Q. 1 – Q. 5 carry one mark each.

Q.1 If I were you, I _____ that laptop. It's much too expensive.

(A) won't buy (B) shan't buy

(C) wouldn't buy (D) would buy

Q.2 He turned a deaf ear to my request.

What does the underlined phrasal verb mean?

(A) ignored (B) appreciated (C) twisted (D) returned

Q.3 Choose the most appropriate set of words from the options given below to complete the following sentence.

_____ _____ is a will, _____ is a way.

(A) Wear, there, their (B) Were, their, there

(C) Where, there, there (D) Where, their, their

Q.4 (x % of y) + (y % of x) is equivalent to _____.

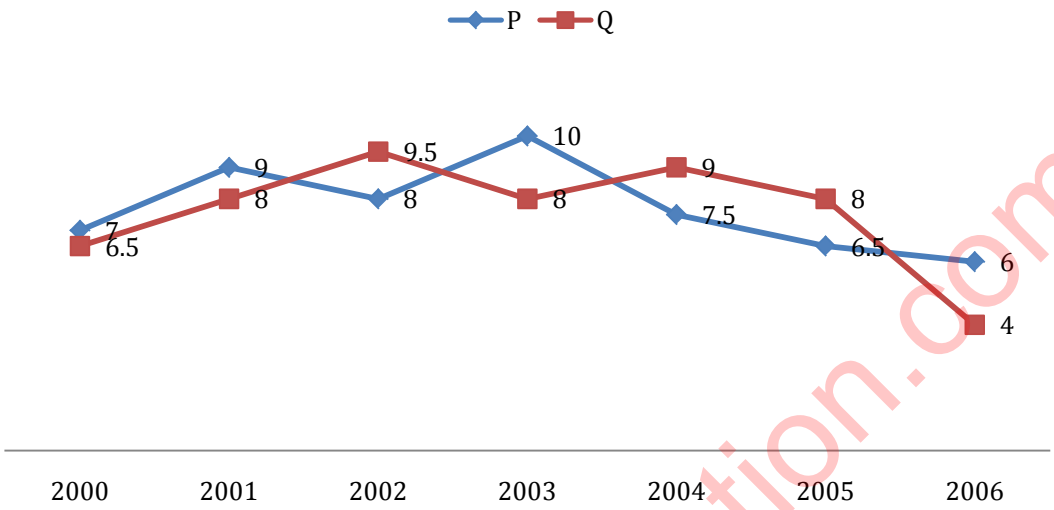
(A) 2 % of xy (B) 2 % of (xy/100) (C) xy % of 100 (D) 100 % of xy

Q.5 The sum of the digits of a two digit number is 12. If the new number formed by reversing the digits is greater than the original number by 54, find the original number.

(A) 39 (B) 57 (C) 66 (D) 93

Q. 6 – Q. 10 carry two marks each.

Q.6 Two finance companies, P and Q, declared fixed annual rates of interest on the amounts invested with them. The rates of interest offered by these companies may differ from year to year. Year-wise annual rates of interest offered by these companies are shown by the line graph provided below.



If the amounts invested in the companies, P and Q, in 2006 are in the ratio 8:9, then the amounts received after one year as interests from companies P and Q would be in the ratio:

(A) 2:3
(B) 3:4
(C) 6:7
(D) 4:3

Q.7 Today, we consider Ashoka as a great ruler because of the copious evidence he left behind in the form of stone carved edicts. Historians tend to correlate greatness of a king at his time with the availability of evidence today.

Which of the following can be logically inferred from the above sentences?

(A) Emperors who do not leave significant sculpted evidence are completely forgotten.

(B) Ashoka produced stone carved edicts to ensure that later historians will respect him.

(C) Statues of kings are a reminder of their greatness.

(D) A king's greatness, as we know him today, is interpreted by historians.

Q.8 Fact 1: Humans are mammals.
Fact 2: Some humans are engineers.
Fact 3: Engineers build houses.

If the above statements are facts, which of the following can be logically inferred?

I. All mammals build houses.
II. Engineers are mammals.
III. Some humans are not engineers.

(A) II only. (B) III only.

