



INDIAN INSTITUTE OF SCIENCE  
BANGALORE - 560012

**ENTRANCE TEST FOR ADMISSIONS - 2009**

**Program : Research**  
**Entrance Paper : Ecological Sciences**  
**Paper Code : ES**

Day & Date  
**SUNDAY, 26<sup>TH</sup> APRIL 2009**

Time  
**9.00 A.M. TO 12.00 NOON**

# **GENERAL INSTRUCTIONS**

1. This paper consists of 100 questions and carries a total of 100 marks, one mark for each question.
2. Answers to all the questions should be marked only on the OMR sheet provided.
3. For each question, darken the appropriate bubble to indicate your answer.
4. Use only HB pencils for bubbling answers.
5. Mark only one bubble per question. If you mark more than one bubble, the answer will be evaluated as incorrect.
6. If you wish to change your answer, please erase the existing mark completely before making the other bubble.
7. There will be no negative marking for wrong answers.
8. Candidates should fill in the required fields on the OMR sheet attached.

## ECOLOGICAL SCIENCES

1. Each of the five departments from the division of biological sciences deutes two members to serve on the interview committee. If the committee can have only five members, and if each of the departments has to be represented in the committee, in how many different ways can the committee be constituted?

- (A)  $5^2$
- (B) 32
- (C)  $5!$
- (D)  ${}^{10}C_2$

2. Ten pairs of laboratory mice were kept in a research station located at high altitude (3000 m) and ten pairs of the same strain at a low altitude station located at sea level. Both were allowed to breed and their progeny were tested at 4 weeks of age on a treadmill for aerobic performance. The mice born and raised at high altitude outperformed the low-altitude reared ones when subjected to experimentally-induced low oxygen levels. Mice born and raised at low altitudes outperformed their high-altitude cohorts when oxygen levels were experimentally raised. This experiment demonstrates that

- (A) Low oxygen levels experienced during development are always adaptive.
- (B) High oxygen levels experienced during development are always maladaptive.
- (C) Mice are adapted to the oxygen levels experienced during their development.
- (D) Mice are not adapted to the oxygen levels experienced during their development.

3. Ant colonies often have colony-specific hydrocarbon cocktails on their bodies. When a queen from one colony was removed, then re-introduced a few hours later after being coated with the hydrocarbon cocktail of another colony, she was aggressively attacked. Presentation of a paper soaked in the cuticular cocktail of the other colony elicited strong aggressive responses. In the control situation, where the queen was removed and re-introduced after the same time without any treatment, she was immediately re-accepted. This experiment shows that the cuticular hydrocarbon cocktail

- (A) Is necessary to detect strangers.
- (B) Is sufficient to detect strangers.
- (C) Is both necessary and sufficient to detect strangers.
- (D) Is neither necessary nor sufficient to detect strangers.

4. In carrier pigeons there is a rare inherited condition that causes the death of the chicks before hatching. In order for this disease to be passed from generation to generation there must be parent birds that

- (A) Are heterozygous for the disease.
- (B) Have the disease themselves.
- (C) Produce new mutations for this disease.
- (D) Are closely interbred.

5. Caterpillars of an insect species are specialised to feed on the leaves of a single host plant species, which is toxic and contains a chemical which releases cyanide when degraded. Concentrations of this chemical were measured in the leaves as well as the blood, gut and faeces of the caterpillars. The chemical was found to be higher in concentration in the gut and faeces of the caterpillars than in the leaves but absent in the blood. The caterpillars were not seen to suffer any ill effects from feeding on the leaves but were instantly killed on artificial exposure to cyanide. This suggests that the caterpillars have evolved a mechanism to

- (A) Absorb and detoxify the cyanide precursor by metabolising it.
- (B) Selectively forage on leaves that do not contain the cyanide precursor.
- (C) Resist the toxic effects of cyanide.
- (D) Inhibit the cyanide precursor from breaking down to release cyanide.

6. Mantises belong to the insect order

- (A) Isoptera
- (B) Dictyoptera
- (C) Orthoptera
- (D) Coleoptera

7. Current phylogenetic studies indicate that seals and sea lions are part of

- (A) Perissodactyla
- (B) Sirenia
- (C) Carnivora
- (D) Cetacea

8. The major nitrogenous excretory product in birds and reptiles is

- (A) Urea
- (B) Uric acid
- (C) Ammonia
- (D) Ammonium salts

9. Adult male frogs produce loud calls from a stationary calling position, which are detected by distant females of their species, who then approach them. Given that a male frog calls with a sound pressure level of 80 decibels (measured at a distance of 1 m), that sound attenuates by 6 dB for every doubling of distance and that females need a minimum sound pressure level of 50 dB to hear the male, what is the maximum distance at which a female will hear the male?

- (A) 16 m
- (B) 32 m
- (C) 64 m
- (D) 128 m

10. Of three lizard species A, B and C that form a monophyletic group, A and B possess the ability to glide in the air, while C does not. Molecular genetic studies indicate that B and C are more closely related to each other than either is to A. Which of the following statements is most likely to be true, given the principle of parsimony?

