

請依題號順序作答

一、單選題 (每題 2 分, 共 84 分)

1. Which of the following combinations of geo-climate region and the corresponding prevailing terrestrial biome is realistic?

- (A) Boreal desert.
- (B) Mediterranean woodland.
- (C) Temperate savanna.
- (D) Tropical tundra.

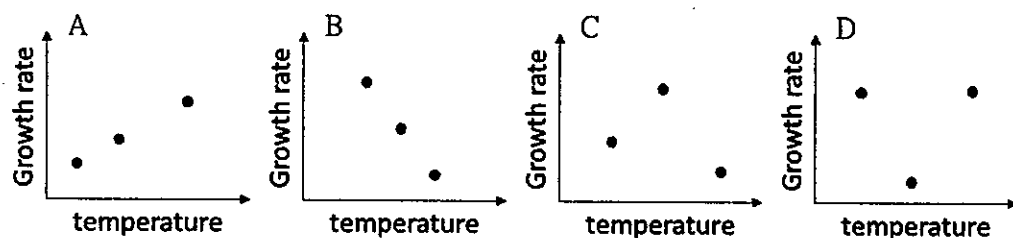
2. Which of the following descriptions regarding the chemical conditions in aquatic biomes is correct?

- (A) The salinity is more variable in the open ocean than in the intertidal zone.
- (B) Low phosphorus and low nutrients are signatures of eutrophic lakes.
- (C) Aquatic organisms that require high oxygen level to survive often inhabit the downstream of rivers.
- (D) Coral reefs and kelp beds occur where the water is rich of dissolved oxygen.

3. Menghuan Lake (夢幻湖) is a natural lake within Yangmingshan National Park, Taiwan. It locates at a height of 870 m above sea level, and it is rather shallow—with averaged < 1 m water depth. Which of the following scenarios is unlikely for this lake?

- (A) While walking along the lake shore, you spot some *Isoetes taiwanensis* (台灣水韭) which is an aquatic herbaceous plant.
- (B) During the night, the calls of the frog *Kurixalus idiotocus* (面天樹蛙) break the silence.
- (C) You tried to find big carnivorous fish, as big as around 80 cm long, in the lake. But you could not find anything as such.
- (D) Due to its closeness to the nearby volcanos, the microbiome living in the lake is mostly composed of species adapted to high environmental pH.

4. You sampled a species of bacteria from the field and brought it back to the lab, then cultured it under different temperature settings. You subsequently recorded the population growth rates of this bacterium. Which of the following figures is the most unlikely one generated from your records?



5. As regards water regulation, which of the following statement is correct?

- (A) An animal's internal water generally reflects a balance between ingested or absorbed water and the water loss due to evaporation or various body secretions.
- (B) It feels cool when wind blows, thus wind generally decreases water evaporation from creatures.
- (C) In extremely dry and hot habitats, like deserts, plants tend to have many big flat leaves to shade themselves so as to minimize water evaporation.
- (D) Fish live in the water and thus require no water regulation mechanism to survive.

6. As regards the energy sources for living, which of the following trophic types has not yet been discovered on earth?

- (A) Chemosynthetic autotrophic fungi
- (B) Heterotrophic plants
- (C) Photosynthetic autotrophic protists
- (D) Chemosynthetic autotrophic archaea

7. Which of the following combinations of term and corresponding definition and/or function is correct?

- (A) Countershading: a mechanism to keep the heat in an organism's body.
- (B) Countercurrent: a body color pattern that make an organism less visually detectable.
- (C) Carrying capacity: the maximum population of a species that a given (eco)system can sustain.
- (D) Camouflage: an individual that leaves its original home range.

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8. Which of the following terms is describing intraspecific ecological relationships/phenomena?

