

國 立 清 華 大 學 命 題 紙

98 學年度 生醫工程與環境科學 系(所) 甲 分子生醫光電 組碩士班入學考試

科目 普通生物學 科目代碼 2305 共 10 頁第 1 頁*請在【答案卡】內作答

Multiple choice (Only one best answer for each question) (2.5 points/each)

每題 2.5 分，答錯倒扣 2 分，請謹慎回答！

1. Cells of the pancreas will incorporate radioactively labeled amino acids into proteins. This “tagging” of newly synthesized proteins enables a researcher to track the location of these proteins in a cell. In this case, we are tracking an enzyme that is eventually secreted by pancreatic cells. Which of the following is the most likely pathway for movement of this protein in the cell?
 - (A) ER → Golgi → nucleus
 - (B) nucleus → ER → Golgi
 - (C) Golgi → ER → lysosome
 - (D) ER → lysosomes → vesicles that fuse with plasma membrane
 - (E) ER → Golgi → vesicles that fuse with plasma membrane
2. Which of the following statements is a correct distinction between prokaryotic and eukaryotic cells attributable to the absence of a prokaryotic cytoskeleton?
 - (A) Only eukaryotic cells are capable of movement.
 - (B) Compartmentalized organelles are found only in eukaryotic cells
 - (C) Prokaryotic cells are usually 10 μm or less in diameter
 - (D) Cytoplasmic streaming is not observed in prokaryotes
 - (E) Only the eukaryotic cell concentrates its genetic material in a region separate from the rest of the cell
3. Some bacteria are metabolically active in hot springs because
 - (A) they are able to maintain an internal temperature much cooler than that of the surrounding water
 - (B) their enzymes are insensitive to temperature
 - (C) their enzymes have high optimal temperatures
 - (D) the high temperatures facilitate active metabolism without the need of catalysis
 - (E) they use molecules other than proteins as their main catalysts
4. Which of the following processes could still occur in a chloroplast in the presence of an inhibitor that prevents H^+ from passing through ATP synthase complexes?
 - (A) the Calvin cycle
 - (B) photophosphorylation
 - (C) sugar synthesis
 - (D) oxidation of NADPH
 - (E) generation of a proton-motive force

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5. Which of the following statements is a correct distinction between cyclic and noncyclic photophosphorylation?
- (A) Chemiosmosis is unique to noncyclic photophosphorylation
 - (B) In addition to ATP, cyclic photophosphorylation also produces O₂ and NADPH
 - (C) Only noncyclic photophosphorylation produce ATP
 - (D) Only cyclic photophosphorylation can operate in the absence of photosystem II
 - (E) Only cyclic photophosphorylation utilizes light at 700 nm
6. In what respect are the photosynthetic adaptations of C₄ plants and CAM plants similar?
- (A) In both cases, the stomata normally close during the day
 - (B) Both types of plants make their sugar without the Calvin cycle
 - (C) In both cases, an enzyme other than rubisco carries out the first step in carbon fixation
 - (D) Both types of plants make most of their sugar in the dark
 - (E) Neither C₄ plants nor CAM plants have grana in their chloroplasts
7. Which of the following is an RNA nucleotide?
- (A) phosphate - ribose - cytosine
 - (B) phosphate - deoxyribose - adenine
 - (C) phosphate - deoxyribose - thymine
 - (D) phosphate - cytosine - guanine
 - (E) phosphate - ribose - thymine
8. Positions within the genome where DNA nucleotides of 2 or more individuals differ, i.e., where different nucleotides occupy the same position are called _____.
- (A) polypeptide protein parts (PPP's)
 - (B) single nucleotide polymorphisms (SNP's)
 - (C) Restriction fragment length polymorphisms (RFLPs)
 - (D) unique nucleotide differentiators (UND's)
 - (E) palindromes
9. "Sticky ends" is a term that describes
- (A) the DNA that is left behind after bacteria have been removed from a culture plate
 - (B) the last sequence of a DNA strand that codes for STOP
 - (C) the bacterial strain that ends with the same initials as its corresponding restriction enzyme
 - (D) the unpaired DNA bases after the DNA has been exposed to a restriction enzyme
 - (E) the affinity of a restriction enzyme for a particular sequence on the DNA strand