- (A) Gliding in the air is an ancestral trait for this group.
- (B) Gliding in the air is a derived trait for this group.
- (C) Gliding in the air is an ancestral trait for all lizards.
- (D) The ability to glide has been lost only in this group of lizards.

11. Which of the following ions is a critical player in the event of neurotransmitter release at synapses between neurons?

- (A)  $\text{Na}^+$
- (B)  $\text{K}^+$
- (C)  $\text{Ca}^{++}$
- (D)  $\text{Mg}^{++}$

12. Individually marked bees were trained to forage from a feeder kept 100 m away from their hive. In test trials, the feeders were removed and the distance at which bees started searching for the feeders was noted in each trial. Small weights of 2, 5 and 10 mg were then glued on to each bee's thorax and the trials repeated with each of these weights. The results are shown below:

Weight added to the bees (mg)	Distance from hive at which searching behaviour was initiated (m)
0	100
2	85
5	75
10	50

This experiment suggests that

- (A) The estimation of distance by flying bees is positively correlated with the energy expended during flight.
- (B) The estimation of distance by flying bees is negatively correlated with the energy expended during flight.
- (C) The estimation of distance by flying bees is uncorrelated with the energy expended during flight.
- (D) Bees are unable to perform distance estimation when weights are added to their bodies.

13. Newborn chicks will react by fleeing for cover when a model of a hawk is drawn above them in the air. Experiments reveal that this response is completely non-specific and can be elicited by a moving object of any shape in the air. When the chicks are three weeks old, they respond selectively to objects that have the shapes of birds of prey and ignore others. In an experiment, newly hatched chicks were divided into two groups: One was exposed twice a day to models of different shapes and sizes, and the other was reared with no exposure to such models at any point. After three weeks, both groups were tested for their responses to differently shaped models. Chicks of both groups showed selective avoidance responses only to models shaped like birds of prey. This experiment shows that

- (A) The avoidance behaviour by fleeing for cover is learned in the first three weeks post-hatching.
- (B) The selective avoidance of birds of prey is learned in the first three weeks post-hatching.
- (C) The selective avoidance of birds of prey develops in the first three weeks post-hatching and is not learned.
- (D) The selective avoidance of birds of prey is learned before hatching.

14. A species of bird preys on two insect species, A and B that occur in the same habitat and breed in the same season. At the height of the breeding season, the relative abundance of insect species A and B in the habitat is 0.2 and 0.8 respectively. When the proportion of insect species A and B in the diet of the bird was examined, however, the ratio (A:B) was found to be 0.5:0.5. Which of the following statements is correct?

- (A) The bird preys randomly on the two insect species.
- (B) The bird prefers species A over species B.
- (C) The bird prefers species B over species A.
- (D) The bird preys on the two insect species in accordance with their relative abundance.

15. The relative abundance of individuals in a community can be described by a model known as the 'broken stick' where a stick can be broken in different ways to produce a distribution of pieces that represent the proportion of a species in the community. A method that will produce very unequal pieces is

- (A) Random breakage of the stick.
- (B) Uniform breakage of the stick.
- (C) Sequential breakage of the stick where the largest piece is further subdivided.
- (D) Sequential breakage of the stick where the smallest piece is further subdivided.

16. Myelination of axons results in

- (A) An increase in the frequency of firing of action potentials.
- (B) A decrease in the frequency of firing of action potentials.
- (C) A decrease in the velocity of conduction of action potentials.
- (D) An increase in the velocity of conduction of action potentials.

17. In an experiment with red-winged blackbirds, which are territorial songbirds, females were presented a choice between normal control males and males whose wings were artificially made redder. Females were found to mate more often with males with artificially redder wings than with normal males. The males with artificially reddened wings, however, also attracted more males, who attacked them. The above experiment suggests that redness of male wings evolves due to

- (A) Intersexual selection rather than intrasexual selection.
- (B) Intrasexual selection rather than intersexual selection.
- (C) Both intra- and inter-sexual selection.
- (D) Neither intra- nor inter-sexual selection.

18. A northern population of a frog species that is sympatric with three other frog species was found to have lower call frequencies than a southern population of the same frog species. This is an example of

- (A) Adaptive radiation
- (B) Allopatric speciation
- (C) Character displacement
- (D) Convergence

19. Digger wasps paralyse cockroach prey by injecting venom into their head and thorax via their stings. In an experiment, "hot" wasps were produced, whose venom components were radioactively labelled. Cockroaches were divided into two groups: one group was stung by "hot" wasps, while the other was artificially injected in the head and thoracic capsules with the same amount of radioactive venom. Examination of the cockroaches revealed high radioactivity in the head and thoracic ganglia compared with the rest of the head and thorax in stung cockroaches but only low levels in the ganglia as compared to other tissue in injected cockroaches. This experiment demonstrates that

- (A) Wasps exhibit extreme precision in their stinging behaviour.
- (B) Radiolabeling enables wasps to produce large quantities of venom.
- (C) Radiolabeling increases the rate of diffusion of venom into the nervous system.
- (D) Radiolabeling increases the precision of wasp stinging behaviour.