(C) I, II and III. (D) I only.

Q.9 A square pyramid has a base perimeter x, and the slant height is half of the perimeter. What is the lateral surface area of the pyramid?

(A) x^2 (B) $0.75\,x^2$ (C) $0.50\,x^2$ (D) $0.25\,x^2$

Q.10 Ananth takes 6 hours and Bharath takes 4 hours to read a book. Both started reading copies of the book at the same time. After how many hours is the number of pages **to be** read by Ananth, twice that **to be** read by Bharath? Assume Ananth and Bharath read all the pages with constant pace.

(A) 1 (B) 2 (C) 3 (D) 4

END OF THE QUESTION PAPER

Q. 1 – Q. 25 carry one mark each.

Q.1 Different kinds of limbs, such as the wings of birds and bats, and the flippers of turtles, whales and dolphins, have the same underlying skeletal structure. This is an example of:

(A) Analogy (B) Convergence (C) Homology (D) Genetic drift

Q.2 Forests with a high density of native conifer trees are found in:

(A) Gujarat
(B) Haryana
(C) Himachal Pradesh
(D) Odisha

Q.3 Ozone layer depletion, since the 1970s, is primarily attributed to:

(A) carbon dioxide
(B) chlorofluorocarbons
(C) global warming
(D) UV radiation

Q.4 The evolution of the amniotic egg in reptiles allowed them to:

(A) colonize dry terrestrial environments
(B) give birth to live young
(C) lay eggs in water and on land
(D) live in aquatic environments

Q.5 Which of the following phyla are most closely related to chordates ?

(A) Annelida (B) Arthropoda (C) Echinodermata (D) Mollusca

Q.6 Limb lengths were measured for 50 individuals from a population of lizards and the sample variance was calculated to be 64 cm^2. The standard deviation for this sample is _____ cm. (Use decimal notation, not fractions or percentage)

Q.7 Most terrestrial ecosystems have a pyramidal structure of standing biomass across trophic levels where biomass of producers > primary consumers > secondary consumers > tertiary consumers. However, some aquatic ecosystems have an inverted pyramidal structure where the standing biomass of producers < primary consumers. An explanation for this is:

(A) greater efficiency of primary consumers in aquatic ecosystems
(B) high turnover rates of aquatic producers relative to consumers
(C) low nutrient concentrations in aquatic ecosystems
(D) very high light limitation in aquatic ecosystems

Q.8 In an experiment, a PhD student found that the traits, flower colour and seed size, did not follow Mendel's Law of Independent Assortment. A possible explanation for this observation is:

(A) co-dominance between alleles
(B) incomplete dominance
(C) linkage between the traits
(D) loci on different chromosomes

Q.9 Which of the following invertebrates has the lowest gut length:body length ratio?

(A) dragonflies (B) grasshoppers (C) leaf hoppers (D) termites

Q.10 Allopatric speciation occurs when two populations diverge because of geographical separation. Rates of allopatric speciation are likely to be higher in:

(A) marine organisms with active dispersal
(B) marine organisms with passive dispersal
(C) terrestrial organisms with high dispersal ability
(D) terrestrial organisms with low dispersal ability

Q.11 For nearly 200 years, biogeographers have noted that the tropics have more terrestrial species than temperate regions. Which of the following is NOT a plausible explanation for this pattern?

(A) Diversification rates are higher in the tropics
(B) Energy inputs are higher in the tropics
(C) There is greater land area in the tropics
(D) Tropical species have greater climatic tolerance

Q.12 If the rate of non-synonymous substitution at a locus exceeds that of synonymous substitution, then:

(A) deleterious mutations are accumulating
(B) evolution is not occurring
(C) genetic drift is operating
(D) selection is operating

Q.13 There are N individuals in a haploid population. At a given locus, there are 2 alleles, AL1 and AL2. The number of copies of allele AL1 is Z1, and the number of copies of allele AL2 is Z2 in the population. What is the frequency of allele AL2?

