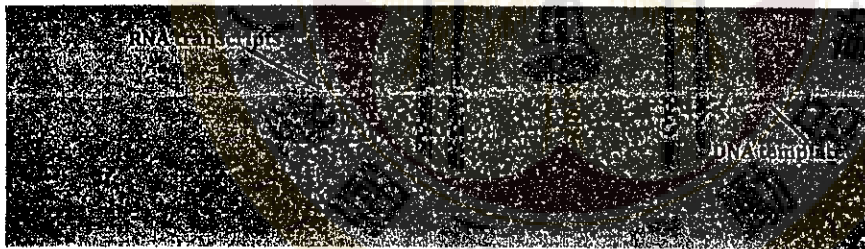


※ 注意：請用 2B 鉛筆作答於答案卡，並先詳閱答案卡上之「畫記說明」。

- Which of the following are DNA sequences?
 - Promoter
 - Repressor
 - Operator
 - Enhancer
 - Activator
- When bacteria produce mammalian proteins, cDNA is used rather than genomic DNA. Which of the following is the best explanation?
 - It is easier to clone RNA than DNA.
 - It is not possible to clone the entire coding region of the gene.
 - It is easier to clone cDNA than genomic DNA of comparable size.
 - Most eukaryotic genes have introns that cannot be removed in bacteria.
 - Most eukaryotic gene promoters do not function in bacteria
- Below is an electron micrograph of a gene that is being transcribed. The DNA strand runs horizontally with RNA transcripts extending vertically outward.



- What is the direction of movement of RNA polymerases along the length of DNA strand?
- Upward
 - Downward
 - Rightward
 - Leftward
 - Can't be determined
- Which of the following statements are true?
 - Bacterial mRNA normally occurs as a double-stranded structure, with one strand containing codons, the other containing anticodons.
 - Bacterial mRNA is broken down within a few minutes of its formation in *E. coli*.
 - Bacterial mRNA consists only of the bases that code for amino acids.
 - The three ribosomal RNAs in a bacterial ribosome are distributed in three separate, large ribosomal subunits.
 - Bacterial mRNA can be translated while it is still being synthesized.

5. A microarray is a large collection of specific DNA oligonucleotides spotted in a defined pattern on a microscope slide. What is the most useful experiment that can be done with such a tool?
- (A) Evaluating the linkage relationships of genes
 - (B) Comparing newly synthesized nuclear RNA with cytoplasmic RNA to locate introns
 - (C) Comparing RNA produced under two different physiological conditions to understand patterns of gene expression
 - (D) Comparing proteins produced under two different physiological conditions to understand their function
 - (E) Predicting the presence of specific metabolites in a cell
6. Which of the following statements are true for the enzyme reverse transcriptase?
- (A) It is sensitive to high temperatures and so can be readily "killed" by heat treatment when the reaction is completed.
 - (B) It does not require a primer to initiate polymerization as do most DNA polymerases.
 - (C) It is insensitive to high temperatures and so can survive the many cycles of heating required to perform the polymerase chain reaction.
 - (D) It is an RNA-dependent DNA polymerase.
 - (E) It lacks the proofreading function of most DNA polymerases and so is able to utilize mRNA from mutated genes as a template.

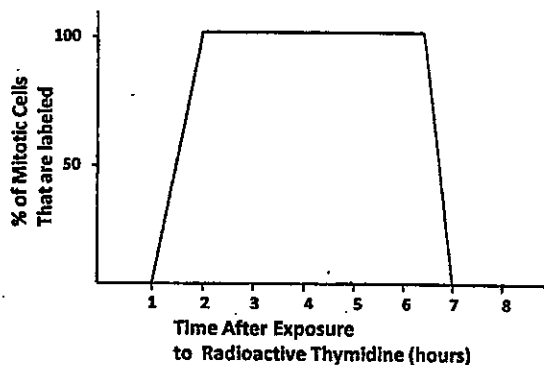
Questions 7-8 refer to the following organisms.