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10. What is recombinant DNA?
- (A) Recombinant DNA is DNA formed by splicing RNA into existing DNA strands
 - (B) Recombinant DNA is DNA formed by replication of an existing DNA strand
 - (C) Recombinant DNA is DNA formed by rearranging the sequence of genes on a single strand of existing DNA
 - (D) Recombinant DNA is DNA formed from synthetic nucleotides
 - (E) Recombinant DNA is DNA formed by joining together DNA fragments of different organisms.
11. Mendel's law of segregation states
- (A) two unlike alleles are always passed together to the offspring
 - (B) alleles of one gene are passed to offspring dependent on gender of parent
 - (C) two alleles are expressed equally in the offspring
 - (D) environment affects the expression of alleles for a trait
 - (E) heterozygous parents are equally likely to pass either of their two alleles on to their offspring
12. A VNTR (variable number tandem repeats) is
- (A) a specific restriction enzyme site located in highly conserved DNA sequences
 - (B) a noncoding, core sequence of DNA that is repeated up to hundred of thousands of times, side by side
 - (C) a section of DNA that is common to 99.9 percent of all people
 - (D) a fragment of DNA that is acted on vigorously by natural selection
 - (E) a single nucleotide polymorphism that accounts for most of the genetic differences among individuals
13. Consider this pathway: epinephrine \rightarrow G-protein-linked receptor \rightarrow G protein \rightarrow adenylyl cyclase \rightarrow cAMP. Identify the "second messenger" is
- (A) cAMP
 - (B) G protein
 - (C) GTP
 - (D) adenylyl cyclase
 - (E) G-protein-linked receptor
14. Lipid-soluble signal molecule, such as testosterone, cross the membranes of all cells but affect only target cells because
- (A) only target cells retain the appropriate DNA segments
 - (B) only target cells possess the cytosolic enzymes that transducer the testosterone
 - (C) most cells lack the Y chromosome required
 - (D) intracellular receptors are present only in target cells
 - (E) only in target cells is testosterone able to initiate the phosphorylation cascade leading to activated transcription factor

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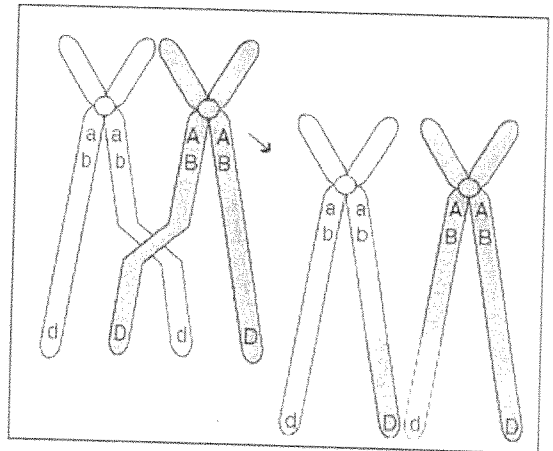
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15. Signal-transduction pathways benefit cells for all of the following reasons *except*
- (A) they help cells respond to signal molecules that are too large or too polar to cross the plasma membrane
 - (B) they enable different cells to respond appropriately to the same signal
 - (C) they help cells use up phosphate generated by ATP breakdown
 - (D) they can amplify a signal
 - (E) variation in the signal-transduction pathway can enhance response specificity

16. A base sequence is "ACAGTGC". How would the base sequence be coded on mRNA?
- (A) TGTCACG (B) GUGACAU (C) UGUCACG (D) CACUGUA (E) GCACUGU

17. The diagram above shows homologous chromosomes during prophase I of meiosis. Which of the following correctly describes the process being illustrated?
- (A) A mutation in which the DNA content of the gene is altered
 - (B) segregation of sister chromatids
 - (C) condensation and segregation of alleles
 - (D) crossing-over in which alleles are exchanged



18. The table lists the typical diploid number of chromosomes of several different organisms. Which of the following is the *best* explanation for why the chromosome number is an even number in each of these organisms?
- (A) It is only a coincidence; many other organisms have an odd number of chromosomes.
 - (B) The diploid chromosome number is always even so that when mitosis occurs each new cell gets the same number of chromosomes.
 - (C) The diploid chromosome number represents pairs of chromosomes, one from each parent, so it is always an even number.
 - (D) Chromosomes double every time the cell divides, so after the first division, the number is always even.

