國立中山大學102學年度碩士暨碩士專班招生考試試題

科目名稱：分子生物學【生科系碩士班乙組】　　題號：421003

※本科目依簡章規定「不可以」使用計算機　　

注意！請在答案卷上作答

一、選擇題每題1分(30%) 單選

1. The genomes of salamanders contain ten times more DNA than the genomes of humans because salamanders
   A. have ten times more genes than humans have.
   B. need more DNA so they can regenerate new limbs.
   C. have more noncoding DNA than humans have.
   D. are more complex than humans.
   E. have larger proteins than humans.

2. Introns in mRNA-coding genes are the transcribed sequences
   A. that code for proteins.
   B. that regulate mRNA translation.
   C. that are removed by nucleases.
   D. between protein-coding sequences.
   E. that code for the mRNA.

3. In the nucleus, introns are removed from transcripts by
   A. restriction nucleases.
   B. splicing.
   C. exonucleases.
   D. endonucleases.
   E. proteases.

4. The human genome is estimated to contain about _____ genes.
   A. 10,000–15,000
   B. 20,000–25,000
   C. 100,000–150,000
   D. 200,000–250,000
   E. 250,000–500,000

5. Introns are found
   A. only in prokaryotic genes.
   B. only in eukaryotic genes.
   C. commonly in both eukaryotic and prokaryotic genes.
   D. commonly in eukaryotic genes and rarely in prokaryotic genes.
   E. only in animal genes.

6. Histone genes have
   A. a single long intron.
   B. no introns.
   C. larger introns than exons.
   D. larger exons than introns.
   E. no exons.

7. Evidence for exon shuffling is that some genes
   A. are chimeras whose exon sequences are derived from other genes.
   B. produce loops when hybridized to their mRNAs.
   C. produce different proteins from the same gene.
   D. produce different mRNAs from the same gene.
   E. produce mRNAs with repeats of the same sequence.

8. Simple-sequence repeats
   A. sediment as unique bands in equilibrium density-gradient centrifugation.
   B. are present in tandem arrays of thousands of copies.
   C. reassociate more rapidly than nonrepeated sequences.
   D. All of the above
   E. None of the above

9. A gene family is a
   A. set of related but slightly different genes present in multiple copies in one individual.
   B. family of individuals with the same gene.
   C. set of slightly different genes present as one copy each in a set of individuals.
   D. family of individuals in which each has a slightly different sequence of the same gene.
   E. family of individuals in which each has an identical sequence of the same gene.

10. Pseudogenes are
   A. genes that code for an RNA but do not code for a protein.
   B. nonfunctional gene copies.
   C. inactive genes.
   D. repetitive DNA sequences.
   E. genes containing variant sequences.

11. The chromosomes of eukaryotes differ from those of prokaryotes in that eukaryotic chromosomes are
   A. linear.
   B. multiple.
   C. complexed with histones.
   D. Both b and c
   E. All of the above

12. The DNA of eukaryotic cells is wrapped around histones to form structures called
   A. nucleoli.
   B. nuclear matrices.
   C. nucleosomes.
   D. centromeres.
   E. centrosomes.

13. Which of the following is *not* part of the nucleosome core particle?
   A. Histone H1
   B. Histone H2A
   C. Histone H2B
   D. Histone H3
   E. Histone H4

14. Nuclease digestion of chromatin occurs at sites separated by approximately 200 base pairs because
   A. an AT-rich region occurs every 200 base pairs.
   B. nucleosomes are spaced 200 base pairs apart.
   C. a restriction nuclease site occurs every 200 base pairs.
   D. one turn of the DNA around a nucleosome consists of 200 base pairs.
   E. two turns of the DNA around the nucleosome consists of 200 base pairs.

15. Heterochromatin consists of

A. DNA associated with nucleosomes.
B. 10-nm chromatin fibers.
C. decondensed, transcriptionally active chromatin.
D. highly condensed, transcriptionally inactive chromatin.
E. DNA associated with heterogeneous nuclear RNA.

16. Which of the following characteristics of DNA-dependent DNA synthesis is NOT the same for DNA-dependent RNA synthesis?
A. Synthesis requires a template.
B. Initiation involves the recognition of a specific DNA sequence.
C. Initiation of synthesis requires a primer.
D. Synthesis is catalyzed in the 5' to 3' direction.