20. Most animals in a coral reef are brightly coloured, especially red, while those in the deeper ocean are not. This is because

- (A) The deep ocean does not contain pigments that animals can absorb for their colouration.
- (B) Longer wavelengths of light are attenuated with water depth.
- (C) Shorter wavelengths of light are attenuated with water depth.
- (D) The coral reef uses photosynthetic organisms to produce a green colour against which other colours, such as red, are clearly visible.

21. One reason that an amoeba cannot be as large as a whale is that

- (A) There simply is not enough food in the ocean to support such a large amoeba.
- (B) The volume would be much too small for its surface area.
- (C) The surface area would be too small to hold that much volume.
- (D) The amount of surface area per unit volume would be too small for sufficient gas exchange.

22. Which of the following allows snakes to eat large prey?

- (A) Long caecum
- (B) Unfused mandibles
- (C) Strong mandibles
- (D) A gizzard

23. Which theory proposes that the number of species at a site is determined by the balancing of rates of immigration of species to that site with the local extinction of species already present?

- (A) Stability-Time Hypothesis
- (B) Pleistocene Forest Refugia Hypothesis
- (C) Theory of Island Biogeography
- (D) Periodic Extinction Hypothesis

24. Two students were testing the amount of fertilizer that would best promote the growth of strawberries in a garden. Which of the following could be an unavoidable source of experimental error?

- (A) Length of the study
- (B) Variation in the plants
- (C) Variable amount of watering
- (D) Fertilization during the study

25. All of the following respiratory surfaces are associated with capillary networks except

- (A) Gills of fishes.
- (B) Skin of earthworms.
- (C) Skin of frogs.
- (D) Tracheae of insects.



26. A songbird species produces specific alarm calls in the presence of aerial predators such as eagles. On hearing an alarm call, individual songbirds drop what they are doing and fly into trees. In an observational field study, the number of eagle alarm calls produced in different contexts was recorded and the results are shown below:

Behavioural context	Number of eagle alarm calls observed/day
Presence of eagles	35
Absence of eagles, songbirds foraging	10
Absence of eagles, songbirds not foraging	0

The above results may be construed as evidence for

- (A) Mimicry
- (B) Aposematism
- (C) Deception
- (D) Camouflage

27. Which of the following transfusions is compatible?

Donor Recipient

- (A) A+ B+
- (B) A- A+
- (C) O+ O-
- (D) AB+ O+

28. A blue whale stranded on a beach will suffocate because

- (A) It needs to breathe water.
- (B) Its evaginated gills will dry out.
- (C) It will not be able to contract its diaphragm.
- (D) It will get air bubbles in its blood stream.

29. The dawn chorus of singing birds is a very striking and widespread phenomenon. Which of the following is unlikely to be a plausible explanation for the evolution of the dawn chorus of birds?

- (A) Increasing light levels at dawn trigger singing activity in birds.
- (B) By singing at dawn, birds avoid acoustic interference from other sympatric callers such as cicadas and frogs.
- (C) By calling at dawn, the bird community can maximise its fitness relative to the frog community.
- (D) Atmospheric conditions for transmission of birdsong are optimal at dawn.

30. Two closely related insect species are found on the same tree. If they mate, they produce sterile offspring. One of the species is active in the early evening, and the other in the late evening. The two species present a case of

- (A) Co-evolution
- (B) Reproductive isolation
- (C) Competition
- (D) Allopatric speciation

31. The bee orchid mimics a female bee and attracts male bees for

- (A) Pollination
- (B) Copulation
- (C) Seed dispersal
- (D) Scaring away herbivores

32. A comparative study of two islands for reptile species is given below

Island A: Species 1 (10)	Island B: Species 1 (75)
Species 2 (30)	Species 3 (10)
Species 3 (30)	Species 5 (5)
Species 4 (20)	Species 6 (5)
Species 5 (10)	Species 7 (5)

The numbers in brackets signify percentage of the total number of individuals contributed by each species on that island. Which of the following is true?

- (A) Island A is more species rich than island B.
- (B) Island B has more species diversity than island A.
- (C) Island A has more species diversity than island B.
- (D) Island B is more species rich and more diverse than island A.

33. A man has a hemophiliac son, and a daughter who is a hemophilia carrier. His mother was a hemophilia carrier, and so was his grandmother. What is the probability that his wife is a hemophilia carrier?

- (A) 33%
- (B) 50%
- (C) 100%
- (D) 25%

34. A certain *Drosophila* mutant grows faster in a medium containing chemical X. The wild type flies were accidentally grown in a medium containing X, and it was observed that 4% of the flies were the faster growing type. What percentage of the population is expected to be homozygous wild type if the gene is in Hardy-Weinberg equilibrium?

- (A) 8%
- (B) 16%
- (C) 32%
- (D) 64%

35. In a population where the sex ratio at birth is 1:1, a couple has three children, two of which are girls. What is the probability of their fourth child being a boy?