Diploid Chromosome Number	
Goldfish	94
Potato	48
Human	46
Pea	14
Fruit fly	8

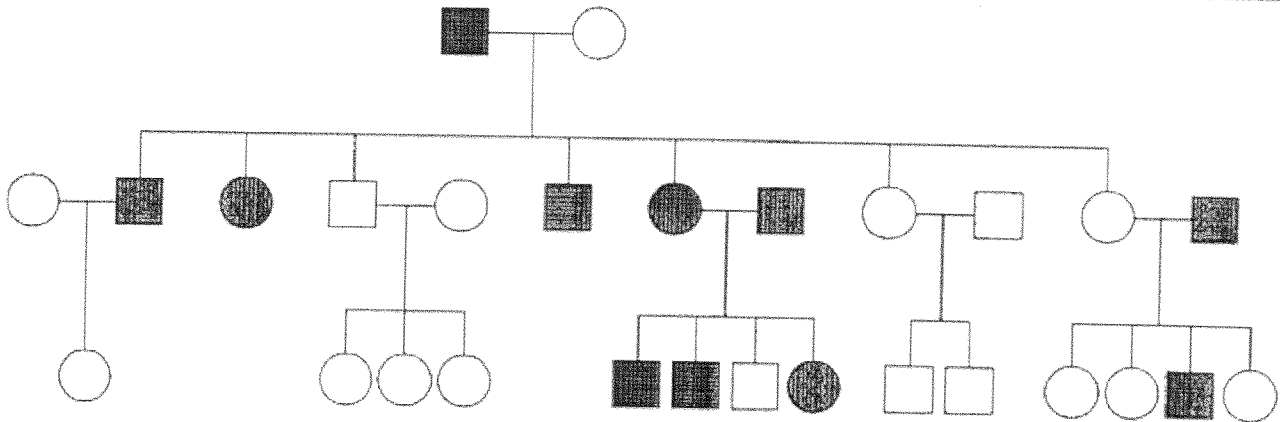
19. The cDNA fragment that includes the ricin gen is 5.7 kilobases. If the entire fragment codes for the ricin polypeptide, the approximate number of amino acids in the polypeptide would be
- (A) 17,100 (B) 5,700 (C) 2,500 (D) 1,900 (E) 570

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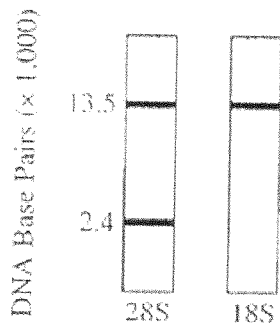
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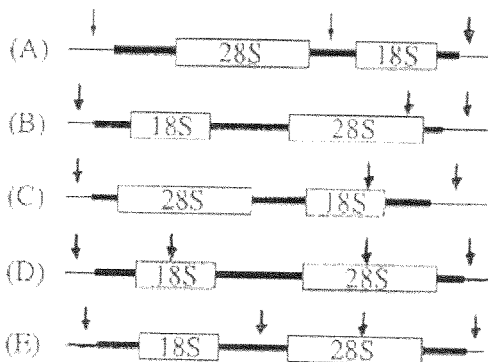
20. To express mammalian genes in a bacterium such as *E. coli*, the vector must have
(A) a bacterial promoter (B) a Shine-Dalgarno sequence.
(C) a Goldberg-Hogness box. (D) both A and B (E) all of the above
21. Which of the following is a positive regulator of the *lac* operon?
(A) allolactose (B) beta-galactosidase (C) CAP-cAMP
(D) all of the above (E) none of the above
22. Why SDS (sodium dodecyl sulfate) is used in polyacrylamide gel electrophoresis?
(A) DNA denature (B) peptide chain digestion (C) cover negative charge
(D) polymerize the peptide chain (E) dissolve hydrophilic domain
23. It has been proposed that mitochondria and chloroplasts evolved from certain bacteria that existed as endosymbiotic organisms in early cells. Which of the following would best support this hypothesis?
(A) Both organelles contain DNA molecules.
(B) Both organelles have microtubules.
(C) Both organelles lack mRNA.
(D) Mitochondria, but not chloroplasts, are surrounded by a double membrane.
(E) Chloroplasts, but not mitochondria, are able to synthesize protein.
24. Sex determination in *Drosophila* is regulated by which cellular mechanism?
(A) addition of a 5' cap (B) post-translational processing (C) differential splicing
(D) choice of alternative poly(A) sites (E) activation of transcription
25. During transcription of the *trp* operon, pairing of regions 2 and 3 in the leader peptide mRNA creates a(n) _____ signal.
(A) induction (B) termination (C) repression (D) antitermination (E) pause
26. At least 30 percent of human DNA exists as repeated multiples of relatively short sequences of nucleotides. Which of the following statements about this repetitive DNA is correct?
(A) Much of the repetitive DNA is transcribed into messenger RNA.
(B) Repetitive DNA is largely responsible for the production of enzymes and other protein molecules.
(C) Most repeated sequences are associated with detectable phenotypes.
(D) Highly repeated sequences rapidly reassociate in DNA hybridization studies.
(E) Most of the repetitive DNA codes for transfer RNA.



