer sheets.
請在答案紙上作答。

1. A series of tRNAs have the following anticodons. Consider the wobble rules and give all possible codons with which each tRNA can pair.
   (A) 5'-GGC-3' (2%)
   (B) 5'-AAG-3' (2%)
   (C) 5'-IAA-3' (2%)

2. Which kind of DNA sequences is always found at the ends of a bacterial insertion sequence (IS)? (2%) Therefore, which of the following pairs of DNA sequences could qualify as the terminal ends of a bacterial IS element (2%):
   (A) 5'-GAATCCGCA-3' and 5'-ACGCCTAAG-3'
   (B) 5'-GAATCCGCA-3' and 5'-CTTAGGCGT-3'
   (C) 5'-GAATCCGCA-3' and 5'-GAATCCGCA-3'
   (D) 5'-GAATCCGCA-3' and 5'-TGCGGATTC-3'

3. An *E. coli* transcript with the first two nucleotides 5'-AG-3' is initiated from the following segment of double-stranded DNA:
   5' TAGTGTATTGACATGATAGAAGCACTCTTACTATAATCTCAATAGCTACG 3'
   3' ATCACATAACTGTACTATCTTCGTGAGAATGATATTAGAGTTATCGATGC 5'
   (A) Which DNA strand is the template strand? (2%)
   (B) Which DNA strand is the RNA-coding strand? (2%)
   (C) Where is the transcription start site? (2%)
   (D) What are the approximate locations of the regions that bind the RNA polymerase holoenzyme? (2%)
   (E) Does transcription elongation proceed towards the right or left? (2%)

4. Give the name of enzyme or protein involving the following event: (10%)
   (A) Prevents supercoiling ahead the replication fork during DNA replication. _____
   (B) Catalyzes the attachment of amino acids to tRNA molecule. _____
   (C) Catalyzes the formation of a peptide bond between the amino acid in the A site of the ribosome and the growing polypeptide chain during translation. _____
   (D) Plays a critical role in sister chromatids alignment. _____
   (E) Recognizes the sequences at the ends of eukaryotic chromosomes and prevents chromosome shortening with each round of DNA replication. _____

5. List two similarities and three differences between DNA replication and transcription. (10%)

6. What are the components of eukaryotic ribosomal subunits? (8%) Where does the assembly of the subunits occur within living cells? (2%)

7. (2%) Adenosine is a
   a. component of RNA.
   b nucleotide.
   c. pyrimidine.
   d. a and b
   e. all of the above

8. (2%) Which of the following are removed from mRNAs during processing?
   a. RNA cap structure
   b. poly(A) tail
   c. exons
   d. noncoding sequences

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9. (2%) Which of the following enzymes will produce a blunt end (the cut site is indicated by the * in the recognition sequence)?
   a. *Eco*RV (GAT*ATC)
   b. *Nsi*I (ATGCA*T)
   c. *Taq*I (T*CGA)
   d. *Eag*I (C*GGCCG)

10. (2%) The polymerase chain reaction (PCR) technique can be used for
   a. direct isolation of a specific segment of genomic DNA.
   b. synthesis of RNA from genomic DNA.
   c. preparation of probes.
   d. a and c
   e. all of the above

11. (2%) Which of the following method(s) can be used to functionally inactivate a gene without altering its sequence?
   a. gene knockout
   b. RNA interference
   c. dominant negative mutation
   d. b and c
   e. all of the above

12. (2%) In RNA interference studies, the double-stranded RNA
   a. disrupts the target DNA sequence.
   b. results in the destruction of the target mRNA.
   c. destroys the target protein.
   d. all of the above

13. (2%) Which process involves two transesterification reactions?
   a. splicing
   b. RNA editing
   c. capping
   d. nuclear transport

14. (2%) The branch point A residue involved in lariat formation is part of the
   a. intron.
   b. exon.
   c. 5′UTR.
   d. 3′UTR.