- (A) 100%
- (B) 50%
- (C) 25%
- (D) 75%

36. An island has an introduced butterfly species. The population has a majority of white butterflies, and a small proportion of individuals that have pink wings. In the mainland, the proportion of white butterflies is much lower than the pink winged ones. This is most likely due to

- (A) Natural selection
- (B) Allopatric speciation
- (C) Mutation
- (D) Genetic drift

37. By synchronizing reproduction, individuals of a prey species can swamp predator populations and thereby increase the chances of survival of their offspring. Such a strategy will yield the greatest benefits if they also space their reproduction so that they reproduce once every

- (A) 9 years
- (B) 21 years
- (C) 23 years
- (D) 16 years

38. In a population of mice, 25 of every 400 individuals died due to a recessive mutation. What percentage of individuals in the resulting population are heterozygotes?

- (A) 37.5%
- (B) 60%
- (C) 56.25%
- (D) 40%

39. A genetic cross yielded the following result:

Number of plants with

- Red flowers, yellow leaves = 558
- Red flowers, mottled leaves = 190
- White flowers, yellow leaves = 188

The most likely explanation for this result is that

- (A) *White flowers with mottled leaves* is lethal.
- (B) *Red* and *Yellow* are the dominant genes.
- (C) There was a counting error.
- (D) *Mottled leaves* is a trait linked to *red flowers*.

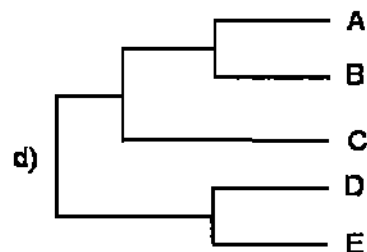
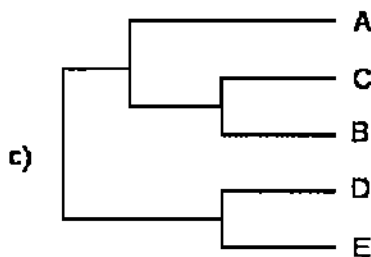
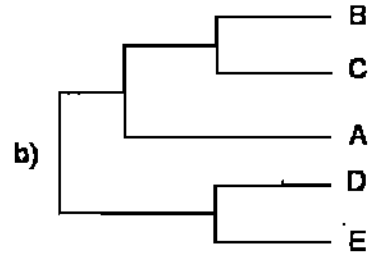
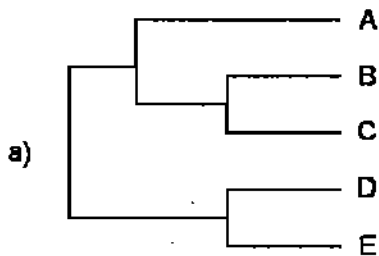
40. Which of the following cells or structures are associated with asexual reproduction in fungi?

- (A) Ascospores
- (B) Basidiospores
- (C) Ascogonia
- (D) Conidia

41. A certain species of toxic butterfly is vividly coloured. A harmless species mimics the colour patterns of the toxic butterfly. The toxic species exhibits an example of

- (A) Warning coloration
- (B) Competition
- (C) Speciation
- (D) Batesian mimicry

42. A phylogeny is an evolutionary tree that shows how species are related to each other. There are four phylogenies shown below. Three of them are identical, in that they show exactly the same relationships between species A, B, C, D and E. Identify the one tree that shows a different relationship.



43. The dominant stage in the life cycle of which of the following groups of plants is the sporophyte?

- (A) Bryophytes, Pteridophytes and Gymnosperms
- (B) Bryophytes, Gymnosperms and Angiosperms
- (C) Pteridophytes, Gymnosperms and Angiosperms
- (D) Only Angiosperms

44. In the control of flowering, the organs that monitor photoperiod are the

- (A) Floral buds
- (B) Lateral buds
- (C) Leaves
- (D) Shoot apex

45. The symbiotic association between plant roots and fungi is called
- (A) Root nodules
  - (B) Mycorrhizae
  - (C) Lichens
  - (D) Parasites
46. Isogamy is characteristic of which of the following taxa?
- (A) Green algae
  - (B) Basidiomycete fungi
  - (C) Liverwort bryophytes
  - (D) Lycopod pteridophytes
47. The woody invasive plant *Lantana camara* has been observed expanding its range into a grassland with C4 grasses. Which of the following factors is most likely to have facilitated this invasion?
- (A) Increased solar radiation
  - (B) Increased atmospheric levels of carbon dioxide
  - (C) Increase in rainfall
  - (D) Increased cloud cover
48. Which of the following is the most potent greenhouse gas per molecule of the gas?
- (A) Carbon dioxide
  - (B) Methane
  - (C) Nitrous oxide
  - (D) Chlorofluorocarbons
49. A certain plant is seen to provide shelter and food to some ant species. The ants help to keep away many insects that feed on the plant. This is an example of
- (A) Herbivory
  - (B) Reciprocal altruism
  - (C) Parasitism
  - (D) Mutualism

50. A DNA strand has the sequence 3'-AGCCTA-5'. What is the sequence of RNA transcribed from it?

- (A) 3'-TCCGAT-5'
- (B) 3'-TAGCCT-5'
- (C) 3'-UAGGCU-5'
- (D) 3'-UCCGAU-5'

51. An experiment to study seed germination started with 1000 seeds. The germination begins on the 11<sup>th</sup> day, and the probability of germination is known to be constant at 0.10 per day between the 11<sup>th</sup> and 15<sup>th</sup> day. How many seeds are likely to germinate on the 13<sup>th</sup> day?