- (A) *E. coli*
 - (B) Yeast
 - (C) Retrovirus
 - (D) Bacteriophage lambda
 - (E) Adenovirus
7. Possesses genes that may be integrated into the genome of an infected eukaryotic cell
8. Can lysogenize bacteria

Questions 9-11

The stages of the cell cycle for a cultured mammalian cell line require the following periods of time: G1 = 8 hr, S = 5 hr, G2 = 1 hr, M = 1 hr. An asynchronous culture of these cells is exposed to radioactive thymidine for five minutes and then allowed to continue to grow in nonradioactive medium. The figure below shows the percent of mitotic cells that are radioactively labeled as a function of time after exposure to the radioactive thymidine.

9. The reason it takes approximately one hour before the first radioactively labeled mitotic cells are observed is that
- (A) cells must repair thymidine-induced DNA damage before entering G2
 - (B) the cells get out of synchrony as they proceed through the cell cycle
 - (C) the period of thymidine labeling is 5 minutes
 - (D) G2 lasts 1 hr
 - (E) M phase lasts 1 hr



10. What percent of labeled cells are in M phase at 4 hours after exposure to labeled thymidine?
- (A) 100
(B) 33
(C) 20
(D) 6
(E) 0
11. If the length of G₂ were increased by one hour, which of the following statements would be true regarding the slope of the line from the point of the first appearance of labeled mitotic cells to the first point at which all the mitotic cells were labeled?
- (A) It would stay the same.
(B) It would decrease.
(C) It would increase.
(D) It would switch from a positive to a negative slope.
(E) No conclusion regarding the slope of the line can be drawn.

Questions 12-13

The levels of incorporation of amino acids in an *in vitro* translation system under the direction of random adenosine (A) : cytosine (C) copolymers of two types, A : C = 5 : 1 and A : C = 1 : 5, were determined, and the results are shown below. The most frequently incorporated amino acid for each type of copolymer is given a value of 100. This value is then used to calculate relative incorporation of the other amino acids.

Amino acid	Incorporation of Amino Acids for A : C = 5 : 1	Incorporation of Amino Acids for A : C = 1 : 5
Asparagine	24.2	5.3
Glutamine	23.7	5.2
Histidine	6.5	23.4
Lysine	100	1.0
Proline	7.2	100
Threonine	26.5	20.8

12. The expected frequency of the triple CCC in the A : C = 1 : 5 copolymer should be
- (A) 1/8
(B) 5/6
(C) 7/8
(D) 15/216
(E) 125/216
13. Which of the following amino acid(s) appear to be coded by triplets containing 2 A's and 1 C?
- (A) Asparagine
(B) Glutamine
(C) Proline
(D) Threonine
(E) Lysine

Questions 14-20

In *E. coli*, when glucose is present, galactose is used to make a component of the bacterial cell wall. When glucose is absent, galactose is MOSTLY used to make energy, but a little is used to make the cell wall. The enzymes for the conversion of galactose into a cell wall component are transcribed as an operon. The operon is transcribed at a high level when glucose is present and at a low level when glucose is absent. In many organisms, this type of regulation is accomplished by having two promoters in front of the operon, one that is “strong”, meaning it causes a high level of transcription, and one that is “weak”, meaning it causes a low level of transcription. You isolate mutants that do not respond appropriately to the presence or absence of glucose, as summarized below. Assume each mutant has a single point mutation. Assume all mutations are disabling. The repressor is under its own promoter, and this promoter is not affected by any of the mutations.

strain	Galactose incorporation into cell wall	
	+ Glucose	- Glucose
Wild type	High	Low
Mutant 1	High	High
Mutant 2	High	High
Mutant 3	Low	Low
Mutant 4	None	None
Mutant 5	None	None

14. Which mutant would have a mutation in the “strong” promoter?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

15. Which mutant(s) would have a mutation in the repressor?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

16. Which mutant(s) would have a mutation in the operator?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

17. Which mutant(s) would have a mutation in the protein coding region?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

To determine which elements are cis-acting and which are trans-acting, you construct E. coli that is diploid for the DNA encoding this operon (merodiploid), and observe how the mutations behave. In this problem, the mutant number will correspond to the element that contains the mutation. An element in this problem can be a gene, promoter, operator, or a repressor. For example, mutant 1 would have a mutation in element 1. If the data indicated that mutant 1 has a mutation in an operator, then, that operator would be numbered 1. Measuring the activity of galactose incorporation into the cell wall, you observe the following results. A “+” means that the element corresponding to a particular mutant is wild type, whereas a “-” means that the element is mutated. For example, 3- 2+ means the DNA sequence has a mutation in element 3, is wild type in element 2, and all other parts of the operon and its regulatory elements are present and wild type on both DNA copies.

