

# 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：生態學【生科系碩士班甲組】

題號：421002

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共 1 頁第 1 頁

## I. 解釋名詞，共 40 分

1. Thermal neutral zone (5 分)
2. Autotroph (5 分)
3. Metapopulation (5 分)
4. net primary production (5 分)
5. logistic growth (5 分)
6. realized niche (5 分)
7. secondary succession (5 分)
8. guild (5 分)

## II. 問答題，共 60 分

9. Discuss and explain the influences of temperature on **PLANTS OR ANIMALS**. (15 分)
10. What are the major causes of current species extinctions? Why should we be concerned about the current rate of species extinctions? (15 分)
11. Using number of prey as X axis, and number of predators as Y axis, explain graphically the Lotka-Volterra model (or Rosenzweig-MacArthur model) for the predator-prey interactions. (15 分)
12. Explain the equilibrium hypothesis of species-area relationship. (15 分)



國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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※本科目依簡章規定「不可以」使用計算機

共 9 頁第 1 頁

**Part A: The Evolutionary History of Biological Diversity (50 points)**

**Section 1: Multiple-Choice Questions: (20 points; one point / each question)**

1. The term *homoplasy* is most applicable to which of the following features?
  - A) the legless condition found in various lineages of extant lizards
  - B) the five-digit condition of human hands and bat wings
  - C) the  $\beta$  hemoglobin genes of mice and of humans
  - D) the fur that covers Australian moles and North American moles
  - E) the bones of bat forelimbs and the bones of bird forelimbs
2. When using a cladistic approach to systematics, which of the following is considered most important for classification?
  - A) shared primitive characters
  - B) analogous primitive characters
  - C) shared derived characters
  - D) the number of homoplasies
  - E) overall phenotypic similarity
3. The most important feature that permits a gene to act as a molecular clock is
  - A) having a large number of base pairs.
  - B) having a larger proportion of exonic DNA than of intronic DNA.
  - C) having a reliable average rate of mutation.
  - D) its recent origin by a gene-duplication event.
  - E) its being acted upon by natural selection
4. Paralogous genes that have lost the function of coding for any functional gene product are known as "pseudogenes." Which of these is a valid prediction regarding the fate of pseudogenes over evolutionary time?
  - A) They will be preserved by natural selection.
  - B) They will be highly conserved.
  - C) They will ultimately regain their original function.
  - D) They will be transformed into orthologous genes.
  - E) They will have relatively high mutation rates.
5. To apply parsimony to constructing a phylogenetic tree,
  - A) choose the tree that assumes all evolutionary changes are equally probable.
  - B) choose the tree in which the branch points are based on as many shared derived characters as possible.
  - C) base phylogenetic trees only on the fossil record, as this provides the simplest explanation for evolution.
  - D) choose the tree that represents the fewest evolutionary changes, either in DNA sequences or morphology.
  - E) choose the tree with the fewest branch points.
6. Which statement about bacterial cell walls is false?
  - A) Bacterial cell walls differ in molecular composition from plant cell walls.
  - B) Cell walls prevent cells from bursting in hypotonic environments.
  - C) Cell walls prevent cells from dying in hypertonic conditions.
  - D) Bacterial cell walls are similar in function to the cell walls of many protists, fungi, and plants.
  - E) Cell walls provide the cell with a degree of physical protection from the environment.

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共 9 頁第 2 頁

7. All protists are
  - A) unicellular.
  - B) eukaryotic.
  - C) symbionts.
  - D) monophyletic.
  - E) mixotrophic.
  
8. Which of the following statements about dinoflagellates is true?
  - A) They possess two flagella.
  - B) All known varieties are autotrophic.
  - C) Their walls are usually composed of silica plates.
  - D) Many types lack mitochondria.
  - E) Their dead cells accumulate on the seafloor, and are mined to serve as a filtering material.
  
9. Which process results in genetic recombination, but is separate from the process by which the population size of *Paramecium* increases?
  - A) budding
  - B) meiotic division
  - C) mitotic division
  - D) conjugation
  - E) binary fission
  
10. What do fungi and arthropods have in common?
  - A) Both groups are commonly coenocytic.
  - B) The haploid state is dominant in both groups.
  - C) Both groups are predominantly heterotrophs that ingest their food.
  - D) The protective coats of both groups are made of chitin.
  - E) Both groups have cell walls.
  