17. Which of the following eukaryotic RNA polymerases is responsible for transcribing nearly all protein-coding genes?
A. RNA polymerase I B. RNA polymerase II C. RNA polymerase III
D. RNA polymerase IV

18. When does the s subunit dissociate from RNA polymerase?
A. After promoter clearance B. At the termination of transcription
C. Immediately after promoter binding D. Not until the enzyme is degraded

19. Which of the following eukaryotic RNA processing events does NOT occur in the nucleus?
A. Intron splicing B. Polyadenylation C. Degradation of mRNA D. RNA editing

20. A frameshift of an entire coding region of an mRNA is most likely to be caused by a
A. nonsense mutation. B. transition mutation.
C. single nucleotide deletion. D. a double nucleotide mutation of an insertion and a deletion.

21. The enzyme that catalyzes the activation of tRNA molecules is:
A. the ribosome. B. RNA polymerase. C. tRNA isomerse. D. aminoacyl-tRNA synthetase.

22. Which of the following is NOT true of the eukaryotic internal ribosome entry site (IRES)?
A. It is important for efficient translation of mRNA molecules lacking a 5' cap.
B. The eIF4F factor binds to this site.
C. They are never found in mRNA molecules containing a 5' cap.
D. It positions the mRNA start codon correctly on the 40S subunit.

23. Which of these stages of translation is most important to the fidelity of protein synthesis?
A. Formation of aminoacyl-tRNAs
B. Initiation of translation at an AUG codon
C. Translocation of the peptidyl-tRNA from the A site to the P site during elongation
D. Termination of translation at a STOP codon

24. A housekeeping gene is one that codes for a product that:
A. functions in removing dirt from the cell.
B. is expressed differentially based on the needs of the cell.
C. is expressed at a constitutive level.
D. functions exclusively in cell membrane maintenance.

25. Which one of the following bacterial translational proteins is NOT a GTP-binding protein?

A. IF-2 B. EF-Tu C. EF-G D. RF-1

26. Which of the following is NOT a common nucleosomal protein covalent modification that affects gene expression?
A. Phosphorylation B. Glycosylation C. Acetylation D. Methylation

27. The upstream activator sequences (UASs) of yeast are analogous to _____ in higher eukaryotes.
A. promoters B. TATA boxes C. operators D. enhancers

28. Adult stem cells are _____ cells, whereas embryonic stem cells are _____ cells.
A. pluripotent; totipotent B. unipotent; multipotent
C. multipotent; pluripotent D. multipotent; totipotent

29. Transcriptionally active chromatin tends to:
A. be devoid of nucleosomes. B. be deficient in histone H1.
C. contain sites hypersensitive to DNase I. D. all of the above.

30. Gene silencing refers to:
A. repression of gene expression by the absence of activator proteins.
B. repression of gene expression by the presence of repressor proteins.
C. the absence of gene expression due to its location in the genome.
D. all of the above.

二、選擇題每題1.5分(60%) 單選

1. A pseudogene is a
A. second copy of a gene that functions when the original copy becomes damaged.
B. gene that is unrelated in sequence to another gene but has the same function.
C. gene that evolved by gene duplication and the acquisition of mutations to yield a gene product that has a slightly different function from that of the original gene product.
D. gene that arose through gene duplication, but by acquiring mutations became nonfunctional.

2. A centromere is defined as a region of the chromosome that
A. is located at the ends of the chromosomes and plays a critical role in chromosome replication and maintenance.
B. is relatively decondensed and distributed throughout the nucleus.
C. is very highly condensed and resembles the chromatin of cells undergoing mitosis.
D. plays a critical role in ensuring the correct distribution of duplicated chromosomes to daughter cells during mitosis.

3. Which of the following statements about introns in the yeast *Saccharomyces cerevisiae* is true?
A. *S. cerevisiae* genes do not contain introns.
B. A small percentage of *S. cerevisiae* genes contain introns, and these introns are usually located near the beginning of the gene.
C. Most genes in *S. cerevisiae* contain introns.
D. Few *S. cerevisiae* genes contain introns, but those that do contain several.

4. The plant *Arabidopsis thaliana* contains significantly more genes than do *C. elegans* or *Drosophila*. Which of the following statements is true?
A. The large number of genes results from duplication of large segments of the *Arabidopsis* genome.
B. The large number of genes reflects a greater diversity of proteins.
C. Very few *Arabidopsis* genes are unique to plants.

D. *Arabidopsis* is the only plant for which the genome has been sequenced.

5. Two groups reported draft sequences of the human genome in 2001. Which of the following statements about these draft sequences is true?
A. The publicly funded team used a whole-genome shotgun sequencing approach.
B. The Celera Genomics team used an approach that had been used to sequence the yeast and *C. elegans* genomes.
C. Both groups reported sequences amounting to five megabases.
D. Both groups presented draft sequences that cover only the euchromatin portion of the genome.