- (A) Damuth's law
- (B) Hamilton's rule
- (C) Batesian mimicry
- (D) Müllerian mimicry

9. In an imaginary scenario, there is a fish species living in ponds, and individuals living in the same pond are more or less genetically related. When predation risk is high in the environment, the fish tends to form fewer breeding groups, each has one bright-colored male who copulates with a harem of females, while many other not-so-bright males stay around and help protect the eggs of the former. On the other hand, when predation risk is low in the environment, the fish tend to form many more smaller breeding groups, again with one bright-colored male but only with two to four females, and with no male helpers. It is known that the gender determination of this fish is chromosomal, and the male fish can adjust their body color during development. With this given scenario, which of the following statements is incorrect?

- (A) There may be a trade-off between mate attraction vs. predator avoidance for the male fish.
- (B) There may be a trade-off between direct fitness vs. indirect fitness for the male fish.
- (C) There may be a trade-off between being a male vs. a female for this fish.
- (D) We shall expect to see higher level of inbreeding in the populations that have been sharing a pond with more predators for a long time.

10. Which of the following is not a mechanism changing allele frequencies in a population?

- (A) Being at Hardy-Weinberg equilibrium
- (B) Immigrants' joining
- (C) Genetic drift
- (D) Natural selection

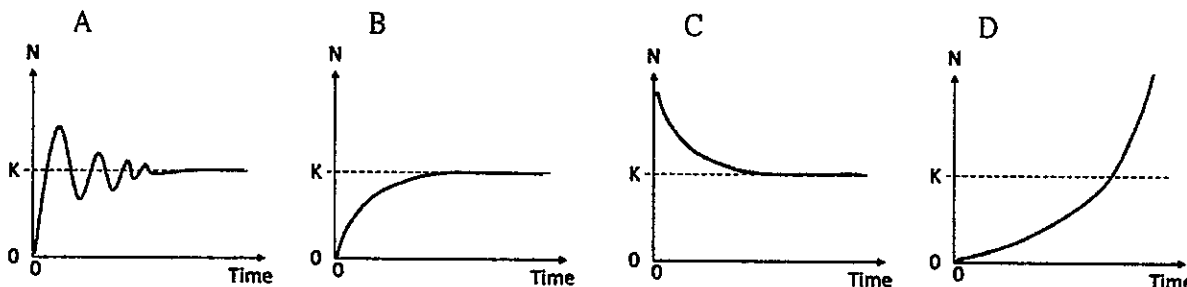
11. In terms of the small-scaled spacing between individuals within a population, which of the following statements/reasonings is sensible?

- (A) Clumped distribution may be shaped by interactions among individuals, but not interactions between individuals and the local environment.
- (B) Random distribution is a strong indication of direct competition among individuals.
- (C) Regularly-spaced plant individuals may reflect that they are competing for resource, possibly the water and nutrients coming from the soil.
- (D) The pattern of such small-scaled spacing is life-long fixed for any given species.

12. Which of the following is not a necessary condition for natural selection of a trait?

- (A) Inheritance of the trait
- (B) Variation of the trait across individuals
- (C) Association of the trait's value to varying fitness
- (D) Ongoing gene mutation

13. Which of the following figures correctly demonstrates the population dynamics under logistic growth: $\frac{dN}{dt} = rN(1 - \frac{N}{K})$?



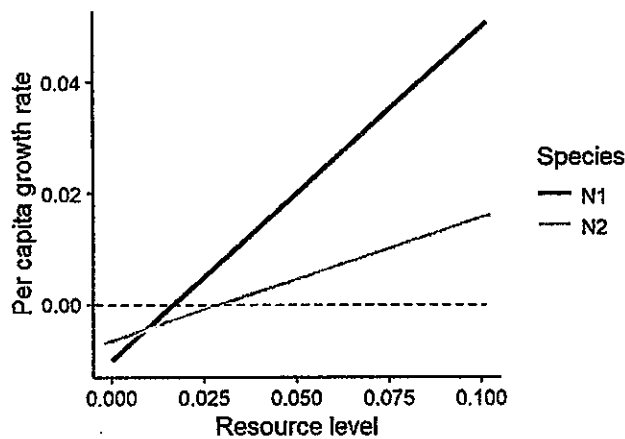
14. Which of the following ecological process cannot promote species coexistence?

