總分 100 分　單選題共三十三題　第一題至第三十二題每題三分　第三十三題四分

1. The DNA sequence is 5'AGGCTACTT3'
3'TCCGATGAA5'
The mRNA sequence created by transcription of this sequence is: 5'AGGCUACUU3'
   A. The upper DNA strand is the template strand
   B. The upper DNA strand is the coding strand
   C. The transcript has gone through RNA editing
   D. The lower DNA strand is the sense strand
   E. Both A and C are correct.

2. In translation of the genetic code, which of the following is correct:
   A. 62 of the 64 possible triplets code for 20 amino acids.
   B. 4 codons do not represent amino acids and cause termination.
   C. Most amino acids are represented by one codon.
   D. Multiple codons for an amino acid are usually not related.
   E. Related amino acids often have related codons, minimizing the effect of mutation.

3. Which of the following is the correct description of basic properties of transcription in prokaryotes?
   A. The -10 conserved region of the promoter is called the Shine-Dalgarno sequence.
   B. All genes in an operon have identical promoters.
   C. An operon consists of multiple genes in a related pathway, organized between a single promoter and terminator.
   D. Both A and C are correct.

4. Which of the following is an incorrect description of gene expression regulation?
   A. glucose prevents uptake of alternative carbon sources from the medium by E. coli.
   B. A repressor protein can regulate translation by preventing a ribosome from binding to an initiation codon.
   C. The precursor of microtubules, free tubulin protein, stimulates translation of tubulin mRNA.
   D. Termination of transcription can be attenuated by controlling formation of the necessary hairpin structure in RNA.
   E. MicroRNA regulates gene expression by base pairing with complementary sequences in target mRNAs.

5. Which of the following is an incorrect description of bacteriophages:
   A. Lytic bacteriophages may have ssRNA, dsRNA ssDNA, or dsDNA as genetic elements.
   B. Lamda DNA is integrated into the bacterial genome at the final stage in establishing lysogeny.
   C. A lysogenic phage confers immunity to further infection by any other phage with a different immunity region.
   D. The two immediate early genes of Lamda are transcribed by E. coli RNA polymerase.

6. Which of the following statement concerning chromatin structure is correct:
   A. DNA methylation is usually associated with activation of a gene.
   B. Histone acetylation is usually associated with inactivation of a gene.
   C. Survival of heterozygotes for imprinted genes is the different depending on the direction of the cross.
   D. Multiple strains of a prion protein have slight variation in their protein sequences and conformations.
   E. answers A and D are correct.

7. A "homeobox"
   A. encodes the transcription activation motif of proteins encoded by homeotic genes.
   B. is a common DNA sequence motif in the promoter regions of homeotic genes.
   C. is a cis-acting element in the promoter regions of genes regulated by homeotic genes.
   D. encodes the DNA binding motif of proteins encoded by homeotic genes.

8. Which of the following statement about splicing is FALSE:
   A. The GT-AG rule is used to predict intron donor and acceptor splice sites.
   B. Trans-splicing refers to an intermolecular splicing reaction between two RNAs.
   C. Introns are sequentially removed from the leftmost intron to the rightmost intron.
   D. snoRNA can methylate rRNAs.

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9. Which of the following is not a function of some type of RNA?
   A. carrying nucleotide sequence information
   B. metabolic energy transformation
   C. control of protein production
   D. translation of nucleotide sequence into amino acid sequence
   E. catalysis of chemical reactions

10. Considering that the production of immunoglobins involves an ordered series of events, of the actions listed below, which one must occur first?
   A. antigen binding
   B. somatic recombination
   C. allelic exclusion
   D. clonal expansion
   E. heavy chain assembly.

11. Which statement about normal cell cycles is FALSE:
   A. At G2 phase, the total DNA content of a cell is the greatest.
   B. Sister chromatids are held together by proteins called securins.
   C. Sister chromatids are released during anaphase by the activity of separin.
   D. Formation of the mitotic spindle requires prior duplication of the centrioles.

12. Mutations in which of the following domain in a receptor tyrosine kinase is lease likely to cause a dominant-negative effect:
   A. the ligand binding domain
   B. the tyrosine kinase domain
   C. the phopsphorylation site
   D. the target protein binding site

13. Apoptosis:
   A. occurs only when cells experience severe DNA damage
   B. can be suppressed by the tumor suppressor p53
   C. depends on both RNA and protein synthesis by the dying cell
   D. results in destruction of organelles while keeping the dying cells' nucleus intact

14. Which of the following terms could describe a situation in which there are multiple functional alleles of a gene segregating in a population?
   A. mutations
   B. polymorphism
   C. loci
   D. complementation
   E. recessive alleles

15. Which of the following statement about T-DNA is FALSE:
   A. T-DNA is a transposon of higher plants.
   B. For plant transformation, native T-DNA had been modified to introduce foreign genes into plant nuclear DNA.
   C. The T-DNA from Ti plasmid is transferred to plant nuclear DNA as a single-stranded DNA molecule initiated from a specific nick at the right border.
   D. Acetosyringone released from the plant upon wounding can be used to increase the efficiency of the T-DNA mediated plant transformation.