11. In most fungi, karyogamy does not immediately follow plasmogamy, which consequently
  - A) means that sexual reproduction can occur in specialized structures.
  - B) results in multiple diploid nuclei per cell.
  - C) allows fungi to reproduce asexually most of the time.
  - D) results in heterokaryotic or dikaryotic cells.
  - E) is strong support for the claim that fungi are not truly eukaryotic.
  
12. You are given an organism to identify. It has a fruiting body that contains many structures with eight haploid spores lined up in a row. What kind of a fungus is this?
  - A) zygomycete
  - B) ascomycete
  - C) deuteromycete
  - D) chytrid
  - E) basidiomycete
  
13. In what structures do both *Penicillium* and *Aspergillus* produce asexual spores?
  - A) asci
  - B) zygosporangia
  - C) rhizoids
  - D) gametangia
  - E) conidiophores

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 9 頁 第 3 頁

14. What do animals as diverse as corals and monkeys have in common?
- A) body cavity between body wall and digestive system
  - B) number of embryonic tissue layers
  - C) type of body symmetry
  - D) presence of *Hox* genes
  - E) degree of cephalization
15. Whatever its ultimate cause(s), the Cambrian explosion is a prime example of
- A) mass extinction.
  - B) evolutionary stasis.
  - C) adaptive radiation.
  - D) All three of the responses are correct.
  - E) Only two of the responses are correct.
16. The most ancient branch point in animal phylogeny is that between having
- A) radial or bilateral symmetry.
  - B) a well-defined head or no head.
  - C) diploblastic or triploblastic embryos.
  - D) true tissues or no tissues.
  - E) a body cavity or no body cavity.
17. Sponges are most accurately described as
- A) marine predators.
  - B) marine filter feeders.
  - C) freshwater scavengers.
  - D) aquatic filter feeders.
  - E) aquatic predators.
18. Corals are most closely related to which group?
- A) jellies
  - B) freshwater hydras
  - C) sea anemones
  - D) sponges
  - E) barnacles
19. Which of the following statements about human evolution is correct?
- A) Modern humans are the only human species to have evolved on Earth.
  - B) Human ancestors were virtually identical to extant chimpanzees.
  - C) Human evolution has occurred within an unbranched lineage.
  - D) The upright posture and enlarged brain of humans evolved simultaneously.
  - E) Fossil evidence indicates that early anthropoids were arboreal and cat-sized.
20. Which of these species was the first to have some members migrate out of Africa?
- A) *Australopithecus garhi*
  - B) *H. erectus*
  - C) *H. ergaster*
  - D) *H. habilis*
  - E) *H. sapiens*

**Section 2: Essay (30 points):**

21. Describe and discuss the delimitation of Kingdom Plantae. (15 points)
22. Discuss the taxonomic position of extant birds within the Kingdom Animalia. (15 points)

