

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：普通生物學【生科系碩士班甲組】

題號：421004

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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 β 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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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

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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)

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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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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.

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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.

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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

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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.

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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?