- (A) Character displacement
- (B) Bird species feeding at different parts of the tree canopy
- (C) Species being checked by their host-specific natural enemy
- (D) Each species consuming more of the competitor's limiting resource

15. _____ is the term used to describe the scenario when species negatively impact each other indirectly by sharing a common predator; _____ is the term used to describe the scenario when competing species impact each other directly (e.g., aggressively defend their use of resources by causing harm to each other).

- (A) Exploitative competition; intransitive competition
- (B) Exploitative competition; interference competition
- (C) Apparent competition; interference competition
- (D) Interference competition; apparent competition

16. Two plant species, N_1 (black) and N_2 (grey), are competing for a shared abiotic resource in a stable environment (e.g., nitrogen following a chemostat dynamics). The relationship between nitrogen level and their per capita growth rate are given in the following figure. Can you predict the winner of competition?



- (A) N_1 (black) will win competition
- (B) N_1 and N_2 can coexist as the lines cross
- (C) N_2 (grey) will win competition
- (D) Depends on which species arrived first

17. Suppose we observed that there are two species of mosses that live on a huge rock, species 1 was mostly observed on the top of the rock and species 2 was observed on the lower part of the rock. When we removed species 2, species 1 tends to grow over the whole rock; alternatively, when we remove species 1, species 2 still only grows on the lower part. What would you conclude from this observation?

- (A) Species 1 has a larger realized niche compared to species 2
- (B) Species 1 has a larger fundamental niche compared to species 2
- (C) Species 1 has a smaller fundamental niche compared to species 2
- (D) Species 1 outcompetes species 2 on the lower part of the rock

18. Based on the stress gradient hypothesis, how would the focal plant individual respond when we remove its surrounding neighbors under a stressful versus a benign (stress-free) environment?

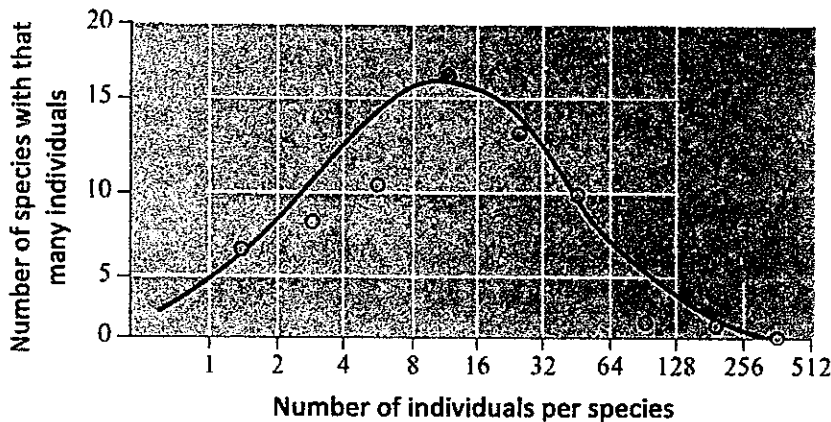
- (A) Grow worse in the stressful environment and grow better in the benign environment
- (B) Grow better in the stressful environment and grow worse in the benign environment
- (C) Grow worse in both environment
- (D) Grow better in both environment

19. Which of the following statements about the concept of ecological succession is most accurate?

- (A) A series of gradual changes in the species composition of a community after a disturbance, following a strictly deterministic path with each stage predictably leading to the next
- (B) Early successional stages are typically characterized by high species diversity and stability, while late successional stages have lower diversity
- (C) In forests, early successional stages often have fast-growing, opportunistic species, whereas late successional stages often have by slower-growing, shade-tolerant species
- (D) Both early and late successional stages are dominated by similar species types, with changes occurring primarily in the physical structure of the habitat

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20. Which of the following statement about the figure below is correct?

