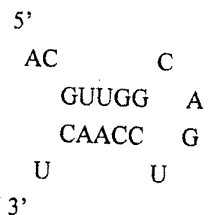


系所別: 生命科學系 科目: 分子生物學

Total 100 points

I. Single Choice (2 points each, total 60 points)

1. AU base pairs contain two hydrogen bonds and GC base pairs contain three hydrogen bonds in RNA molecule. For example RNA molecule 5'ACGUUGGCAGUCCAACU 3' will form the following stem-loop structure.



Please choose the following RNA molecule that will form stem-loop structure ?

- (A) 5'ACGUUUUGGGCAGUCCAACU 3'
- (B) 5'ACGUUGGCAGUCCUUCU 3'
- (C) 5'ACAGCUAGCUUUGUG
- (D) 5'AUGGCUAGGAAGUACCUAGCCGG 3'
- (E) 5'UAAGGUUCACCUG 3'

2. Preparation of labeled probes is an important step for Southern and Northern blot analysis. The following methods of *in vitro* labeling of nucleic acids for Southern and Northern transfer. Please choose the wrong statement.

Labeling method	Enzyme used	Template	Product	Structure at end of reaction
(A) 5' end labeling	Polynucleotide kinase	DNA or RNA	DNA or RNA	ds or ss
(B) 3' end labeling	Klenow	DNA or RNA	DNA or RNA	ds or ss
(C) 3' end labeling	Terminal transferase	DNA or RNA	DNA or RNA	ds or ss
(D) Nick translation	<i>E. coli</i> DNA polymerase I	DNA	DNA	ds
(E) Random priming	Klenow	DNA or RNA	DNA	ds

* ds: double stranded; ss: single stranded.

參考用

3. Approximate 30000 genes are identified after human genome project; however, more than 30000 genes are estimated to be expressed in human. Can any event explain this difference?

- (A) DNA recombination (B) RNA stability (C) alternative splicing (D) protein turn over and degradation (E) all of above

4. What can EST (expressed sequence tag) library tell or provide you?

- (A) look for expression profile (B) identify new genes (C) provide molecular markers (D) all of above (E)

注意: 背面有試題

系所別: 生命科學系 科目: 分子生物學

none of above

5. When you have a piece of DNA encoding an unknown protein and you can not find any sequence homology in the database, what is the most reasonable approach to identify the possible function of this gene?
(A) do site directed mutagenesis of this gene (B) do structure simulation of the protein (C) clone the promoter of this gene (D) manipulate the expression of this gene by transgenic approach (E) all of above
6. The C-value is defined as the total amount of DNA in the (haploid) genome of each living species. The C-value paradox describes our inability to account for the content of the genome in terms of known functions. For instance, rice and maize are very closely related grass species without apparent difference in complexity. The genome size of maize, however, is approximately nine-fold larger than the rice genome. Which of the following statements are correct?
(1) When compared prokaryotes and eukaryotes, there is generally an increase in the C-values as the complexity increases.
(2) The variation of the C-values of species in the same phylum is usually narrow
(3) The presence of higher amount of repetitive sequences in maize than that in rice could account for the genome size difference
(4) The number of genes predicted from human sequence data (109 bp) is about 5-10 times as many as that of the model weed plant *Arabidopsis thaliana* (107 bp)
(A) 1, 2, 3, 4 (B) 1, 2, 3 (C) 1, 3, 4 (D) 1, 2 (E) 1, 3
7. Viruses are parasites capable of infecting animals, plants and microbes. Which of the following descriptions about viruses are incorrect?
(1) Replication of virus genomes follows the central dogma, which describes the unidirectional transfer of genetic information from DNA to RNA and then into protein
(2) Due to their obligated parasitism, viruses are very unstable outside their hosts
(3) Viruses all have coat protein shells as well as envelop structures protecting their genomic nucleic acids.
(4) Viral pathogens of animals and plants are capable of replicating in animal or insect vectors without causing deleterious effects on them.
(A) 1, 2, 3, 4 (B) 1, 2, 3 (C) 1, 3, 4 (D) 1, 2, 4 (E) 2, 3, 4
8. Protein expression is an important parameter monitoring gene's function. One of the following techniques is not used in studying protein:
(A) ELISA
(B) Western analysis
(C) HPLC
(D) FISH
(E) 2-dimentional electrophoresis