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 9 頁第 4 頁

**Part B : Mechanisms of Evolution (50 points)**

**Section 3: Multiple-Choice Questions: (40 points; one point / each question)**

23. Charles Darwin was the first person to propose
- A) that evolution occurs.
  - B) a mechanism for how evolution occurs.
  - C) that Earth is older than a few thousand years.
  - D) a mechanism for evolution that was supported by evidence.
  - E) that population growth can outpace the growth of food resources.
24. Natural selection is based on all of the following except
- A) genetic variation exists within populations.
  - B) the best-adapted individuals tend to leave the most offspring.
  - C) individuals who survive longer tend to leave more offspring than those who die young.
  - D) populations tend to produce more individuals than the environment can support.
  - E) individuals adapt to their environments and, thereby, evolve.
25. The role that humans play in artificial selection is to
- A) determine who lives and who dies.
  - B) create the genetic variants, which nature then selects.
  - C) choose which organisms breed, and which do not.
  - D) train organisms to breed more successfully.
  - E) perform artificial insemination.
26. Which of the following pieces of evidence most strongly supports the common origin of all life on Earth?
- A) All organisms require energy.
  - B) All organisms use essentially the same genetic code.
  - C) All organisms reproduce.
  - D) All organisms show heritable variation.
  - E) All organisms have undergone evolution.
27. Both ancestral birds and ancestral mammals shared a common ancestor that was terrestrial. Today, penguins (which are birds) and seals (which are mammals) have forelimbs adapted for swimming. What term best describes the relationship of the bones in the forelimbs of penguins and seals, and what term best describes the flippers of penguins and seals?
- A) homologous; homologous
  - B) analogous; homologous
  - C) homologous; analogous
  - D) analogous; analogous
  - E) homoplasy; homologous
28. A high degree of endemism is most likely in environments that are
- A) easily reached and heterogeneous.
  - B) isolated and heterogeneous.
  - C) isolated and homogeneous.
  - D) isolated and extremely cold.
  - E) easily reached and homogeneous.
29. Evolutionary trees such as this are properly understood by scientists to be
- A) theories.
  - B) hypotheses.
  - C) guesses.
  - D) dogmas.
  - E) facts.

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共 9 頁第 5 頁

30. DNA sequences in many human genes are very similar to the sequences of corresponding genes in chimpanzees. The most likely explanation for this result is that
- A) humans and chimpanzees share a relatively recent common ancestor.
  - B) humans evolved from chimpanzees.
  - C) chimpanzees evolved from humans.
  - D) convergent evolution led to the DNA similarities.
  - E) humans and chimpanzees are not closely related.
31. During an individual organism's lifetime, which of these is most likely to help the organism respond properly to changes in its environment?
- A) microevolution
  - B) change in allele or gene frequency
  - C) change in gene expression
  - D) change in average heterozygosity
  - E) macroevolution
32. Although each of the following has a better chance of influencing gene frequencies in small populations than in large populations, which one most consistently requires a small population as a precondition for its occurrence?
- A) mutation
  - B) nonrandom mating
  - C) genetic drift
  - D) natural selection
  - E) gene flow
33. A trend toward the decrease in the size of plants on the slopes of mountains as altitudes increase is an example of
- A) a cline.
  - B) a bottleneck.
  - C) relative fitness.
  - D) genetic drift.
  - E) geographic variation.
34. Which of the following is a true statement concerning genetic variation?
- A) It is created by the direct action of natural selection.
  - B) It arises in response to changes in the environment.
  - C) It must be present in a population before natural selection can act upon the population.
  - D) It tends to be reduced by the processes involved when diploid organisms produce gametes.
  - E) A population that has a higher average heterozygosity has less genetic variation than one with a lower average heterozygosity.
35. Evolution
- A) must happen, due to organisms' innate desire to survive.
  - B) must happen whenever a population is not well-adapted to its environment.
  - C) can happen whenever any of the conditions for Hardy-Weinberg equilibrium are not met.
  - D) requires the operation of natural selection.
  - E) requires that populations become better suited to their environments.
36. The production of new types of flu virus in the manner described above is most similar to the phenomenon of
- A) bottleneck effect.
  - B) founder effect.
  - C) natural selection.
  - D) gene flow.
  - E) sexual selection.

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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※本科目依簡章規定「不可以」使用計算機

共 9 頁第 6 頁

37. What is true of natural selection?
- A) Natural selection is a random process.
  - B) Natural selection creates beneficial mutations.
  - C) The only way to eliminate harmful mutations is through natural selection.
  - D) Mutations occur at random; natural selection can preserve and distribute beneficial mutations.
  - E) Mutations occur when directed by the good of the species; natural selection edits out harmful mutations and causes populations to adapt to the beneficial mutations.
38. Sexual dimorphism is most often a result of
- A) pansexual selection.
  - B) stabilizing selection.
  - C) intrasexual selection.
  - D) intersexual selection.
  - E) artificial selection.
39. Adult male humans generally have deeper voices than do adult female humans, which is the direct result of higher levels of testosterone causing growth of the larynx. If one excludes the involvement of gender in the situation, then the pattern that is apparent in the fossil record is most similar to one that should be expected from
- A) pansexual selection.
  - B) directional selection.
  - C) disruptive selection.
  - D) stabilizing selection.
  - E) asexual selection.
40. Heterozygote advantage should be most closely linked to which of the following?
- A) sexual selection
  - B) stabilizing selection
  - C) random selection
  - D) directional selection
  - E) disruptive selection
41. When imbalances occur in the sex ratio of sexual species that have two sexes (i.e., other than a 50:50 ratio), the members of the minority sex often receive a greater proportion of care and resources from parents than do the offspring of the majority sex. This is most clearly an example of
- A) sexual selection.
  - B) disruptive selection.
  - C) balancing selection.
  - D) stabilizing selection.
  - E) frequency-dependent selection.
42. What is true of macroevolution?
- A) It is the same as microevolution, but includes the origin of new species.
  - B) It is evolution above the species level.
  - C) It is defined as the evolution of microscopic organisms into organisms that can be seen with the naked eye.
  - D) It is defined as a change in allele or gene frequency over the course of many generations.
  - E) It is the conceptual link between irritability and adaptation.