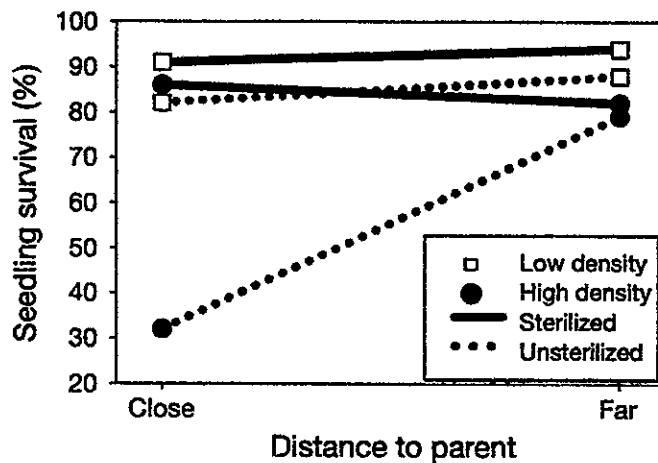


- (A) There are 10 species with a observed population size between 32 and 64 individuals
- (B) Frank Preston proposed to use a normal distribution to describe the curve
- (C) The curve is called the rank abundance curve
- (D) Greater sampling effort will reveal more species on the right tail of the distribution

21. In an aquatic ecosystem, the introduction of a top predator leads to a decrease in the herbivorous fish population, which in turn results in an increase in algae biomass. This scenario best exemplifies which ecological concept?

- (A) Bottom-up control, as the increase in algae indicates a greater availability of nutrients
- (B) Trophic cascade, as the top predator causes indirect effects at lower trophic levels
- (C) Competitive exclusion, as the top predator outcompetes the herbivorous fish
- (D) Mutualism, as the increase in algae benefits both the top predator and the herbivorous fish

22. Packer & Clay (2002; Nature) conducted an experiment where they collected soil from two different locations (i.e., close and far from parent trees) to test the Janzen-Connell hypothesis.



Using those soils, they planted seedlings at either low or high density and added either unsterilized or sterilized soil in a full factorial design. They obtained the following figure. Which of the following interpretation is most accurate given their experimental design and results?

- (A) Comparing the sterilized and unsterilized treatments shows the effects of seedling density
- (B) When planted in low densities, there is a strong effect of distance from parent tree
- (C) Under high planting density, the effect of soil microbes is stronger when closer to parents
- (D) Sterilizing the soil generally result in lower seedling survival

23. All following factors will impact the measurement of alpha and beta diversity within a meta-community. Which one will increase alpha diversity but decrease beta diversity, and therefor has a different effect compared to the other three?

- (A) More uneven distribution in relative abundance within the community
- (B) Higher gamma diversity
- (C) Species' spatial distribution being more clumped
- (D) Smaller survey plot area

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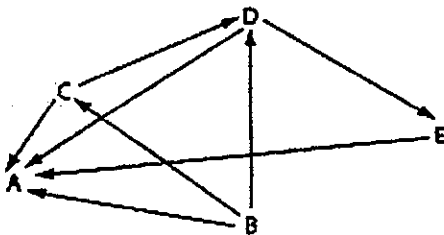
24. The “filtering” metaphor plays a crucial role in shaping the species composition of ecological communities. Which statement best describes the concept of these filtering processes?

- (A) Both environmental and biotic filtering are processes that select for species with specific predatory traits, leading to communities dominated by top predators
- (B) Biotic filtering can be further classified into competition filtering, predation filtering, and mutualism filtering
- (C) Environmental filtering is random processes where community composition is determined by chance events like colonization or extinction
- (D) Environmental filtering involves the selection of species that can tolerate or thrive under certain abiotic conditions, whereas biotic filtering involves species interactions that further refine community composition

25. In the context of mutualistic symbiotic relationships, “cheaters” are sometimes observed. Which of the following best describes this phenomenon?

- (A) Cheaters are species that always benefit from mutualistic relationships, while their partners suffer significant harm, thus converting the interaction into parasitism
- (B) Cheaters refer to individuals or species that benefit from the relationship without providing the reciprocal benefit to their partner, potentially destabilizing the mutualism
- (C) Cheating in mutualism specifically refers to the scenario where both partners try to outcompete each other, leading to the breakdown of the symbiotic relationship
- (D) The term 'cheaters' in mutualism refers to external species that invade and disrupt the symbiotic relationship for their own benefit

26. Use the following diagram of a hypothetical food web to answer the question. The arrows represent the transfer of energy between the various trophic levels.