系所別: 生命科學系 科目: 分子生物學

9. Which one of the following genetic codons is stop codon ?
(A) AGT (B) TGC (C) TAG (D) GAT (E) TTA
10. Bovine spongiform encephalopathy (BSE), widely known as "mad cow disease," is a chronic, degenerative disease affecting the central nervous system of cattle. Prion is now considered to be the possible causative agent of BSE. What is the biochemical property of it ? (A) polyketide (B) polypeptide (C) polynucleotide plus polypeptide (D) polydeoxynucleotide plus polypeptide (E) lipid plus polydeoxynucleotide
11. Which of the following descriptions about *E. coli* DNA replication is **incorrect**?
(A) DNA polymerase I has both 3'→5' and 5'→3' exonuclease activities
(B) Many of the mutational "hot spots" contain a 5-methylcytosine residue
(C) Deamination of 5-methylcytosine yields uracil
(D) Klenow fragment of DNA polymerase I has no 5'→3' exonuclease activity
(E) DNA polymerase III itself has no proofreading activity
(F) *E. coli* genome contains ~4,600,000 base pairs
12. Which of the following proteins is **not** essential for lagging strand synthesis?
(A) DNA ligase
(B) DNA polymerase III
(C) DNA polymerase I
(D) Primase
(E) ribonuclease H.
13. Which of the followings is **not** the biological function of *E. coli* DNA gyrase?
(A) It is inhibited by novobiocin
(B) It cuts two DNA strands at a time
(C) It can introduce positive supercoils into newly synthesized DNA
(D) The linking number change is 2 per reaction
(E) It is a type II topoisomerase and needs ATP for activity
(F) It can relax positive supercoils
14. Which of the following statements regarding the action of the DNA uracil repair system is **incorrect**?
(A) Uracil-DNA N-glycosylase removes uracil arising through deamination of cytosine
(B) Involves nick translation
(C) Needs DNA ligase
(D) Needs DNA gyrase
(E) Removes misincorporated uracil
15. Which of the following statements is **incorrect**?

參考用

注意：背面有試題

系所別: 生命科學系 科目: 分子生物學

- (A) *E. coli* genome is a covalently closed circular duplex DNA
(B) T4 phage genome is a linear duplex DNA
(C) HIV genome is a single-strand RNA
(D) T4 phage contains inverted repeat sequences at the ends of its genome
(E) Adenovirus DNA replication requires a terminal protein for initiation
(F) T4 phage DNA replication involves a special recombination process
16. HIV reverse transcriptase
(A) Is an DNA-dependent DNA polymerase
(B) Is an RNA-dependent RNA polymerase
(C) Has a high proofreading activity
(D) Uses tRNA as a primer
(E) Also exists in healthy human blood
(F) Is a monomer
17. Cordycepin is an antibiotic that
(A) Inhibits bacterial transcription initiation
(B) Inhibits bacterial translation initiation
(C) Inhibits eukaryotic transcription initiation
(D) Inhibits eukaryotic translation initiation
(E) Is 3'-deoxyadenosine
(F) Intercalates between adjacent G-C base pairs
18. D loops and variable loops are generally found in
(A) mRNA
(B) rRNA
(C) tRNA
(D) hnRNA
(E) snRNA
(F) DNA
19. Which of the following statements about tRNA is **incorrect**?
(A) tRNA has a high content of unusual and modified bases
(B) *E. coli* has ~ 40 different tRNAs
(C) The identity elements of most tRNAs are clustered in the anticodon loop and the acceptor stem
(D) The variable loop of tRNA is varied in nucleotide composition, but not in length
(E) tRNA was the first natural polynucleotide sequence to be determined
20. DNA polymerase β is believed to be involved in
(A) Eukaryotic DNA repair
(B) Mitochondrial DNA replication