國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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※本科目依簡章規定「不可以」使用計算機

共 9 頁第 7 頁

43. What is true of the flightless cormorants of the Galápagos Islands?
- A) They are descendants of the same common ancestor that gave rise to the unique finches of these islands.
  - B) They are close relatives of flightless cormorants from the Americas.
  - C) If they are still able to breed successfully with flying cormorants, it would probably be with North American cormorants, rather than with South American cormorants.
  - D) Flightless cormorants on one island have restricted gene flow with those on other islands, which could someday lead to a macroevolutionary event.
  - E) Their DNA has low levels of sequence homology with the DNA of flying American cormorants.
44. Dog breeders maintain the purity of breeds by keeping dogs of different breeds apart when they are fertile. This kind of isolation is most similar to which of the following reproductive isolating mechanisms?
- A) reduced hybrid fertility
  - B) hybrid breakdown
  - C) mechanical isolation
  - D) habitat isolation
  - E) gametic isolation
45. Theoretically, the production of sterile mules by interbreeding between female horses (mares) and male donkeys (jacks) should
- A) result in the extinction of one of the two parental species.
  - B) cause convergent evolution.
  - C) strengthen postzygotic barriers between horses and donkeys.
  - D) weaken the intrinsic reproductive barriers between horses and donkeys.
  - E) eventually result in the formation of a single species from the two parental species.
46. What does the biological species concept use as the primary criterion for determining species boundaries?
- A) geographic isolation
  - B) niche differences
  - C) gene flow
  - D) morphological similarity
  - E) molecular (DNA, RNA, protein) similarity
47. The difference between geographic isolation and habitat differentiation is the
- A) relative locations of two populations as speciation occurs.
  - B) speed (tempo) at which two populations undergo speciation.
  - C) amount of genetic variation that occurs among two gene pools as speciation occurs.
  - D) identity of the phylogenetic kingdom or domain in which these phenomena occur.
  - E) the ploidy of the two populations as speciation occurs.
48. Beetle pollinators of a particular plant are attracted to its flowers' bright orange color. The beetles not only pollinate the flowers, but they mate while inside of the flowers. A mutant version of the plant with red flowers becomes more common with the passage of time. A particular variant of the beetle prefers the red flowers to the orange flowers. Over time, these two beetle variants diverge from each other to such an extent that interbreeding is no longer possible. What kind of speciation has occurred in this example, and what has driven it?
- A) allopatric speciation; ecological isolation
  - B) sympatric speciation; habitat differentiation
  - C) allopatric speciation; behavioral isolation
  - D) sympatric speciation; sexual selection
  - E) sympatric speciation; allopolyploidy

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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※本科目依簡章規定「不可以」使用計算機