27. In the pedigree above, circles denote females, squares denote males, and shaded figures denote individuals expressing a specific trait. Which of the following is the most probable mode of inheritance of this trait?
- (A) Simple Mendelian dominant (B) Simple Mendelian recessive
 (C) Codominant relationship of a single pair of alleles (D) X-linked dominant transmission
 (E) Polygenic inheritance



28. The autoradiograms above (after electrophoresis and Southern blotting) show human DNA digested with a specific restriction enzyme and probed with labeled rRNA. In the autoradiogram on the left, the probe was 28S rRNA; at the right, the probe was 18S rRNA. If the arrows in the following maps locate the recognition sites of the restriction enzyme, which map best explains the results shown above?

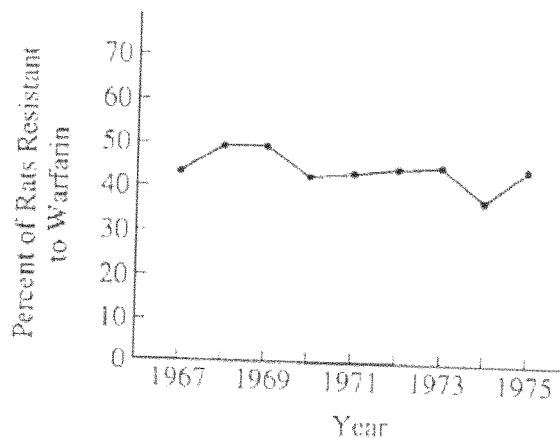


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29. Successful reproduction of a lytic virus requires that all of the following processes occur *except*
- (A) incorporation of viral DNA into host cell DNA (B) translation of viral mRNA
(C) binding of the virus to the host cell's surface (D) replication of the viral genome
(E) penetration of the viral genome in to the host cell
30. All of the following are responses of the vertebrate egg to fusion with the male gamete *except*
- (A) completion of maturation (meiotic division) (B) loss of the ability to undergo mitosis
(C) transient elevation of intracellular free calcium (D) fusion of male and female pronuclei
(E) activation of the metabolic machinery
31. Which of the following is secreted principally by the corpus luteum of the human ovary?
- (A) Luteinizing hormone (B) Follicle-stimulating hormone (C) Testosterone
(D) Gonadotropin-releasing factor (E) Progesterone
32. The fact that the tail muscle of an amphibian tadpole degenerates during metamorphosis, while the tadpole limb muscle differentiates and grows, best supports which of the following statements?
- (A) The effect of a hormone can be predicted if it is known that a tissue has receptors of that hormone.
(B) Similar tissue can respond to a hormone in different ways.
(C) Only the tail muscle has receptor for thyroxine.
(D) Only the limb muscle has receptors for thyroxine.
(E) A hormonal response is a function of the molecular structure of the hormone.
- (33~36) The Norway rat (*Rattus norvegicus*), a widespread pest, was controlled for about a decade by the anticoagulant warfarin. This chemical substance, placed in food pellets, is absorbed by the intestinal tract and inhibits the clotting of blood. After a population decline for about 10 years, rat populations increased and stabilized. In one European population, as illustrated in the graph below, the percentage of rats resistant to warfarin has remained fairly stable over a number of years.



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Resistance to warfarin is governed by a dominant autosomal gene, R . More than 15 percent of the resistant animals are heterozygous at this locus (Rr). The table below indicates the response to warfarin and relative reproductive fitness of individuals that are homozygous or heterozygous for the dominant gene (R). The RR individuals have a 20-fold increase in vitamin K requirement over rr individuals.