16. What form of the *E. coli* chromosome is capable of undergoing replication?
   A. nonmethylated DNA
   B. methylated DNA
   C. hemi-methylated DNA
   D. both A and B
   E. both A and C
   F. both B and C

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17. Which of the following activities CAN NOT be performed by E. coli DNA polymerase I
    A. 3'→ 5' exonuclease
    B. 5'→ 3' exonuclease
    C. 3' → 5' DNA synthesis
    D. 5' → 3' DNA synthesis
    E. both A and D
    F. both B and C

18. Which of the following statements about solute transport across plasma membrane is FALSE:
    A. Plasma membrane has a voltage difference across the membrane that favors the entry of cations.
    B. Plasma membrane contains channels to create water-filled path that permits ion to travel through the membrane.
    C. Active transport requires energy in the form of ATP or electrochemical gradient.
    D. Channels only allow ion bound to water to pass
    E. An antiporter is a carrier that transport one solute in one direction and a second solute in the opposite direction

19. In comparing homologous genes from different species, which statement is true?
    A. Gene length variation can be attributed primarily to exon length variation.
    B. Exon sequences vary more than intron sequences.
    C. Intron positions vary more than intron sequences.
    D. Exon length varies more than intron length.
    E. Intron sequences vary more than intron positions and exon sequences.

20. Which of the following method(s) can be used to map a genome?
    A. SNP
    B. transcriptome analysis using microarray
    C. zoo blot
    D. restrinction fragment length polymorphism
    E. A and D
    F. C and D

21. For the *E. coli* and mammalian chromosomes, DNA replication is:
    A. bi-directional and conservative
    B. bi-directional and semi-conservative
    C. unidirectional and conservative
    D. unidirectional and semi-conservative

22. Which of the following statement is FALSE:
    A. Minisatellite sequences can be used to establish the parental identities for an individual offspring.
    B. Horizontal transfer could explain why some genes homologous to bacterial genes, are found in vertebrates but not other eukaryotes.
    C. Nonautonomous transposable elements in Maize are moblilized only when an autonomous element of the same family is present in the genome.
    D. Many mitochondrial genome do not have rRNA genes.

Read the abstracts and answer the questions accordingly.

I. Coordinated Nuclear Import of RNA Polymerase III Subunits

Eukaryotic RNA polymerases are multisubunit assemblies, whose enzymatic function in the nucleus is intensively studied. However, little is known about the biogenesis of the three RNA polymerases and coupling to nucleo-cytoplasmic transport. Here, we show that Rpc128, the second largest subunit of RNA polymerase III, was mislocalized to the cytoplasm, when a short sequence in the N-terminal domain was deleted. Importantly, nuclear import of other, but not all, RNA polymerase III subunits was impaired in this *RPC128ΔN* mutant. These data suggest that RNA polymerase III subunits are not imported independently into the nucleus but may require preassembly into cytoplasmic subcomplexes for coordinated nuclear uptake. We expect these studies to be a starting point to dissect the complex biogenesis pathway of eukaryotic RNA polymerases.

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23. The purpose of the study is to:
    A. analyze the enzymatic functions of RNA polymerases.
    B. analyze the function of Rpc128 in the transcription activity of RNA polymerase III
    C. analyze how RNA polymerases are imported into the nucleus
    D. analyze where RNA polymerase is synthesized.

24. This paper has shown that:
    A. nuclear import of RNA polymerase III affect some other, but not all, RNA polymerases.
    B. RNA polymerase III is preassembled in the cytoplasm.
    C. a short segment in the N terminal domain in Rpc128 is necessary for its nuclear import.
    D. A, B, and C are all correct.
    E. A and C are correct.