- (A) 81
- (B) 90
- (C) 100
- (D) 80.1111

52. A population is said to be polymorphic for a locus if it has at least

- (A) One allele at that locus.
- (B) Two different alleles at that locus.
- (C) Two different genotypes at that locus.
- (D) Three different genotypes at that locus.

53. Which of the following mutations in a protein coding gene is least likely to produce a non-functional protein?

- (A) Single base deletion in the exon
- (B) Substitution at the third position of an amino acid-coding codon
- (C) Single base insertion in the exon
- (D) A substitution that results in a change of TGC to TGA codon

54. Which of the following is common between prokaryotic and eukaryotic cells?

- (A) Presence of mitochondria
- (B) Presence of chloroplasts
- (C) Membrane enclosed nucleus
- (D) Protein-synthesizing system

55. An allele A is fixed in a population when

- (A) Heterozygosity is 0.
- (B) Homozygosity is 0.
- (C) Heterozygosity is 0.5.
- (D) Homozygosity is 0.5.

56. New mutations are an important source of variation in a population but in the absence of selection they do not contribute significantly to change in allele frequencies. This is because in the absence of selection, most new mutations

- (A) Are likely to be lost due to random sampling.
- (B) Are likely to be fixed due to drift.
- (C) Arise at a very low rate.
- (D) Arise at a very high rate.

57. In a population of N individuals, the frequency of a new unique mutation at a locus is

- (A)  $2N$
- (B)  $1/2N$
- (C)  $1/4N$
- (D)  $4N$

58. In the Hanuman langur, African lion, and many other species, adult males invading and taking over a group of females kill existing infants. Such infanticidal behaviour is likely to have evolved

- (A) To reduce competition for food and thereby increase the reproductive success of invaders.
- (B) As an aberrant trait in small populations.
- (C) To reduce interbirth intervals and thereby increase reproductive success of the invaders.
- (D) To reduce parental care by females and thereby increase foraging behaviour of females.

59. A 22 meter long python is just able to curl itself around the trunk of a cylindrical tree. The radius of the tree-trunk is

- (A) 7 meters
- (B) 349.86 meters
- (C) 350.14 cm
- (D) 3.14159 meters



60. Population X grows linearly and population Y grows exponentially. Population Z follows logistic growth, and has a carrying capacity of 2000. The population size of each was 1600 on 1<sup>st</sup> Jan 2008 and 1800 on 31<sup>st</sup> Dec 2008. Which of the three populations would have had the highest number of individuals on 1<sup>st</sup> July 2008?

- (A) Z
- (B) Y
- (C) X
- (D) Both Y and Z

61. Which of the following is **not** a measure of genetic diversity?

- (A) Heterozygosity
- (B) Number of polymorphic loci
- (C) Number of mitochondrial haplotypes
- (D) Number of chromosomes

62. One third of a class of 360 students failed in mathematics, one fourth failed in physics, one fifth in chemistry and one sixth in biology. If none of the students failed in more than one subject, how many students passed in all the four subjects?

- (A) 36
- (B) 3
- (C) 18
- (D) 0

63. Males of a grasshopper species attract mates using songs. Females reply to each verse of male song with a reply song, enabling males to find them. Song rates are species-specific and are used by both males and females to identify their species. Being poikilotherms (no physiological control of body temperature) their song rates change with temperature, rising linearly with rising temperature in both males and females. Individuals singing in sunny patches have a body temperature of 35° C, those singing in the shade have a temperature of 20° C. Which of the following is most likely to be true?

- (A) A female in the sun will respond most to a male singing in the shade.
- (B) A female in the sun will be found most easily by a male singing in the shade.
- (C) A female in the sun will respond most to a male singing in the sun.
- (D) A female in the sun will not respond to a male singing in the sun.

64. When data from a million families with two children each was compiled, it was found that there were exactly one million boys and one million girls. The proportion of parents with one son and one daughter is likely to be

- (A) 0.50
- (B) 0.25
- (C) Slightly less than 0.50
- (D) Slightly more than 0.50

65. On an island, the number of bird species per sq km, 'S' at a distance 'D' from a mainland is known to satisfy the relation

$$S = \frac{1000}{K + D}$$

where K is a constant.

If the area of the island is 'A', the number of species on the island is  $S * (A^{1/3})$ .

If the mainland has 20 species per sq km, how many species of birds are expected on an island of area 125 sq km and at a distance of 150 km?

- (A) It cannot be calculated since the value of K is not given.
- (B) 20
- (C) 5
- (D) 25

66. Inbreeding is known to be detrimental to populations as deleterious alleles can combine to result in lowered fitness. However, outbreeding may also cause depression because

- (A) Deleterious alleles may be dominant.
- (B) Animals from different populations will not breed with each other.
- (C) Gene complexes may be adapted to a particular environment.
- (D) Deleterious alleles come together when they are inherited by descent from the same ancestor.

67. The probability of passing an exam is 0.5, 0.6 and 0.7 in the first, second and third attempt respectively. How many students out of 10000 are expected to fail even after the third attempt?