共 9 頁第 8 頁

49. A hybrid zone is properly defined as
- A) an area where two closely related species' ranges overlap.
  - B) an area where mating occurs between members of two closely related species, producing viable offspring.
  - C) a zone that features a gradual change in species composition where two neighboring ecosystems border each other.
  - D) a zone that includes the intermediate portion of a cline.
  - E) an area where members of two closely related species intermingle, but experience no gene flow.
50. The most likely explanation for the recent decline in cichlid species diversity in Lake Victoria is
- A) reinforcement.
  - B) fusion.
  - C) stability.
  - D) geographic isolation.
  - E) polyploidy.
51. According to the concept of punctuated equilibrium, the "sudden" appearance of a new species in the fossil record means that
- A) the species is now extinct.
  - B) speciation occurred instantaneously.
  - C) speciation occurred in one generation.
  - D) speciation occurred rapidly in geologic time.
  - E) the species will consequently have a relatively short existence, compared with other species.
52. Which of the following statements about speciation is correct?
- A) The goal of natural selection is speciation.
  - B) When reunited, two allopatric populations will interbreed freely if speciation has occurred.
  - C) Natural selection chooses the reproductive barriers for populations.
  - D) Prezygotic reproductive barriers usually evolve before postzygotic barriers.
  - E) Speciation is a basis for understanding macroevolution.
53. Plant species A has a diploid number of 12. Plant species B has a diploid number of 16. A new species, C, arises as an allopolyploid from A and B. The diploid number for species C would probably be
- A) 12.            B) 14.            C) 16.            D) 28.            E) 56.
54. Which of the following factors would not contribute to allopatric speciation?
- A) A population becomes geographically isolated from the parent population.
  - B) The separated population is small, and genetic drift occurs.
  - C) The isolated population is exposed to different selection pressures than the ancestral population.
  - D) Different mutations begin to distinguish the gene pools of the separated populations.
  - E) Gene flow between the two populations is extensive.
55. The synthesis of new DNA requires the prior existence of oligonucleotides to serve as primers. On Earth, these primers are small RNA molecules. This latter observation is evidence in support of the hypothesized existence of
- A) a snowball Earth.
  - B) earlier genetic systems than those based on DNA.
  - C) the abiotic synthesis of organic monomers.
  - D) the delivery of organic matter to Earth by meteors and comets.
  - E) the endosymbiotic origin of mitochondria and chloroplasts.

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 9 頁 第 9 頁

56. If the half-life of carbon-14 is about 5,730 years, then a fossil that has one-sixteenth the normal proportion of carbon-14 to carbon-12 should be about how many years old?  
A) 1,400                      B) 2,800                      C) 11,200                      D) 16,800                      E) 22,900
57. What is true of the Cambrian explosion?  
A) There are no fossils in geological strata that are older than the Cambrian explosion.  
B) Only the fossils of microorganisms are found in geological strata older than the Cambrian explosion.  
C) The Cambrian explosion is evidence for the instantaneous creation of life on Earth.  
D) The Cambrian explosion marks the appearance of filter-feeding animals in the fossil record.  
E) Recent evidence supports the contention that the Cambrian explosion may not have been as "explosive" as was once thought.
58. Recent evidence indicates that the first major diversification of multicellular eukaryotes may have coincided in time with the  
A) origin of prokaryotes.  
B) switch to an oxidizing atmosphere.  
C) melting that ended the "snowball Earth" period.  
D) origin of multicellular organisms.  
E) massive eruptions of deep-sea vents.
59. Which event is nearest in time to the end of the period known as snowball Earth?  
A) oxygenation of Earth's seas and atmosphere  
B) evolution of mitochondria  
C) Cambrian explosion  
D) evolution of true multicellularity  
E) Permian extinction
60. An organism has a relatively large number of *Hox* genes in its genome. Which of the following is true of this organism?  
A) These genes are fundamental, and are expressed in all cells of the organism.  
B) The organism must have multiple paired appendages along the length of its body.  
C) The organism has the genetic potential to have a relatively complex anatomy.  
D) Most of its *Hox* genes owe their existence to gene fusion events.  
E) Its *Hox* genes cooperate to bring about sexual maturity at the proper stage of development.
61. Bagworm moth caterpillars feed on evergreens and carry a silken case or bag around with them in which they eventually pupate. Adult female bagworm moths are larval in appearance; they lack the wings and other structures of the adult male and instead retain the appearance of a caterpillar even though they are sexually mature and can lay eggs within the bag. This is a good example of  
A) allometric growth.                      B) paedomorphosis.  
C) sympatric speciation.                      D) adaptive radiation.  
E) changes in homeotic genes.
62. Many species of snakes lay eggs. However, in the forests of northern Minnesota where growing seasons are short, only live-bearing snake species are present. This trend toward species that perform live birth in a particular environment is an example of  
A) natural selection.                      B) sexual selection.  
C) species selection.                      D) goal direction in evolution.  
E) directed selection.