系所別: 生命科學系 科目: 分子生物學

- (C) Chloroplast DNA replication
(D) Prokaryotic DNA synthesis
(E) Chloroplast DNA repair
21. DNA is synthesized in which of the following directions?
(A) In the 5' → 3' direction on the leading strand and 3' → 5' direction in the lagging strand
(B) In the 3' → 5' direction on the leading strand and the 5' → 3' direction on the lagging strand
(C) In the 5' → 3' direction on both DNA strands
(D) The direction differs depending on the genes being duplicated
(E) None of the above are correct.
22. Puromycin is an antibiotic that
(A) Inhibits prokaryotic peptidyl transferase
(B) Cause mRNA misreading via binding to the 30S subunit
(C) Interferes with aminoacyl-tRNA binding via binding to 30S subunit
(D) Inhibits eukaryotic peptidyl transferase
(E) Resembles the 3'-end of Tyr-tRNA
(F) Is a novel DNA replication inhibitor
23. Which of the following antibiotics should **not** be used to treat humans?
(A) Tetracycline
(B) Chloramphenicol
(C) Streptomycin
(D) Cycloheximide
(E) Erythromycin
24. Which of the following statements about translation in *E. coli* is **incorrect**?
(A) IF1 and IF3 promote dissociation of 70S ribosome
(B) IF2 helps attach initiator tRNA
(C) EF-Tu carries tRNA into the A site
(D) EF-G facilitates translocation
(E) EF-Ts participates in recharging EF-Tu with GTP
(F) Translocation of peptidyl-tRNA from A site to P site requires ATP as energy
25. Which of the following descriptions about translation initiation is **incorrect**?
(A) The AUG initiator codon with its bound tRNA^{Met} aligns with the A site of the 30S ribosomal subunit
(B) The initiator tRNA normally carries N-formylmethionine
(C) All prokaryotic proteins are synthesized with the same N-terminal residue, N-formylmethionine
(D) In most cases the formyl group is removed during chain elongation
(E) For many proteins the first methionine is cleaved off after translation

參考用

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系所別:

生命科學系

科目:

分子生物學

26. Which of the following descriptions about *lacZ* operon is **incorrect**?
- (A) The *lacZ* operon is transcribed as a long mRNA
 - (B) The *lacZ* operon mRNA contains 3 distinct open reading frames
 - (C) The *lacZ* operon mRNA contains 3 Shine-Dalgarno sequences
 - (D) The *lacZ* operon mRNA contains 3 AUG initiator codons
 - (E) Transcription of the *lacZ* operon can be induced by allolactose
 - (F) Transcription of the *lacZ* operon can be inhibited by glucose
27. Which of the following statements about genetic code is **incorrect**?
- (A) Francis Crick and Sidney Brenner demonstrated that the genetic code is nonoverlapping and unpunctuated
 - (B) Marshall Nirenberg used homopolynucleotides to decipher some of the genetic codes
 - (C) H. G. Khorana used synthetic triplets to decipher most of the genetic codes
 - (D) Occasionally, AUU, GUU, and UUG are used as the initiation codons
 - (E) The genetic code used in *E. coli* is almost identical to that used in humans
28. Which of the following descriptions about transcription in *E. coli* is **incorrect**?
- (A) RNA polymerase has a very high affinity for the open promoter complex
 - (B) The two conserved promoter sequences are called the -35 and the -10 region
 - (C) Not all mutations in the promoter region decrease promoter strength
 - (D) The contacts with -35 and -10 boxes involve polymerase α subunit
 - (E) A functional *E. coli* RNA polymerase is a multisubunit complex
 - (F) A single species of RNA polymerase catalyzes the synthesis of *E. coli* mRNA, tRNA, and rRNA
29. Which of the following is **incorrect**?
- (A) Each *E. coli* chromosome has only one replication origin
 - (B) *E. coli* DNA replication is bi-directional
 - (C) It requires ~0.7 hrs to complete *E. coli* genome replication
 - (D) It requires a minimum of ~0.7 hrs to complete an *E. coli* cell division
 - (E) Mammalian cells have $10^3 \sim 10^4$ replication origins per complete genome
30. Regarding λ phage gene expression, which of the followings is **incorrect**?
- (A) cI repressor is a dimer protein
 - (B) Cro can be considered an antirepressor because it antagonizes the action of cI in a very specific way
 - (C) cI repressor can be hydrolyzed by activated RecA protein
 - (D) Lytic and lysogenic infection is determined by the interactions between cI and Cro
 - (E) cI repressor also forms a heterodimer with Cro protein