- (A) 210
- (B) 2100
- (C) 60
- (D) 600

68. A measure of diversity is Beta diversity or the turnover of species between sites. Comparing the beta diversity of different taxa, which of the following is likely to be true?

- (A) Birds < Reptiles < Amphibians
- (B) Reptiles < Birds > Amphibians
- (C) Reptiles < Birds < Amphibians
- (D) Amphibians < Reptiles > Birds

69. Several species of moths belonging to a variety of lepidopteran families have evolved chemical communication and use chemical signals (pheromones) to attract mates. In some species, females call (release pheromone) and males approach whereas in other species, males produce pheromones and females approach them. Individuals of species with female signalling produce pheromones in tiny quantities while those with male signalling produce pheromones in large quantities. Which of the following is not a likely explanation for this difference between male and female signalling strategies across species?

- (A) Resources are more limiting for females than for males.
- (B) The ability to locate odour sources evolves faster in males than in females.
- (C) Females usually employ low-cost, low-risk strategies while males often employ high-cost, high-risk strategies for reproduction.
- (D) Males that can locate females using minute quantities of odour may have been favoured by sexual selection as this ability may be an honest signal of male quality.

70. The closest biogeographic affinities of the Andaman and Nicobar Islands are to

- (A) The Indian mainland.
- (B) Myanmar and Thailand
- (C) Myanmar, Thailand and Indonesia
- (D) Mainland India and southeast Asia

71. Conservation geneticists believe that conservation must seek to increase genetic diversity, in order to have the necessary raw material to be resilient to change. One conservation action that can help is

- (A) Breeding animals in captivity.
- (B) Maintaining large populations.
- (C) Cloning.
- (D) Maintaining small populations.

72. Species A, B, C and D flower every alternate year, every five years, every three years and every four years respectively. If all of them flowered in 2001, how many times will all of them flower in the same year before 2180?

- (A) Twice
- (B) Three times
- (C) 60 times
- (D) Once

73. Taxa that have close relatives in the Western Ghats and the Western Himalaya are

- (A) Tahr, *Ficus*, Hornbills
- (B) Tahr, *Pinus*, Foxes
- (C) Tahr, Rhododendrons, Squirrels
- (D) Tahr, Rhododendrons, Martens

74. Which of the following pairs is most closely related ?

- (A) Porpoises and whales
- (B) Dugongs and dolphins
- (C) Dolphins and sperm whales
- (D) Dolphins and killer whales

75. Plot A has fewer species of plants than Plot B. The species diversity (Shannon's index) in the two plots of equal size can be exactly the same if

- (A) Species are more evenly distributed in plot A.
- (B) Species are less evenly distributed in plot A.
- (C) The relative abundance is similar in the two plots.
- (D) All species are equally distributed in both plots.

76. Insectivorous plants are adapted to soils that are

- (A) Rich in water.
- (B) Deficient in water.
- (C) Deficient in nitrogenous compounds.
- (D) Deficient in trace elements.

77. Species richness is believed to be correlated with area. Along an altitudinal gradient in a large hill range, this would suggest that

- (A) There are most number of species at high altitudes.
- (B) There are most number of species at very low altitudes.
- (C) There are most species at intermediate altitudes.
- (D) Species richness does not change along altitude.

78. A marine biologist studies two species of reef fish. In species A, only the females disperse between reefs. In species B, only the males disperse between reefs. Which of the following is most likely to be true?

- (A) Species A has greater population genetic structure in mitochondrial DNA.
- (B) Species B has greater population genetic structure in mitochondrial DNA.
- (C) Species A has greater nuclear DNA structure.
- (D) Dispersal has no effect on genetic structure.

79. The rapid appearance of most complex groups of animals and major diversification of other organisms took place during which geological period?

- (A) Permian
- (B) Cambrian
- (C) Silurian
- (D) Jurassic

80. The time spent self-grooming by a gazelle, denoted by  $G$  is related to its parasite load  $P$  by the equation:  $3G - 4P = 2$ . If self-grooming is plotted on the Y axis and parasite load on the X axis, the slope of this relationship is

- (A) 4
- (B) 6
- (C)  $4/3$
- (D)  $3/4$

81. Sorenson's index of similarity is calculated as  $C_s = 2j / (a + b)$ , where  
 j = number of species found in both sites  
 a = number of species in site a  
 b = number of species in site b

Species identity	Community A	Community B
A	3	0
B	0	2
C	8	0
D	0	3
E	5	2
F	1	1
G	0	15
H	0	13
I	3	3
J	5	4
Total	45	45

The similarity between community A and B is

- (A) 0.57
- (B) 0.29
- (C) 1.42
- (D) 0.4

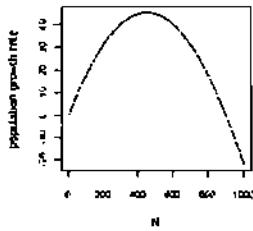
82. To study kin recognition in mice, researchers conducted split brood experiments on ten litters (litter size = 4 in all cases). In each nest 2 of the original resident offspring were joined by 2 offspring transferred from a randomly chosen other litter. Preference tests conducted after 20 days gave the following result: offspring preferred unfamiliar genetic siblings over familiar unrelated nest-mates; familiar genetic siblings over unfamiliar genetic siblings; and familiar unrelated nest-mates over unfamiliar unrelated mice. Which of the following conclusions is least supported by these results?