Strain	Incorporation of Galactose into cell wall	
	+ Glucose	- Glucose
$\frac{4^- 5^+}{4^+ 5^-}$	High	Low
$\frac{3^- 4^+ 5^+}{3^+ 4^- 5^-}$	Low	Low
$\frac{1^- 4^+ 5^+}{1^+ 4^- 5^-}$	High	High
$\frac{2^- 4^+ 5^+}{2^+ 4^- 5^-}$	High	Low

18. Which element(s) are cis-acting?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

19. Which element(s) are trans-acting?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

20. Which element is the repressor?

- (A) 1
- (B) 2
- (C) 3
- (D) 4
- (E) 5

21. Which of the following statements about "Transcription" is/are TRUE?
- (A) Transcription factors function to help move ribosomes along the mRNA.
 - (B) The release of pyrophosphate from a nucleoside triphosphate drives the reaction.
 - (C) RNA is synthesized from the 5' end to the 3' end.
 - (D) Transcription requires the use of a primer.
 - (E) DNA to RNA base pairing includes A to U and G to C.
22. In prokaryotic RNA synthesis
- (A) the rate of incorporation of nucleotides is constant throughout the elongation process
 - (B) the ρ (rho) protein is always required for termination
 - (C) a unique series of three bases leads to termination
 - (D) inverted-repeat sequences in the DNA being transcribed can lead to termination
 - (E) the sigma (σ) subunit stays with the RNA Polymerase throughout synthesis.
23. Which of the following statements about "the genetic code" is/are TRUE?
- (A) Some codons do not specify an amino acid.
 - (B) Some amino acids share the same codon.
 - (C) The first two nucleotides of a codon are often enough to specify a given amino acid.
 - (D) Nearly all organisms use the same genetic code.
 - (E) The initiation codon specifies methionine.
24. Which of the following elements can function as "eukaryotic promoters"?
- (A) a TATA box.
 - (B) an initiator element.
 - (C) CpG islands.
 - (D) an enhancer.
 - (E) silencers.
25. Which of the following is/are category for the gene product for an Oncogene?
- (A) Glycolytic enzyme.
 - (B) Transcription factor.
 - (C) Housekeeping gene.
 - (D) Nonreceptor protein kinase.
 - (E) Growth factor receptor.
26. A mutant bacterium is isolated. This bacterial strain has the characteristic of very slow, "sickly" growth. You isolate mRNA from this bacteria to use in an in vitro translation system and note that even in vitro it is difficult to use this message and obtain protein. Of the following, which is/are likely explanation for these results?
- (A) There may be a mutation in the ribosomal rRNA recognizing the Shine-Delgarno sequence of the message.
 - (B) In this mutant, the ribosomal subunits may not associate well enough for effective translation.
 - (C) This mutant may have altered tRNA molecules, such that the codon-anticodon interaction during translation is affected.
 - (D) These bacteria may not manufacture enough translation factors for effective translation.
 - (E) There may be a mutation in the Shine-Delgarno sequence of the DNA, resulting in a RNA that poorly binds the ribosome.

27. You are working with a gene associated with an essential pathway that is necessary at two time points in an organism's lifetime. With regard to gene regulation, you would expect the gene to be
- (A) associated with response to distinct events.
 - (B) not constitutive.
 - (C) "activated" by particular signals (induced).
 - (D) "turned off" by particular signals (repressed).
 - (E) None of the above.
28. In a histone protein, what modification(s) to lysine mark the nucleosome as a transcription target?
- (A) alkylation
 - (B) acetylation
 - (C) phosphorylation
 - (D) methylation
 - (E) ubiquitylation
29. microRNAs play a key role in which of the following?
- (A) repressed translation of the mRNA.
 - (B) degradation of viral RNA
 - (C) rapid translation of the mRNA.
 - (D) degradation of the mRNA
 - (E) repeated translation as the miRNA prevents destruction of the mRNA
30. Which of the following statements is/are TRUE?
- (A) Restriction endonucleases can cut DNA and RNA.
 - (B) It is common to use ddNTPs (dideoxyribonucleoside triphosphates) in DNA sequencing.
 - (C) Enzymes that seal nicks in DNA are called ligases.
 - (D) In recombinant DNA technology, a YAC is an enzyme isolated from a large South American four-legged mammal.
 - (E) The "c" in cDNA stands for Circular.
31. Which property of DNA is crucial for the conservation of genetic information?
- (A) antiparallelism
 - (B) semiconservative replication
 - (C) the ability to form a circular DNA
 - (D) base-pair complementarity
 - (E) The amount of A is the same as the amount of C
32. The ability of DNA to denature is important for which process?
- (A) DNA synthesis
 - (B) nucleic acid hybridization experiments
 - (C) RNA synthesis
 - (D) PCR reaction
 - (E) DNA separation by agarose gel electrophoresis