**Section 4: Essay (10 points):**

63. Which evolutionary mechanisms could affect allele frequencies in a population being maintained in captivity? Why?

# 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：生物化學【生科系碩士班乙組】

題號：421001

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共 1 頁第 1 頁

## 問答題 (100 分)

1. Give the reasons for the following facts or observations: (20 分, 每小題 4 分)
  - (1) DNA contains thymine (T) instead of uracil (U).
  - (2) DNA is chemically more stable than RNA.
  - (3) Triacylglycerols are the molecules of choice for energy storage.
  - (4) Glycerophospholipids are the essential components of cell membranes.
  - (5) Monosaccharides are reducing sugars.
2. Protein structure can be described in terms of four levels of organization: (20 分, 每小題 10 分)
  - (1) Define each level of the structural organization.
  - (2) Describe how each level of the protein structure is maintained.
3. The Michaelis-Menten equation is the fundamental equation of enzyme kinetics. This equation says that the initial rate ( $v$ ) of an enzyme reaction is determined by two constants ( $K_m$  and  $V_{max}$ ) and the initial concentration of substrate ( $[S]$ ): (20 分, 每小題 5 分)
  - (1) Write out this equation.
  - (2) Describe the important assumptions underlie this equation.
  - (3) Describe the practical significance of  $K_m$  and  $V_{max}$ .
  - (4) Explain that why allosteric enzymes do not follow this equation.
4. Metabolic pathways are usually divided into the catabolic pathways and the anabolic pathways: (12 分, 每小題 6 分)
  - (1) Describe the features that generally distinguish the pathways of catabolism from the pathways of anabolism.
  - (2) Considering the gluconeogenesis pathway and glycolysis pathway; explain why anabolic pathways and catabolic pathways differ.
5. Describe how ATP is formed through the substrate-level phosphorylation and the oxidative phosphorylation. (12 分)
6. Define and contrast the following pairs of terms: (16 分, 每小題 4 分)
  - (1) Integral membrane protein and peripheral membrane protein
  - (2) Glycerol-phosphate shuttle and malate-aspartate shuttle
  - (3) Nucleoside and nucleotide
  - (4) Ketogenic amino acid and glucogenic amino acid



# 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

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共 10 頁第 1 頁

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.

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 10 頁第 2 頁

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

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 10 頁第 3 頁

- 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  $\sigma$  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 isomerase.      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?



國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 10 頁第 4 頁

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.

# 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】

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共 10 頁第 5 頁

- 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

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 10 頁第 6 頁

- 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. Retrotransposons
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 irreproducible.  
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.

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共 10 頁第 7 頁

19. Retrovirus and retrotransposon DNA sequences insert into the DNA of the host with the aid of sequences at their ends called
- telomeres.
  - long terminal repeats (LTRs).
  - inverted repeats.
  - J (joining) segments.
20. What is the function of viral integrase in the life cycle of a retrovirus?
- Integrase synthesizes a DNA molecule from the template of the RNA viral genome.
  - Integrase describes duplicate sites on viral RNA at which primers bind to initiate DNA synthesis.
  - Integrase integrates linear viral DNA into the host chromosome for subsequent transcription.
  - Integrase introduces strand breaks in front of the unwound helix to release tension.
21. Which of the following statements about gene amplification is *false*?
- Gene amplification is responsible for amplification of ribosomal RNA genes in amphibian oocytes.
  - Amplified DNA sequences can be found as free extrachromosomal molecules.
  - Gene amplification occurs as an abnormal event in cancer cells.
  - Amplified DNA sequences are a common occurrence in virally infected cells.
22. "DNA footprinting" is a technique that can be used to identify:
- a region of DNA that has been damaged by mutation.
  - the position of a particular gene of a chromosome.
  - the position of internally double-stranded regions in a single-stranded DNA molecule.
  - 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?
- tRNA molecules are single-stranded RNA.
  - The 3'-terminal nucleotide of tRNA is the site of amino acid attachment.
  - The anticodon arm of tRNA contains a three nucleotide sequence that is identical to a specific mRNA codon.
  - 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?
- Ribosomal translocation occurs before the first aminoacyl-tRNA molecule binds to the small subunit.
  - Initiation of translation occurs only after the small subunit dissociates from the mRNA.
  - The large subunit of the ribosome binds the mRNA before the small subunit.
  - 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?
- GTP-bound EF-Tu interacts with the tRNA acylated with the next amino acid to be added.
  - The function of EF-Ts is to exchange the GDP bound by EF-Tu with GTP.
  - EF-Tu hydrolyzes GTP after dissociation from the aminoacyl-tRNA bound in the A site.
  - Correct codon-anticodon interactions are proofread when the EF-Tu dissociates through a process called accommodation.