Which letter represents an organism that could only be a primary consumer?

- (A) A
- (B) B
- (C) C
- (D) D

27. According to the nonequilibrium model of community diversity, _____.

- (A) community structure remains stable in the absence of interspecific competition
- (B) communities are assemblages of closely linked species that are permanently changed by disturbance
- (C) interspecific interactions induce changes in community composition over time
- (D) communities are constantly changing after being influenced by disturbances

28. The feeding relationships among the species in a community determine the community's

- (A) secondary succession.
- (B) ecological niche.
- (C) species richness.
- (D) trophic structure.

29. Regarding the global carbon cycle, which is the largest active terrestrial carbon pool?

- (A) Soil
- (B) Forest
- (C) Grassland
- (D) Tundra
- (E) Rock

30. Which of the following outcomes is caused by excessive nutrient runoff into aquatic ecosystems?
(A) depletion of ozone layer
(B) acid precipitation
(C) biological magnification
(D) eutrophication
31. The main cause of the increase in the amount of carbon dioxide in Earth's atmosphere over the past 150 years is _____.
(A) increased worldwide primary production
(B) an increase in the amount of infrared radiation absorbed by the atmosphere
(C) the burning of larger amounts of wood and fossil fuels
(D) additional respiration by the rapidly growing human population
32. Why do logged tropical rain forest soils typically have nutrient-poor soils?
(A) Tropical bedrock contains little phosphorous.
(B) Logging results in soil temperatures that are lethal to nitrogen-fixing bacteria.
(C) Most of the nutrients in the ecosystem are removed in the harvested timber.
(D) The cation exchange capacity of the soil is reversed as a result of logging.
33. Of the following statements about protected areas that have been established to preserve biodiversity, which one is NOT correct?
(A) About 25% of Earth's land area is now protected.
(B) National parks are one of many types of protected areas.
(C) Management of a protected area should be coordinated with management of the land surrounding the area.
(D) It is especially important to protect biodiversity hot spots.
34. Which of the following is a generally accurate statement about the current research regarding forest fragmentation?
(A) Fragmented forests promote biodiversity because they result in the combination of forest-edge species and forest-interior species.
(B) In fragmented forests, the number of forested-adapted species tend to decline and the number of edge species tend to increase.
(C) Fragmented forests are the goal of conservation biologists who design wildlife reserves.
(D) The disturbance of timber extraction causes the species diversity to increase because of the new habitats created.
35. What are the consequences if decomposers are removed from the carbon cycle?
(A) CO₂ levels in the atmosphere increase.
(B) Primary consumers are not able to consume as many producers.
(C) The burning of wood and fossil fuels increases.
(D) Fewer carbon compounds are broken down.
36. Agricultural lands frequently require nutrient augmentation because _____.
(A) nitrogen-fixing bacteria are not as plentiful in agricultural soils because of the use of pesticides
(B) the nutrients that become the biomass of plants are not cycled back to the soil on lands where they are harvested
(C) land that is available for agriculture tends to be nutrient-poor
(D) cultivation of agricultural land inhibits the decomposition of organic matter
37. Which of the following has the greatest effect on the rate of chemical cycling within an ecosystem?
(A) the ecosystem's rate of primary production
(B) the secondary production efficiency of the ecosystem's consumers
(C) the rate of decomposition in the ecosystem
(D) the trophic efficiency of the ecosystem
38. Which of the following factors could cause the largest increase in the effective population size of a species?
(A) an increased number of males
(B) an increase in the total population size
(C) an increase in the number of breeding males and females
(D) an increased number of females

39. Which of the following threats to biodiversity is targeted at specific species rather than groups of species?

- (A) introduced species
- (B) habitat destruction
- (C) increased levels of atmospheric carbon dioxide, a cause of global warming
- (D) overharvesting