(A) Z1/N (B) Z2/N (C) Z1+Z2 (D) (Z1+Z2)/N

Q.14 According to Hamilton's Rule, an altruistic act will spread in a population due to kin selection, when $B/C > 1/r$, where B is the benefit to the recipient, C is the cost to the actor and r is the genetic relatedness of the recipient to the actor. Given this relationship, a human may forego producing one of her own offspring to help her full sibling raise offspring, only if it results in at least _____ or more extra offspring produced by her sibling.

(A) 1 (B) 2 (C) 4 (D) 8

Q.15 Which of the following is NOT a plant hormone?

(A) Corticosterone (B) Ethylene (C) Jasmonic acid (D) Salicylic acid

Q.16 Among foraging shore birds, feeding rates (F, number of prey items consumed in 5 minutes) decrease as the number of neighbours (N) increases as follows: $F = 10 - 0.9N$. The maximum feeding rate is _____. (Use decimal notation, not fractions or percentage)

Q.17 Which of the following is NOT an adaptation to reduce the risk of predation?

(A) Alarm calling (B) Cannibalism
(C) Group living (D) Sentinel behaviour

Q.18 Which of the following is NOT an example of an evolutionary arms race?

(A) Brood parasite and host interactions
(B) Conflict between parents and offspring
(C) Predator and prey interactions
(D) Recognition between kin

Q.19 The Weber-Fechner law states that the magnitude of a perceived sensation increases as $\log_{10}$ of stimulus intensity. Let us assume a background stimulus level of 1 unit, which increases to 10 units in situation P and to 100 units in situation Q. The perceived sensation in situation Q is stronger than the sensation perceived in situation P by a factor of _____. (Use decimal notation, not fractions or percentage)

Q.20 Monotremes are unique among mammals because they:

(A) have claws
(B) lay eggs
(C) possess hair
(D) produce milk

Q.21 The most important reason for a neuron to be myelinated is to:

(A) decrease the possibility of excitation from nearby muscle activity
(B) increase the diameter of the axon to slow down the action potential
(C) increase the speed of an action potential
(D) protect the nerve from physical damage

Q.22 A small isolated population is more likely to undergo speciation than a large population because, compared to the large population, the small population:

(A) has greater genetic diversity
(B) has a higher mutation rate
(C) is more affected by genetic drift
(D) is more susceptible to gene flow

Q.23 To which of the following families do the important timber species, sal and teak, belong?

(i) Dipterocarpaceae; (ii) Poaceae; (iii) Solanaceae; (iv) Verbenaceae

(A) i and ii
(B) i and iv
(C) ii and iii
(D) iii only

Q.24 The yields of which of these crops are most likely to be reduced by ongoing declines in bee populations?

(A) coffee
(B) rice
(C) tea
(D) wheat

Q.25 Dichlorodiphenyltrichloroethane is related to the phenomenon of:

(A) biomagnification in food webs
(B) coral bleaching in oceans
(C) the greenhouse effect
(D) ozone layer depletion

Q. 26 – Q. 55 carry two marks each.

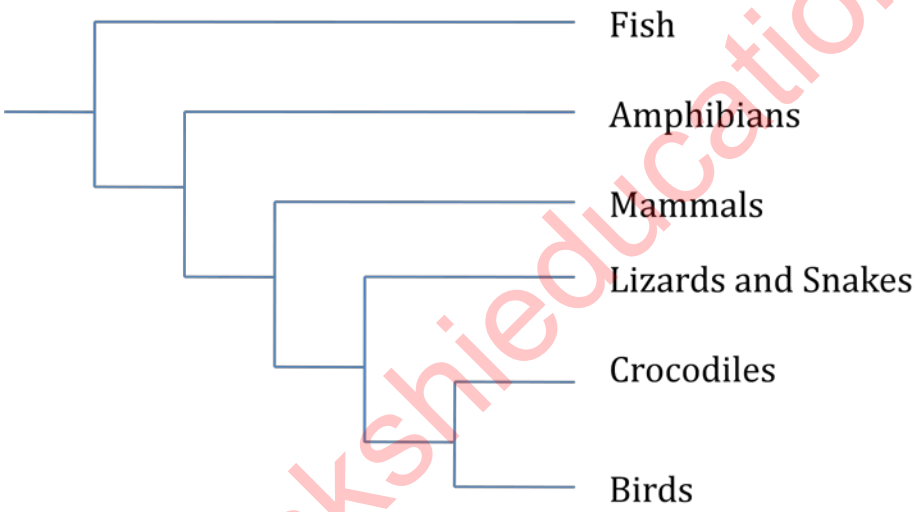
Q.26 Here is a data set on wing lengths in cm: 8, 9, 10, 10, 12, 13, 13, 14, 15, 15, 15, 19, 22, 25, 25. For this sample data set, the mean, median and mode are _____, _____, and _____ respectively.