- (A) Relatives are generally preferred over non-relatives.
- (B) Cues associated with genetic relatedness are involved in kin recognition.
- (C) Familiar nest-mates are preferred over unfamiliar mice.
- (D) Sharing a nest is used as a rule of thumb in kin recognition.

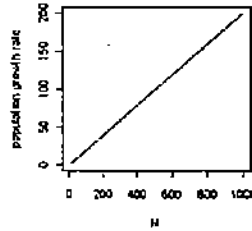
83. Consider a population whose growth rate can be represented as:  $\frac{dn}{dt} = rn \left( \frac{K-N}{K} \right)$

Where  $dn/dt$  is the growth of the population,  $r$  is a constant representing the intrinsic rate of increase,  $K$  is a constant representing carrying capacity, and  $N$  is a variable representing population size. This equation describes a population in which the growth rate of the population is influenced by the size of the population. Which of the following graphs best describes this relationship between growth rate and size, assuming  $r > 0$  and  $100 < K < 1000$ ?

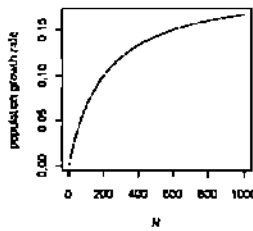
(A)



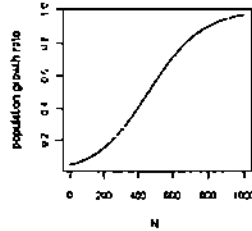
(B)



(C)



(D)



84. Two populations of frogs, P1 and P2, had mean body masses of 24 gm and 20 gm respectively and variances of 4 gm and 16 gm respectively. The coefficient of variation of body mass is approximately \_\_\_\_\_ in P1 and \_\_\_\_\_ in P2.

- (A) 1200; 500
- (B) 8; 20
- (C) 16; 80
- (D) 12; 50

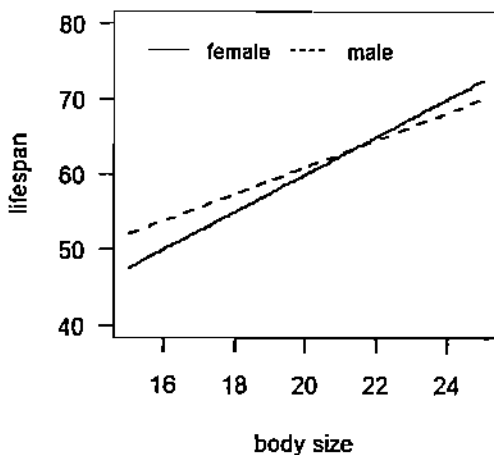
85. The amniotic egg first appeared in early

- (A) Amphibians
- (B) Reptiles
- (C) Birds
- (D) Mammals

86. In several animal societies with female dispersal, offspring stay back with their parents and help rear the next set of offspring. Which of the following benefits is not shared by male and female helpers?

- (A) Inclusive fitness benefits
- (B) Access to resources in a saturated habitat
- (C) Gaining experience for future breeding
- (D) Inheritance of breeding position

87. In a certain species of mongoose, male and female lifespan show the following relationship with body size (figure below).

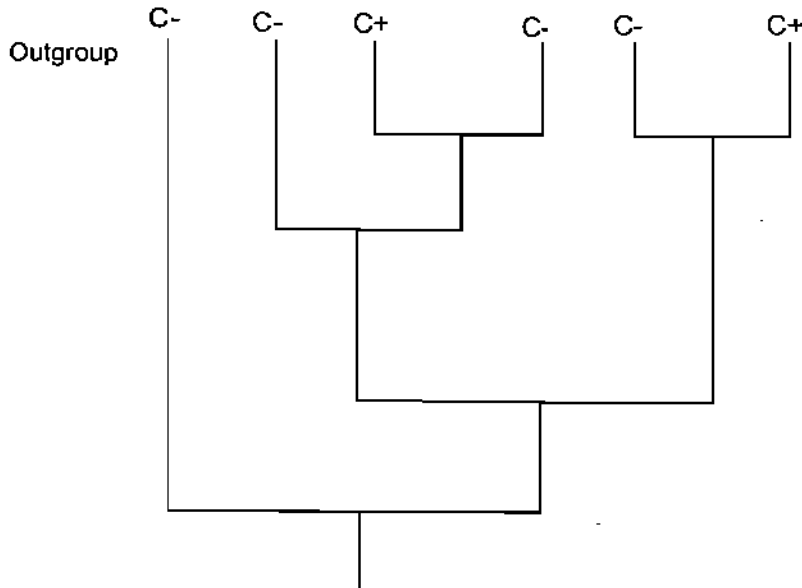


Which of the following statements is least supported by the graph?