6. The genomes of two unrelated people differ in approximately one out of every thousand bases. Most of this variation is in the form of
A. introns.
B. pseudogenes.
C. gene families.
D. single nucleotide polymorphisms (SNPs).

7. Which of the following statements is true of all known DNA polymerases?
A. They synthesize DNA in the 5′ to 3′ direction, and they require a preformed primer hydrogen-bonded to the template.
B. They synthesize DNA in the 5′ to 3′ direction, and they possess primase activity.
C. They require a preformed primer, and they possess helicase activity.
D. They synthesize DNA in the 3′ to 5′ direction, and they possess exonuclease activity.

8. Which of the following statements concerning elongation of DNA at the replication fork is *false*?
A. The leading strand is synthesized continuously in the direction of replication fork movement.
B. The lagging strand is synthesized in Okazaki fragments backward from the overall direction of replication.
C. The Okazaki fragments are joined by the action of DNA ligase.
D. Both strands are synthesized continuously at the replication fork.

9. DNA polymerase requires a primer and cannot initiate synthesis *de novo*. What serves as a primer for DNA replication?
A. Short fragments of DNA complementary to the template strand
B. A protein with a free OH group
C. Short fragments of RNA complementary to the template strand
D. The DNA forms a loop resulting in the formation of double-stranded hairpins at the end of the DNA molecule, and these hairpins serve as primers.

10. The twisting of the parental DNA strands around each other ahead of a replication fork is relieved by enzymes called
A. DNA helicases.
B. topoisomerases.
C. DNA ligases.
D. DNA polymerases.

11. Estimates of mutation rates for a variety of genes indicate that the frequency of errors during replication is much lower than would be predicted on the basis of complementary base pairing. Which of the following mechanisms accounts for the higher degree of fidelity?
A. Conformational changes in DNA polymerase
B. 3′ to 5′ exonuclease activity of DNA polymerase

C. Requirement of a primer for DNA synthesis by DNA polymerase
D. All of the above

12. Which of the following statements is *false* about pyrimidine dimers?
A. They are lesions in DNA caused by UV radiation.
B. They are formed between adjacent pyrimidines on a DNA strand.
C. Their formation blocks DNA replication and transcription.
D. They can be repaired by photoreactivation in human cells.

13. How does nucleotide-excision repair differ from base-excision repair?
A. Base-excision repair recognizes and removes single damaged bases, whereas nucleotide-excision repair is more general, recognizing many different kinds of lesions that distort the DNA molecule.
B. Nucleotide-excision repair reverses the chemical reaction that caused the lesion, whereas base-excision repair removes the damaged bases and replaces them with normal ones.
C. Only the base is removed in base-excision repair, whereas the entire nucleotide is removed in nucleotide-excision repair.
D. Base-excision repair requires no protein components and can occur by simple absorption of UV light, whereas nucleotide-excision repair requires several enzymes.

14. During mismatch repair in *E. coli*, the parental strand is recognized by
A. single-stranded breaks.
B. glycosylated adenines.
C. methylated adenines.
D. methylation of the O6 position of guanine residues.

15. A DNA recombination intermediate before its resolution into two recombined strands is called a(n)
A. Holliday junction.
B. RecBCD complex.
C. cross-over complex.
D. attachment site.

16. Which of the following does *not* contribute to the large variety of antigen-binding specificities found among the immunoglobulins?
A. Recombination between different versions of V, D, and J segments
B. Somatic hypermutation
C. Imprecise joining of immunoglobulin segments
D. Retrotranspons

17. Which of the following statements regarding somatic hypermutation is *false*?
A. The enzyme activation-induced deaminase (AID) is a key player in somatic hypermutation.
B. Somatic hypermutation is thought to be the result of a high frequency of errors during DNA repair.
C. Somatic hypermutation is thought to control the proliferation of B lymphocytes by rendering their genome irreplicable.
D. Somatic hypermutation substantially increases affinity for antigen.

18. Which of the following statements about bacterial transposons are *false*?
A. Insertion sequences range from 800–2000 nucleotides.
B. The insertion sequence contains a gene that encodes the enzyme transposase.
C. An RNA intermediate is required to shuttle the DNA into a new location.
D. The transposase cleaves target DNA with single-strand overhangs.

19. Retrovirus and retrotransposon DNA sequences insert into the DNA of the host with the aid of sequences at their ends called
   A. telomeres.
   B. long terminal repeats (LTRs).
   C. inverted repeats.
   D. J (joining) segments.