(A) 15, 8 and 25 (B) 15, 14 and 8 (C) 15, 14 and 15 (D) 15, 15 and 15

Q.27 Dragonflies eat plant pollinators. Fish eat dragonfly larvae. A study compared the fitness of plants growing near ponds with and without fish. Given the above set of trophic interactions in a community, this study will likely find that:

(A) the fitness of plants is not affected by dragonflies
(B) the fitness of plants is not affected by whether ponds have fish
(C) plants growing near ponds without fish have higher fitness
(D) plants growing near ponds with fish have higher fitness

Q.28 Which of the following statements CANNOT be inferred from the following phylogenetic tree?



(A) Crocodiles are more closely related to birds than to the other reptiles
(B) Fish, lizards and snakes have a common ancestor
(C) Mammals and reptiles have evolved from amphibians
(D) Mammals are more closely related to crocodiles than to amphibians

Q.29 Assume that the abundance of a species in a community is proportional to the size of its niche. As each new species colonises this community, an existing niche is split. The resultant relative abundances of species in this community will be most uneven if:

(A) The largest niche is always split when a new species colonises
(B) The niches are split at random, independent of their size
(C) The probability of a niche being split is proportional to its size
(D) The smallest niche is always split when a new species colonises

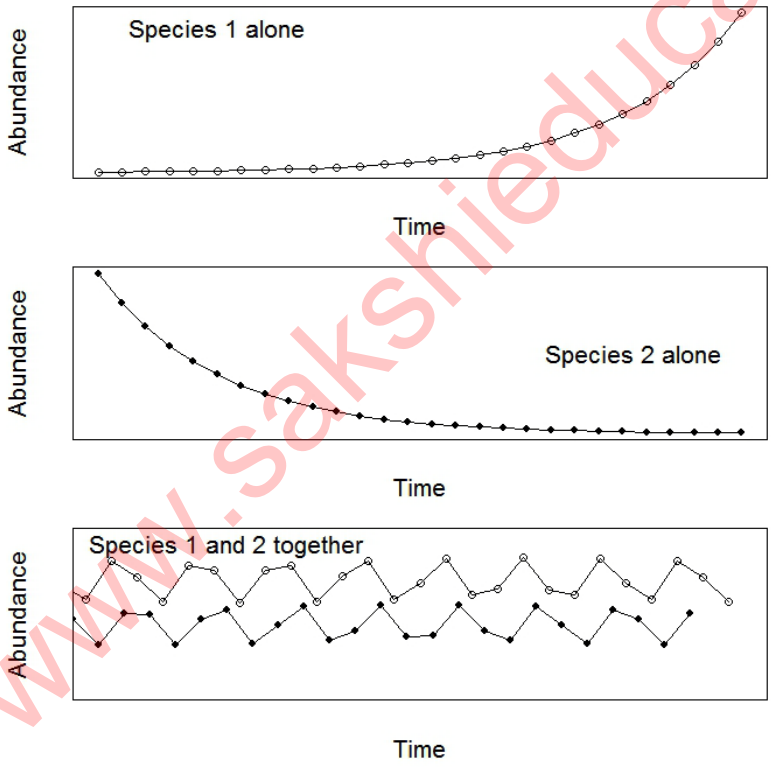
Q.30 To study colour preference in bees, a student uses artificial flowers with a sugar reward. She gives bees a choice between blue round flowers and yellow square flowers of the same size. She finds that bees choose the blue flowers significantly more often than the yellow flowers and concludes that bees have a colour preference for blue flowers. However, her friend disagrees and suggests that she should have done the experiment differently. Which of the following would have been more appropriate to test for colour preference in bees?