- (A) Among females, lifespan increases with body size.
- (B) Lifespan of small females is lower than that of small males.
- (C) Large individuals generally live longer than small individuals.
- (D) Males generally live longer than females.



88. The figure below shows evolutionary relationships among several species of bird. The distribution of a trait, head crest, is also shown. C+ indicates presence of a crest and C- the absence of this trait. According to this figure, the presence of a crest evolved independently \_\_\_\_\_ times according to the principle of parsimony (simplest explanation involving the fewest evolutionary changes).

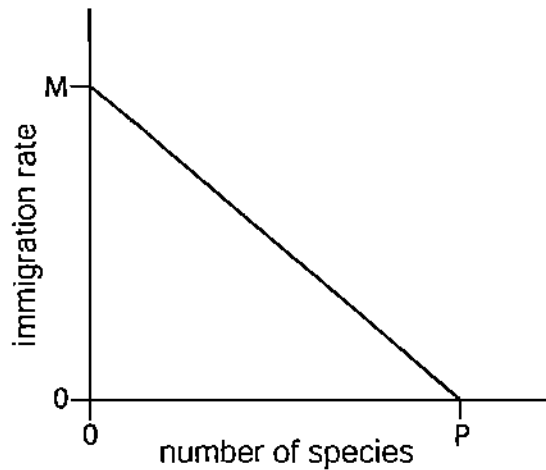


- (A) 2
- (B) 3
- (C) 4
- (D) 5

89. Vampire bats returning to their roost often regurgitate a part of their blood meal from a foraging session to a hungry individual who has been unsuccessful at foraging. Which of the following is the least likely explanation for the maintenance of this behaviour in the population?

- (A) Such altruism is maintained because it reduces the risk of extinction as the population is much more likely to survive through periods of low resources.
- (B) The altruistic individual benefits through future reciprocal acts from the beneficiary.
- (C) Individuals who sacrifice a part of their meal to a hungry individual are more likely to receive blood meals from other individuals in the future.
- (D) Individuals at a roost are related and therefore such altruistic acts result in inclusive fitness benefits.

90. The graph below shows the expected colonization rate by new species as a function of existing species richness in a habitat patch. The slope of this relationship is:



- (A) 1  
(B)  $M/P$   
(C)  $M/P$   
(D)  $1/P$
91. Three predators are foraging independently in a habitat patch where the probability of a predator finding a prey individual during a foraging session is 0.3. The probability that at least one predator successfully feeds in that foraging session is
- (A) 0.30  
(B) 0.66  
(C) 0.90  
(D) 0.70
92. Multiple mating by females is widely seen across mammals. Which of the following is the least likely evolutionary explanation of this behaviour?
- (A) Paternity confusion resulting in lowered infanticide by males.  
(B) Female confusion over the identity of males.  
(C) Female strategy to reduce the risk of sperm depletion and unsuccessful fertilizations.  
(D) Female choice for male traits involved in sperm competition.

93. In general, when it comes to finding mates, males tend to be the competing sex while females are the choosy sex. Which of the following is not an explanation of the evolution of this pattern?

- (A) Males are larger and stronger than females and possess weapons such as antlers and horns.
- (B) Male reproductive success is limited by females.
- (C) Anisogamy
- (D) Female reproductive success is limited by resources, not males.

94. The most limiting nutrients for plants are generally

- (A) Nitrogen and Potassium
- (B) Nitrogen and Phosphorus
- (C) Potassium and Sodium
- (D) Phosphorus and Potassium

95. An inverted pyramid of biomass is likely to be seen in

- (A) A grassland system with tall grasses.
- (B) A grassland system with short grasses.
- (C) A forest system with stunted trees.
- (D) A pond ecosystem with phytoplankton.

96. Two rodents are believed to compete with each other. An experiment is carried out where the first species (Rodent A) is removed from a patch and the growth of the other (Rodent B) is observed. Rodent B increases in number. We can conclude that

- (A) Rodent A has negative impact with Rodent B.
- (B) Rodent B has negative impact with Rodent A.
- (C) Rodent A and Rodent B have no effect on each other.
- (D) There is insufficient evidence on the basis of this experiment.

97. Large reserves are generally considered to be better than many small reserves of equivalent area. One reason why many small reserves might be better is

- (A) Maintenance of minimum viable populations.
- (B) Dispersal of animals.
- (C) Impact of disease.
- (D) Edge to interior ratio.

98. In many species, an individual invests all its reproductive effort into one breeding event in its lifetime. Such a life history strategy is called

- (A) Semelparity
- (B) Iteroparity
- (C) Ovoviviparity
- (D) Bet-hedging

99. Two populations of peafowl were sampled for the length of the ornamental train in males. Mean train length was  $p$  cm in the first population and  $q$  cm in the second. To test whether these two means are statistically significantly different, using a  $t$ -test, the two other pieces of information we need from each population sample are measures of

- (A) Skewness and variance.
- (B) Skewness and the number of observations.
- (C) The number of observations and variance.
- (D) Variance and central tendency.

100. If predator-prey interactions are denoted as '+-' and mutualistic interactions as '++', then detritivory can be denoted as

- (A) --
- (B) 0 0
- (C) + -
- (D) + 0

**End of question paper**