RELATIVE FITNESS* AT THE R LOCUS IN THE NORWAY RAT IN THE PRESENCE OF WARFARIN			
	rr	Rr	RR
Response to warfarin	Susceptible	Resistant	Resistant
Vitamin K dependence	No	Intermediate	Yes
Relative fitness	0.68	1.00	0.37

*Fitness is a measure of the reproductive success of a particular genotype.
The highest fitness is 1.00.

33. There is a substantial number of heterozygotes in the population. Which of the following is the best explanation of this observation?
- (A) Heterozygotes (Rr) have a selective advantage over both homozygotes (RR and rr)
 - (B) The gene for susceptibility (r) is increasing rapidly each generation.
 - (C) The gene for susceptibility (r) is being lost by chance each generation.
 - (D) Dominant homozygotes (RR) enjoy a reproductive advantage over heterozygotes.
 - (E) Dominant homozygotes (RR) produce more offspring each generation than either heterozygotes (Rr) or recessive homozygotes (rr)
34. In a population where warfarin is no longer applied, the expectation is that the
- (A) dominant gene (R) will supplant the recessive gene (r) in the population
 - (B) heterozygotes (Rr) will have a reproductive advantage over both homozygotes (RR and rr)
 - (C) frequency of the dominant gene (R) will decline
 - (D) frequency of recessive individuals will gradually decline
 - (E) frequency of the recessive gene (r) will decline
35. The strong dependence of RR individuals on large quantities of vitamin K probably is responsible for
- (A) their lowered fitness
 - (B) their susceptibility to warfarin
 - (C) their superiority to heterozygotes (Rr)
 - (D) their increasing numbers in the population each generation
 - (E) the persistent decline of recessive homozygotes (rr) in the population

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36. Which of the following is most likely correct concerning the gene for resistance to warfarin?

- (A) It is a wild-type gene induced to mutate by the direct action of warfarin.
- (B) It is a mutation subsequently favored by natural selection.
- (C) It is increased in frequency by virtue of its dominant status.
- (D) It is carried by a bacterial plasmid vector.
- (E) It is a cytoplasmic gene transmitted by maternal inheritance.

(37~40) Nuclei from both the liver and brain cells of a rat are isolated and incubated with highly radioactive RNA precursors. The RNA transcripts synthesized in these nuclei become radioactively labeled. These radioactive RNA molecules are incubated with a single-stranded DNA segment (cDNA) complementary to an mRNA molecule found in live-cell cytoplasm but not brain-cell cytoplasm. The RNA and DNA are allowed to form RNA/DNA hybrid double helices with the specific cDNA probe. An RNA-digesting enzyme is added to destroy RNA that is not in hybrid form. Radioactivity in the remaining hybrids is measured as counts per minute. The results are presented in the table below.

<u>Incubation Components</u>	<u>Counts per Minute</u>
Liver cDNA probe plus primary RNA transcripts from liver-cell nuclei	15,000
Liver cDNA probe plus primary RNA transcripts from brain-cell nuclei	150

37. Which of the following statements concerning the DNA sequence corresponding to this liver-specific mRNA molecule is best supported by the data?

- (A) It is transcribed in brain-cell nuclei only
- (B) It is transcribed in both brain- and liver-cell nuclei at approximately the same rate.
- (C) It is not transcribed in brain-cell nuclei but is transcribed in liver-cell nuclei.
- (D) It is not transcribed in either liver- or brain-cell nuclei.
- (E) It may be transcribed in both brain- and liver-cell nuclei but cannot be detected by this experimental procedure.

38. To produce radiolabeled transcripts, the isolated nuclei from both liver and brain must have which of the following?

- (A) DNA polymerase
- (B) RNA polymerase
- (C) Reverse transcriptase
- (D) Ribosomes
- (E) Plasmid DNA

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39. To make the single-stranded cDNA used in this experiment, which of the following enzymes was required?
(A) DNA polymerase (B) Reverse transcriptase (C) DNase (D) Protease (E) Protein kinase
40. The regulation of the expression of mRNA in the isolated nuclei from the two cell types as demonstrated in this experiment is an example of
(A) translational control (B) mRNA degradation control (C) transcriptional control
(D) transport control (E) lack of control

<<END>>