20. What is the function of viral integrase in the life cycle of a retrovirus?
   A. Integrase synthesizes a DNA molecule from the template of the RNA viral genome.
   B. Integrase describes duplicate sites on viral RNA at which primers bind to initiate DNA synthesis.
   C. Integrase integrates linear viral DNA into the host chromosome for subsequent transcription.
   D. Integrase introduces strand breaks in front of the unwound helix to release tension.

21. Which of the following statements about gene amplification is *false*?
   A. Gene amplification is responsible for amplification of ribosomal RNA genes in amphibian oocytes.
   B. Amplified DNA sequences can be found as free extrachromosomal molecules.
   C. Gene amplification occurs as an abnormal event in cancer cells.
   D. Amplified DNA sequences are a common occurrence in virally infected cells.

22. "DNA footprinting" is a technique that can be used to identify:
   A. a region of DNA that has been damaged by mutation.
   B. the position of a particular gene of a chromosome.
   C. the position of internally double-stranded regions in a single-stranded DNA molecule.
   D. the specific binding site of a repressor, polymerase, or other protein on the DNA.

23. Which one of the following is not true of tRNA molecules?
   A. tRNA molecules are single-stranded RNA.
   B. The 3'-terminal nucleotide of tRNA is the site of amino acid attachment.
   C. The anticodon arm of tRNA contains a three nucleotide sequence that is identical to a specific mRNA codon.
   D. tRNA molecules contain the unusual nucleotides dihydrouridine, pseudouridine, and ribothymine.

24. What is the approximate length of an mRNA molecule that encodes for a protein with a molecular weight of 30,000? (The average molecular weight of an amino acid is 110.)
   A. 275 nucleotides　B. 550 nucleotides　C. 825 nucleotides　D. 2475 nucleotides

25. Which of the following describes an accurate order of events in translation?
   A. Ribosomal translocation occurs before the first aminoacyl-tRNA molecule binds to the small subunit.
   B. Initiation of translation occurs only after the small subunit dissociates from the mRNA.
   C. The large subunit of the ribosome binds the mRNA before the small subunit.
   D. The first aminoacyl-tRNA molecule binds to the small subunit before the large subunit binds.

26. Which of the following is NOT true of the first step of translational elongation in bacteria?
   A. GTP-bound EF-Tu interacts with the tRNA acylated with the next amino acid to be added.
   B. The function of EF-Ts is to exchange the GDP bound by EF-Tu with GTP.
   C. EF-Tu hydrolyzes GTP after dissociation from the aminoacyl-tRNA bound in the A site.
   D. Correct codon-anticodon interactions are proofread when the EF-Tu dissociates through a process called accommodation.

27. Which of the following is NOT true of signal integration by more than one transcription factor?
A. It occurs in both bacteria and eukaryotes.
B. It allows for multiple environmental signals to control the expression of a single gene.
C. It is used to control the expression of genes in opposite orientations that are controlled by the same promoter.
D. It can include the use of both repressors and activators at the same promoter.

28. Which of the following is true of the protein ubiquitination pathway?
A. The ubiquitin carboxyl terminus is covalently linked to the protein targeted for degradation.
B. The ubiquitin is covalently linked to the amino terminus protein targeted for degradation.
C. The protein targeted for degradation is modified by three different enzymes in the pathway.
D. A single molecule of ubiquitin linked to the target protein is sufficient for destruction.

29. The binding of tryptophan to the Trp repressor protein results in:
A. the dissociation of the repressor from the operator sequence.
B. a conformational change in the repressor that allows the repressor to bind the operator.
C. the recruitment of RNA polymerase.
D. an increase in the expression of tryptophan biosynthetic enzymes.

30. The LexA protein is:
A. the repressor of the SOS response.
B. the coprotease for the cleavage of RecA protein.
C. a DNA repair enzyme.
D. a regulatory protein for the *lac* operon.

31. How does the RecA protein contribute to the increased expression of SOS genes?
A. RecA protein competes with LexA protein for binding to the operator sequences.
B. RecA protein binds to LexA protein bound to the operator, directly lowering the affinity of LexA protein for DNA.
C. RecA protein binds to free LexA protein, mediating the self-cleavage of the repressor.
D. RecA protein binding to the promoter region recruits RNA polymerase.

32. Upon the initial infection of a host cell by bacteriophage λ, the first two proteins produced from expression of the phage genome are:
A. cI and cII B. N and cI C. N and Cro D. Cro and cI

33. Which of the following is generally NOT involved in gene inactivation by histone modification?
A. Modification leads to chromatin condensation.
B. The RNA polymerase associated with the gene dissociates from DNA when HDACs bind to the corepressor.
C. Increased acetylation of the nucleosomes in the vicinity of the gene.
D. Increased methylation of the nucleosomes in the vicinity of the gene.