參考用

系所別:

生命科學系

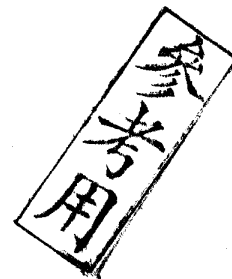
科目:

分子生物學

II. Matching Test (10 points)

31. Match each of the terms in the left column to the best-fitting phrase from the right column.

- | | |
|------------------------------|---|
| a. cosmid | 1. a DNA molecule used for transporting, replicating, and purifying a DNA fragment |
| b. vector | 2. contains genetic material from two different organisms |
| c. sticky ends | 3. an artificial chromosome containing centromere and telomere structural sequences from yeast |
| d. recombinant DNA | 4. DNA copies from RNA by reverse transcriptase |
| e. chromosome walking | 5. a lambda-plasmid hybrid vector able to contain large (45-kb) DNA fragments |
| f. YAC | 6. using a DNA probe from the end of one clone to isolate a clone containing adjacent chromosomal DNA |
| g. positional cloning | 7. way to clone a gene without prior knowledge of its function or the protein product |
| h. cDNA | 8. short single-stranded sequences at the ends of many restriction fragment |
| i. polymerase chain reaction | 9. a collection of the DNA fragments of a given species, inserted into a vector |
| j. RFLP | 10. single-stranded DNA with enough base pair complementarity to form double-stranded molecules |
| | 11. efficient and rapid technique for amplifying the number of copies of a DNA fragment |
| | 12. variation in the length of the restriction fragment detected by a particular probe |
| | 13. detection of genotype at a number of unlinked polymorphic loci using one probe |
| | 14. polymorphism in the three-dimensional conformation of a single-stranded DNA fragment |



系所別: 生命科學系 科目: 分子生物學**III. Question and Answer (5 points each; total 30 points)**

32. The gene for the A peptide (encoding ten amino acids) is completely contained on an *Nco*RI (5' C[^]CATGG 3') and *Eco*RI (5' G[^]AATTC 3') fragment, which can be cut out the larger fragment shown below. (The [^] symbol indicates the site where the sugar-phosphate backbone is cut by the restriction enzyme)
- 5' AAAGAATTC[^]TATCGAAAAAAGCACCTTGATGGATCCATGGCTG3'
3' TTTCTTAAGAATAGCTTTTTTTTCGTGGAACATACCTAGGTACCGAC5'
- What is the amino acid sequence of A peptide gene? (Please write three-letter abbreviation)
 - Indicate the direction of transcription of this gene.
33. *Arabidopsis* has a small genome size yet carries out the same functions as plants such as tobacco and pea that have genomes 50-100 times larger. How can *Arabidopsis* accomplish similar physiology with so little DNA?
34. The CDC28 protein of budding yeast *S. cerevisiae* and CDC2 protein of fission yeast *S. pombe* are protein kinase required at the "start" of the cell cycle. Both genes were identified by mutational analysis (temperature-sensitive mutations in each gene cause arrest in early G1) and both genes have been cloned. How could you determine if one could substitute for the other functionally? (Be sure to mention sources of DNA and genotypes involved.)
35. *DREB1A* is a transcriptional activator that turns on the expression of several cold responsive genes (*COR*) in plant cells. The *Ex* gene product inhibits *DREB1A* action. How could you determine if *Ex* acts by quenching *DREB1A* or blocking access to the enhancer? What differences would you expect to see experimentally?
36. (A) Describe the two-step reaction of aminoacylation
(B) How could protein synthesis be carried out with only 19 aminoacyl-tRNA synthetases in Gram-positive bacteria?
37. Answer the following questions related to Trp operon:
(A) It was found that the activities of the Trp enzymes varied over a 600-fold range under different physiological conditions. How could this regulation be achieved in *E. coli*?
(B) What would be the consequences of deleting the two tryptophan codons in the leader peptide of the Trp operon? Why?