國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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※本科目依簡章規定「不可以」使用計算機

共 10 頁第 8 頁

27. Which of the following is NOT true of signal integration by more than one transcription factor?
- It occurs in both bacteria and eukaryotes.
  - It allows for multiple environmental signals to control the expression of a single gene.
  - It is used to control the expression of genes in opposite orientations that are controlled by the same promoter.
  - 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?
- The ubiquitin carboxyl terminus is covalently linked to the protein targeted for degradation.
  - The ubiquitin is covalently linked to the amino terminus protein targeted for degradation.
  - The protein targeted for degradation is modified by three different enzymes in the pathway.
  - 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:
- the dissociation of the repressor from the operator sequence.
  - a conformational change in the repressor that allows the repressor to bind the operator.
  - the recruitment of RNA polymerase.
  - an increase in the expression of tryptophan biosynthetic enzymes.
30. The LexA protein is:
- the repressor of the SOS response.
  - the coprotease for the cleavage of RecA protein.
  - a DNA repair enzyme.
  - a regulatory protein for the *lac* operon.
31. How does the RecA protein contribute to the increased expression of SOS genes?
- RecA protein competes with LexA protein for binding to the operator sequences.
  - RecA protein binds to LexA protein bound to the operator, directly lowering the affinity of LexA protein for DNA.
  - RecA protein binds to free LexA protein, mediating the self-cleavage of the repressor.
  - RecA protein binding to the promoter region recruits RNA polymerase.
32. Upon the initial infection of a host cell by bacteriophage  $\lambda$ , 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?
- Modification leads to chromatin condensation.
  - The RNA polymerase associated with the gene dissociates from DNA when HDACs bind to the corepressor.
  - Increased acetylation of the nucleosomes in the vicinity of the gene.
  - 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?
- Mediator binds to RNA polymerase II.
  - Mediator binds to upstream enhancer sequences.
  - Mediator binds to general transcription factors.
  - Mediator binds to transcription activators.
35. The process of human X-chromosome inactivation in female cells:

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科目名稱：分子生物學【生科系碩士班乙組】

題號：421003

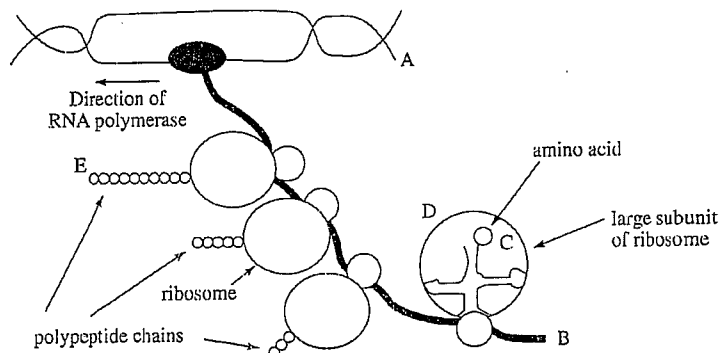
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共 10 頁第 9 頁

- 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. cdab      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?

# 國立中山大學 102 學年度碩士暨碩士專班招生考試試題

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共 10 頁第 10 頁

- (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  $\beta$ -galactosidase would be expected to be produced at induced levels. (Assume that glucose is not present in the medium.) (5 points)

<u>Genotype</u>	β-galactosidase production	
	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)