34. Which of the following is NOT true about the role of Mediator complex in transcription initiation?
A. Mediator binds to RNA polymerase II.
B. Mediator binds to upstream enhancer sequences.
C. Mediator binds to general transcription factors.
D. Mediator binds to transcription activators.

35. The process of human X-chromosome inactivation in female cells:

A. is more common for the paternal X chromosome than the maternal X chromosome.
B. condenses one copy of the X chromosome into heterochromatin.
C. is necessary to ensure that only Y chromosome genes are expressed in some cells.
D. all of the above.

36. What is the main difference between siRNA and miRNA?
A. siRNAs are involved in RNA interference; miRNAs are not.
B. miRNAs are encoded by the genome; siRNAs are not.
C. miRNAs are processed by Dicer; siRNAs are not.
D. siRNAs are double-stranded; miRNAs are not.

37. Following are four processes common to most cloning experiments. (a) transforming bacteria, (b) plating bacteria on selective medium, (c) cutting DNA with restriction endonucleases, (d) ligating DNA fragments. Which order would be the most likely occur during a cloning experiment.
A. abcd　　B. cdba　　C. acdb　　D. cdab

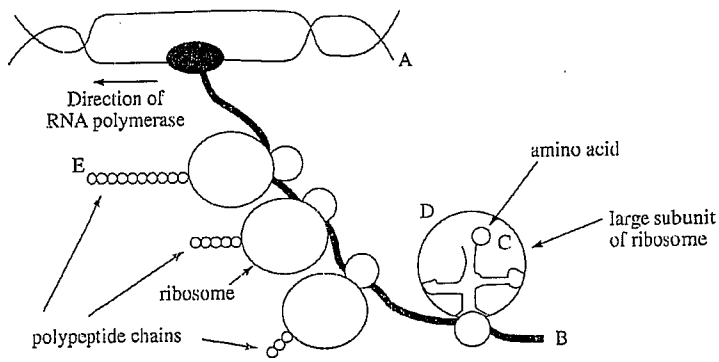
38. Under strictly controlled conditions, a probe can be used that will hybridize only with its complementary sequence and not with other sequences that may vary by as little as one nucleotide. What are such probes called?
A. generation-specific probes　　B. short, variable repeats
C. microsatellites　　D. allele-specific oligonucleotides (ASOs)

39. Assume that a plasmid (circular) is 3200 base pairs in length and has restriction sites at the following locations: 400, 700, 1400, 2600. Give the expected sizes of the restriction fragments following complete digestion.
A. 400, 800, 1000 (2 of these)　　B. 300, 700, 2200
C. 700, 400, 1400, 2600　　D. 300, 700, 1000, 1200

40. Which one of the following statements about G protein coupled receptor-mediated stimulation of adenylate cyclase is NOT correct?
A. Adenylate cyclase is stimulated by GTP-bound G-protein.
B. The cAMP generated by adenylate cyclase binds directly to a transcriptional activator.
C. The cAMP generated by adenylate cyclase is a second messenger.
D. The stimulation of adenylate cyclase is transduced through protein phosphorylation.

三、問答題(10%)

1. The following drawing represents simultaneous transcription and translation in *E. coli*. Answer the questions below the drawing. The direction of the RNA polymerase is given by the arrow. (5 points)



(a) Is the letter A nearer the 5' or the 3' end of the molecule? _____

(b) Is the letter B nearer the 5' or the 3' end of the molecule? _____

(c) Is the letter C nearer the 5' or the 3' end of the tRNA molecule? _____

(d) What is the "S" value (5S, 18S, 23S?) for the large rRNA that is closest to the letter D? _____

(e) Which terminus (N or C) of the growing polypeptide chain is nearer to the letter E? _____

2. The following table lists several genotypes associated with the *lac* operon in *E. coli*. For each, indicate with a "+" or a "-" whether active β-galactosidase would be expected to be produced at induced levels. (Assume that glucose is not present in the medium.) (5 points)

	β-galactosidase production	
Genotype	**No Lactose**	**with Lactose**
$I^+ O^+ Z^+$ (wild type)	--	+
a) $I^- O^+ Z^+$	___	___
b) $I^+ O^c Z^+$	___	___
c) $I^- O^+ Z^+ / F' I^+$	___	___
d) $I^- O^+ Z^+ / F' O^+$	___	___
e) $I^s O^+ Z^+$	___	___

I^+ = wild-type repressor

I^- = mutant repressor (unable to bind to the operator)

I^s = mutant repressor (insensitive to lactose)

O^+ = wild-type operator

O^c = constitutive operator (insensitive to repressor)