15. (2%) RNA editing is
   a. post-transcriptional alteration of sequences in mRNAs.
   b. pretranscriptional alteration of sequences in RNAs.
   c. post-transcriptional joining of two RNA molecules.
   d. none of the above

16. (2%) microRNAs play a key role in which of the following?
   a. translational repression
   b. viral RNA degradation
   c. RNA interference
   d. all of the above

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17. (2%) All of the following are known to involve a Ca^{2+}-activated, vesicle-mediated secretory event EXCEPT
a. synaptic transmission
b. elevation of the fertilization membrane of the sea urchin
c. release of histamine from mast cells
d. sperm acrosomal reaction
e. constitutive secretion of collagen

18. A graduate student uses restriction enzymes to digest a 4-kb DNA molecule with *Xho*I, yielding two fragments of 0.5 kb and 3.5 kb each. Digestion of the same molecule with *Hind*III yields fragments of 1.5 kb and 2.5 kb. Finally digestion with *Xho*I and *Hind*III in combination yields fragments of 0.5 kb, 1.5 kb, and 2 kb. Draw a restriction map indicating the positions of the *Xho*I and *Hind*III cleavage sites (4%).

19. A graduate student is studying a regulatory element of a gene that normally is expressed only in neurons. Constructs with this regulatory element linking to a reporter gene are expressed in neurons but not in fibroblasts. However, when mutating a specific sequence within this regulatory element, that student finds expression in both fibroblasts and neurons. What types of regulatory protein could bind to the specific sequence? (2%) Design an experiment to verify your hypothesis with appropriate controls. (4%)

20. A graduate student is studying a transcriptional factor that is regulated by phosphorylation of serine residues that inactivate its nuclear localization signal and decrease expression level of its target gene. How would mutating these serines to alanines affect subcellular localization of the transcriptional factor and expression of its target gene? Why? How would mutating these serines to glutamates affect subcellular localization of the transcriptional factor and expression of its target gene? Why? (8%)

21. Why are the carbohydrate groups of glycoproteins always exposed on the surface of the cell? (2%)

22-24. A graduate student generates a library of plasmids containing 12 kilobase (kb) inserts from the genome of a bacterium by partially digesting the bacterial genomic DNA with *BamH*I and cloning the resulting fragments into the *BamH*I site of a plasmid vector. The student must then identify the plasmids carrying the *purB* gene. To do this, five of the plasmids from the library are digested with *BamH*I and the digests are separated by gel electrophoresis (Figure 1). In the following experiment, the same five plasmids are analyzed by PCR using primers derived from sequences internal to the *purB* gene and electrophoresis is performed on the PCR products (Figure 2). Both gels are stained with SYBR green to visualize the DNA.

Figure 1. Electrophoresis of digests

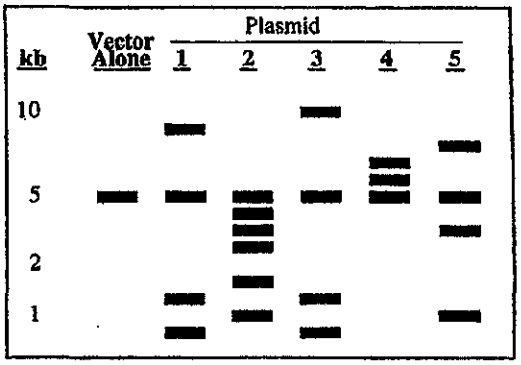
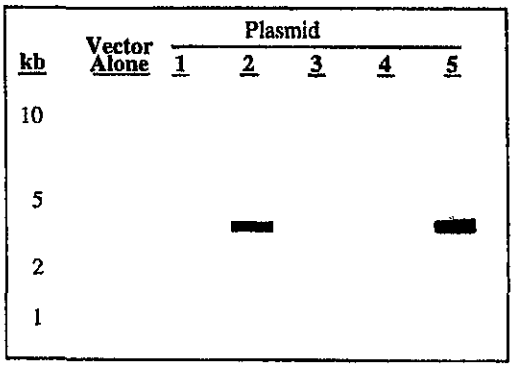


Figure 2. Electrophoresis of PCR products



22. (2%) Which of the following pairs of plasmids may contain the overlapping inserts?
a. 3 with 4 only.
b. 3 with 5 only.
c. 1 with 2 and 3 with 4 only.
d. 1 with 3 and 2 with 5 only.
e. All of the inserts may overlap.

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23. (2%) The part of the *purB* gene complementary to the *purB* primers is contained in which of the following plasmids?
a. 2 only.
b. 5 only.
c. 2 and 5 only.
d. 1, 3 and 4 only.
e. 1, 2, 3, 4 and 5.

24. List two alternative methods (other than the method used in Figure 2) to determine which plasmids may contain the *purB* gene? (4%)

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