33. Which of the following is required for both DNA replication and RNA transcription?
- (A) DNA
 - (B) primers
 - (C) RNA polymerase
 - (D) phosphodiesterase
 - (E) topoisomerase
34. Which of the following mobile elements is a retrotransposon?
- (A) yeast Ty element
 - (B) bacterial IS sequence
 - (C) Drosophila P element
 - (D) maize activator (Ac) element
 - (E) RNA genome of influenza H7N9 virus
35. Which of the following is correct for the eukaryotic chromosomes?
- (A) The ends of eukaryotic chromosomes are called telomeres, and contain special repeat sequences, called telomeric sequences.
 - (B) Telomere terminal transferase containing the reverse transcriptional activity is important to maintain the chromosomal ends in eukaryotes.
 - (C) The centromeric sequences are important for proper chromosome segregation during replication.
 - (D) Kinetochores assemble at the centrosome.
 - (E) Telomerase activity declines with age and this could explain why cells lose their ability to divide after many replications.
36. For the DNA replication in *E. coli*, which of the following is correct?
- (A) The leading strand is initially synthesized as Okazaki fragments
 - (B) It has the DNA strand synthesized in a 5'-3' direction
 - (C) DNA polymerase I adds nucleotides to the primer strand
 - (D) The leading strand is synthesized continuously
 - (E) It synthesizes each strand in the opposite direction (one 5'→3', one 3'→5'), so they can be synthesized at once.
37. A mutation that changes the recognition sequence for the restriction enzyme *EcoRI* from GAATTC to GATTC is an example of a
- (A) restriction fragment length polymorphism (RFLP).
 - (B) single nucleotide polymorphism (SNP).
 - (C) simple sequence repeat (SSR).
 - (D) genetic heterogeneity
 - (E) none of the above

38. When a segment of DNA duplicates, causing two or more copies of a gene to be present in the chromosome, the most unlikely fate of the duplicate(s) would be
- (A) to lose function in subsequent mutation.
 - (B) to improve function in subsequent mutation.
 - (C) to gain a new function in subsequent mutation.
 - (D) to become a pseudogene.
 - (E) to become part of a gene family.
39. There are 45 different kinds tRNA (anticodons) available to serve as amino acid carriers, but there are 64 mRNA codons. Why aren't the tRNA anticodons and mRNA codons equal in number?
- (A) The reason is that the third base pair on the tRNA allows some flexibility (wobble); thus, some tRNA anticodons can recognize more than one mRNA codon.
 - (B) The reason is that some tRNA anticodons can misread some of the mRNA codons, which creates a "wobble" in the tRNA anticodons that can be repaired by RNA repair enzymes.
 - (C) The reason is that the third base pair on the mRNA codon allows some flexibility (wobble); thus, some tRNA anticodons can recognize more than one mRNA codon.
 - (D) The reason is that the tRNA has the flexibility to choose which mRNA codons are necessary for building the polypeptide chain.
 - (E) This broader recognition occurs because of the nonstandard pairing between bases in the wobble position corresponding to the 3' base in the mRNA and the complementary 5' base in the tRNA anticodon.
40. Which one of the following statements comparing the human and mouse genomes is false?
- (A) Human and mouse have about the same number of genes.
 - (B) The human genome shares 99% of its genes with the mouse.
 - (C) A comparison of genomes confirms that mouse and humans shared a common ancestor more recently than humans and pufferfish.
 - (D) Mitochondrial DNA is paternally inherited in both human and mouse.
 - (E) Little rearrangement of genes has occurred in the two genomes.

試題隨卷繳回