(A) choice between blue round and blue square flowers
(B) choice between blue round and yellow round flowers
(C) choice between yellow round and blue square flowers
(D) choice between yellow round and yellow square flowers

Q.31 Which of the following does NOT form a component of phytohormone action?

(A) recognition of specific proteins
(B) regulation of gene activity
(C) splitting of water molecules
(D) signal transduction across the cell

Q.32 The following three panels show the change in population size over time for two species when they are found alone and when they are found together. Which kind of interaction best describes the relationship between the two species?



(A) Amensalism (B) Competition (C) Mutualism (D) Predation

Q.33 Fresh water fish belonging to the family Galaxoidae are found exclusively in the southern parts of the continents of South America, Africa and Australia. This pattern is explained by the theory proposed by:

(A) Alfred Russel Wallace
(B) Alfred Wegener
(C) Charles Darwin
(D) Charles Lyell

Q.34 Ant species X preys upon ant species Y. A researcher has the following set of observations regarding the behaviour of species X where aggression signifies a predatory response.

Stimulus	Reaction of Species X individuals
Glass bead coated with surface chemicals extracted from Species Y	Aggression
Washed glass bead	No reaction
Freshly immobilised Species Y individual	Aggression
Freshly immobilised Species Y individual with surface chemicals removed	Aggression

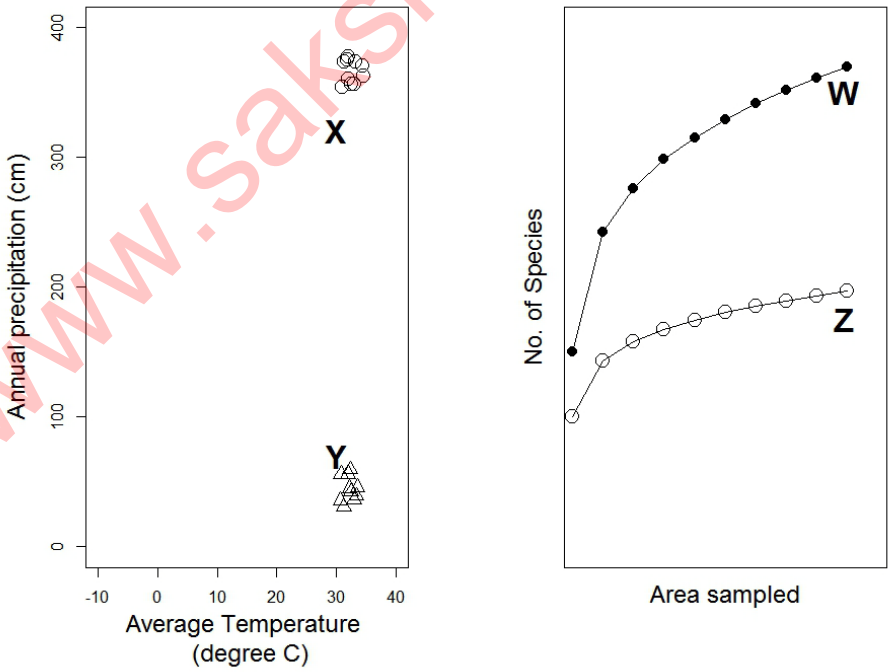
Which of the following statement(s) are correct regarding the behaviour of Species X?

(i) A glass bead is sufficient to elicit the predatory response.
(ii) Both chemical and non-chemical cues are involved in the predatory response.
(iii) Chemical cues are necessary to elicit the predatory response.
(iv) Chemical cues are sufficient to elicit the predatory response