25. Assuming that further work by the authors showed that Rcp128 actually travels through endoplasmic reticulum before entering the nucleus, what will be a defined piece of evidence to show that Rpc128 has gone through the endoplasmic reticulum:
    A. Rpc128 can be found in clathrin-coated vesicles.
    B. Rpc128 can be co-immunoprecipitated with a Rab protein
    C. Rpc128 can interact with ribosome.
    D. Rpc128 is glycosylated

II. Histone H1 Depletion in Mammals Alters Global Chromatin Structure but Causes Specific Changes in Gene Regulation

Linker histone H1 plays an important role in chromatin folding in vitro. To study the role of H1 in vivo, mouse embryonic stem cells null for three H1 genes were derived and were found to have 50% of the normal level of H1. H1 depletion caused dramatic chromatin structure changes, including decreased global nucleosome spacing, reduced local chromatin compaction, and decreases in certain core histone modifications. Surprisingly, however, microarray analysis revealed that expression of only a small number of genes is affected. Many of the affected genes are imprinted or are on the X chromosome and are therefore normally regulated by DNA methylation. Although global DNA methylation is not changed, methylation of specific CpGs within the regulatory regions of some of the H1 regulated genes is reduced. These results indicate that linker histones can participate in epigenetic regulation of gene expression by contributing to the maintenance or establishment of specific DNA methylation patterns.

26. What can be concluded from this paper:
    A. Mouse has 6 genes encoding H1.
    B. Depletion of H1 resulted in imprinting of some genes on the X chromosome.
    C. Depletion of H1 has only a small effect on global gene expression.
    D. microarray can be used to analyzed the extend of DNA methylation.

27. Which experimental tool is likely to have been used in this study:
    A. gene knock-out
    B. western blot analysis of protein amounts
    C. epigenetic crosses
    D. A, B and C
    E. A and B.

28. According to the paper, the effect of H1 depletion on gene expression was "surprising", because normally, as the level of structural organization of chromatin increases:
    A. the ability of the DNA to be transcribed decreases.
    B. the susceptibility of DNA to nucleolytic enzymes increases.
    C. the amount of core DNA per nucleosome increases.
    D. the structural periodicity decreases.
    E. answers A and D are correct

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III. RNA-mediated response to heat shock in mammalian cells

The heat-shock transcription factor 1 (HSF1) has an important role in the heat-shock response in vertebrates by inducing the expression of heat-shock proteins (HSPs) and other cytoprotective proteins1. HSF1 is present in unstressed cells in an inactive monomeric form and becomes activated by heat and other stress stimuli. HSF1 activation involves trimerization and acquisition of a site-specific DNA-binding activity, which is negatively regulated by interaction with certain HSPs. Here we show that HSF1 activation by heat shock is an active process that is mediated by a ribonucleoprotein complex containing translation elongation factor eEF1A and a previously unknown non-coding RNA that we term HSR1 (heat shock RNA-1). HSR1 is constitutively expressed in human and rodent cells and its homologues are functionally interchangeable. Both HSR1 and eEF1A are required for HSF1 activation *in vitro*; antisense oligonucleotides or short interfering (si)RNA against HSR1 impair the heat-shock response *in vivo*, rendering cells thermosensitive. The central role of HSR1 during heat shock implies that targeting this RNA could serve as a new therapeutic model for cancer, inflammation and other conditions associated with HSF1 deregulation.

29. The major function of HSF1 is:
    A. tumor suppression
    B. anti-inflammation
    C. inducing transcription of genes encoding HSP.
    D. increasing the activity of HSP.

30. What is required for HSF1 activation:
    A. transcription activation
    B. eEF1A
    C. siRNA against HSR1
    D. HSP
    E. All of the above.

31. What is the new finding reported by this paper:
    A. HSF1 trimerization is required for heat shock response in mammalian cells.
    B. RNA alone mediates heat shock responses in mammalian cells.
    C. a new therapeutic model for cancer is reported.
    D. a ribonucleoprotein complex is required for HSF1 activation

IV. Probing Gene Expression in Live Cells, One Protein Molecule at a Time

We directly observed real-time production of single protein molecules in individual *Escherichia coli* cells. A fusion protein of a fast-maturing yellow fluorescent protein (YFP) and a membrane-targeting peptide was expressed under a repressed condition. The membrane-localized YFP can be detected with single-molecule sensitivity. We found that the protein molecules are produced in bursts, with each burst originating from a stochastically transcribed single messenger RNA molecule, and that protein copy numbers in the bursts follow a geometric distribution. The quantitative study of low-level gene expression demonstrates the potential of single-molecule experiments in elucidating the workings of fundamental biological processes in living cells.

32. The purpose of the study is to:
    A. analyze the membrane protein targeting.
    B. analyze the translation efficiency.
    C. develop sensitive method to detect single protein molecular.
    D. develop new method to increase protein expression level.

33. What can be concluded from this paper:
    A. Before translation, some mRNA will be aggregated.
    B. Membrane targeting is important for high-level of expression.
    C. The membrane-localized YFP can't be detected when it is expressed at low-level.
    D. Protein synthesized from single messenger RNA molecule can be visualized in E. coli.
    E. All of the above.

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