40. Which of the following observations provides the best evidence of a biodiversity crisis?

- (A) the incursion of a non-native species
- (B) increasing pollution levels
- (C) high rate of extinction
- (D) climate change

41. Global warming is a phenomenon in which global temperature is increasing because of increasing greenhouse gas concentrations in the atmosphere. Scientists believe that the Earth can tolerate X-Y degree Celsius temperature increase before it passes the point of no return and moves into a positive feedback loop. "X-Y" should be

- (A) 1-2
- (B) 3-4
- (C) 5-6
- (D) 7-8

42. Which of the following is primarily responsible for limiting the number of trophic levels in most ecosystems?

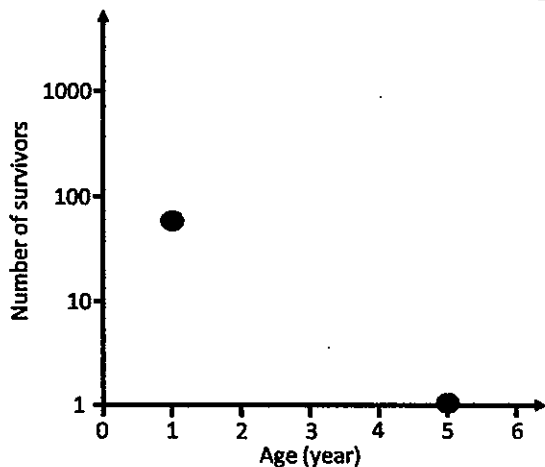
- (A) Many primary and higher-order consumers are opportunistic feeders.
- (B) Decomposers compete with higher-order consumers for nutrients and energy.
- (C) Nutrient cycling rates tend to be limited by decomposition.
- (D) Energy transfer between trophic levels is usually less than 20 percent efficient.

二、簡答題 (共 16 分)

43-48. Based on the given values, please complete the below life table of a species (questions 43-46, each blank 1pt), then draw its survivorship curve (question 47) and answer question 48 (questions 47-48, 2pt each).

Age (years)	Num. of survivors at the beginning of each year	Number of deaths during the year
0-1	1000	927
1-2	(43)	63
2-3	10	(44)
3-4	(45)	1
4-5	2	(46)
5-6	1	1

On the answer sheet, draw the survivorship curve with the coordinates below (47).



Following the above, this kind of survivorship curve is typical for (48)-selected animals in terms of r/K life-history strategy.

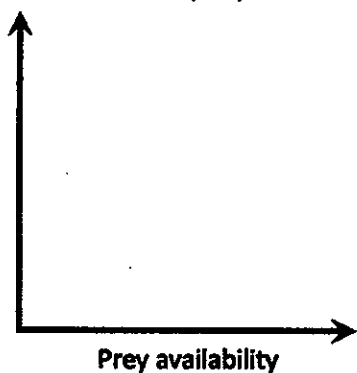
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49-52. A predator's functional response describes how per predator consumption rate varies with prey availability. The commonly-used ones are Holling type-I, type-II, and type-III. Please draw the classic shape of the Holling type-II and type-III functional response. On the answer sheet, draw a plot with the coordinates below (i.e., x-axis is "prey availability" and y-axis is "predation rate per predator") and sketch the shape of the functional response. Then, name one biological mechanism that cause the functional response to have the specific shape. (4 questions, 2 points each)

(49)

Holling type-II functional response

Predation rate per predator

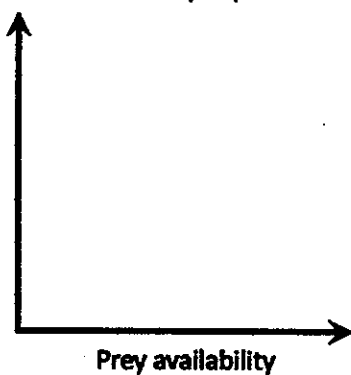


Biological mechanism: (50)

(51)

Holling type-III functional response

Predation rate per predator



Biological mechanism: (52)

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