(A) i, ii (B) ii, iv (C) i, iii (D) iii, iv

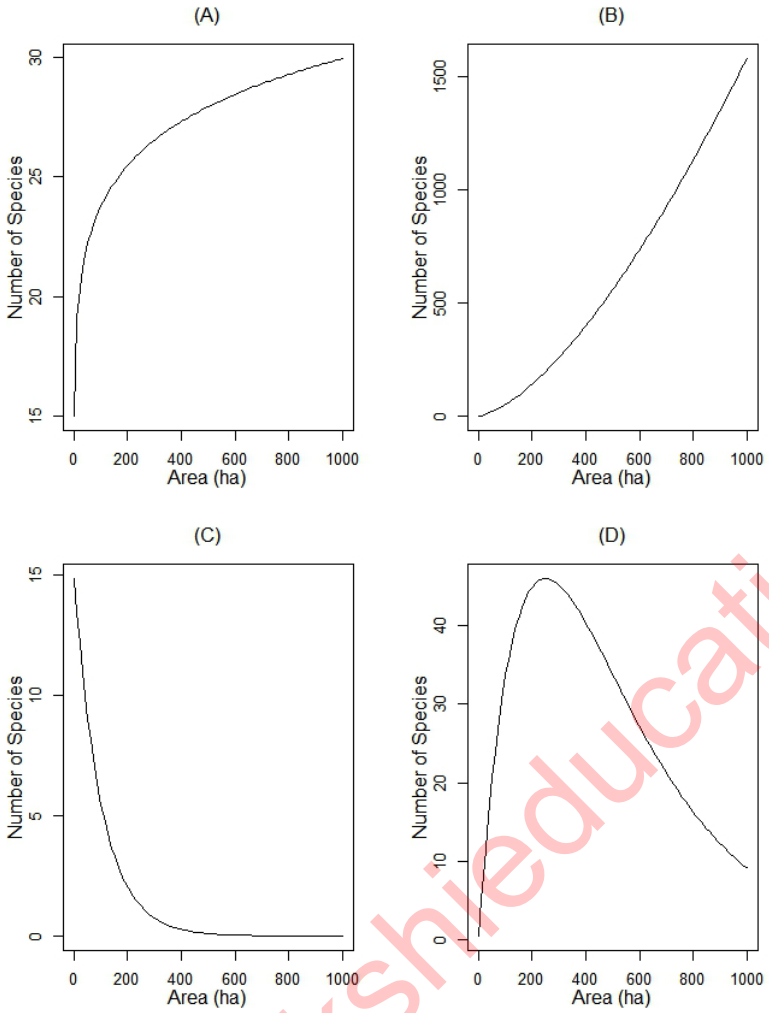
Q.35 In the schematic below, the left panel represents climatic zones occupied by two different biomes, X and Y, along gradients of temperature and precipitation. The right panel depicts the expected species-area relationships of these two biomes. From the figures below, which of the following are most likely to be true?

(i) Biome X will show pattern W
(ii) Biome Y will show pattern Z
(iii) Biome X will show pattern Z
(iv) Biome Y will show pattern W



(A) i and ii (B) i and iv (C) ii and iii (D) iii and iv

Q.36 In many plant and animal communities that are found on islands, the number of species (S) changes with the area (A) of the island as follows: $S = cA^z$, where $0 < z < 1$ and $c > 0$. Which of the following graphs best represents such a species-area relationship?



Q.37 Males in a population differ in the time they spend displaying to females. A researcher hypothesizes that predators are responsible for these differences. Males display for longer durations when there are no predators in the vicinity and for shorter durations when there is a predator nearby. Which of the following study designs is the most appropriate test of this hypothesis?

(A) Map predator distribution in the area; measure the abundance of females; quantify the natural variation in male display rates in areas without predators
(B) Measure display rates of males at the beginning of the breeding season; remove all predators from the study site; then measure male display rates later in the breeding season; repeat for multiple populations
(C) Measure display rates of males in areas with and without predators; randomly assign males to two treatments: (i) capture and release back in original area (ii) capture and switch between areas; measure display rates for all experimental males
(D) Measure display rates of males in areas with and without predators; randomly assign males to two treatments: (i) addition of females to the area (ii) removal of females from the area; measure display rates for all experimental males

Q.38 In Batesian mimicry, a harmless species mimics a harmful or toxic model species. Increasing the relative abundance of the mimic will:

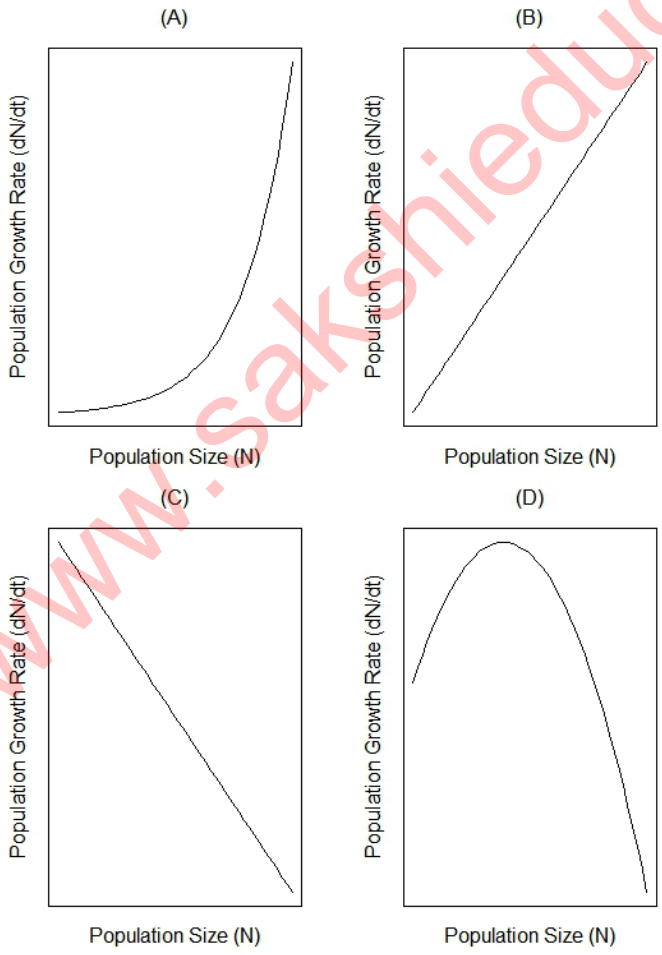
(A) negatively affect both model and mimic populations
(B) negatively affect the model but not the mimic population
(C) positively affect both model and mimic populations
(D) positively affect the mimic but not the model population

Q.39 There are two alleles at a locus in a population in Hardy-Weinberg equilibrium. If the proportion of the dominant phenotype is 0.99, what proportion of the population is heterozygous? (Use decimal notation, not fractions or percentage)

Q.40 Haemophilia is a condition resulting from a sex-linked recessive gene in which individuals can suffer from excessive bleeding due to a blood-clotting disorder. In a human family with three children, the two sons are afflicted with haemophilia while the parents are normal. The probability that the daughter has inherited the gene for haemophilia is _____, and the probability that she is afflicted by haemophilia is _____.

(A) 1/2, 0 (B) 1/2, 1 (C) 1/2, 1/4 (D) 1/4,0

Q.41 Which of the graphs below represents the relationship between population size (N) and population growth rate (dN/dt) for a population showing exponential growth?



Q.42 Two islands, P and Q, are similar in habitat and other features. They are 100 and 200 km^2 in size respectively, but have the same number of species. Which of the following statements can independently explain this observation?

(i) P is closer to the mainland than Q
(ii) P is further away from the mainland than Q
(iii) P has higher speciation rates than Q
(iv) P has lower speciation rates than Q

(A) i and iv (B) i and iii (C) ii and iii (D) ii and iv

Q.43 In reverse sexual selection, variance in mating success is higher in females than in males. In such species, which of the following is most expected?

(A) Females are the competing sex and males are the choosy sex
(B) Males are the competing sex and females are the choosy sex
(C) Mating is random and both sexes are not choosy
(D) Mating is non-random and both sexes are equally choosy

Q.44 According to the Hamilton-Zuk hypothesis, females prefer males with the most elaborate ornaments because those ornaments signal parasite resistance. Which of the following is NOT an assumption of this hypothesis?

(A) Parasites reduce male fitness
(B) Parasite resistance is indicated by male ornamentation
(C) Parasite resistance is genetic
(D) Parasite load is positively correlated with male ornamentation

Q.45 A plant produces flowers that are open through the day and the night. An experimenter places pollen on the stigmas of freshly opened flowers and covers them after pollination to prevent natural pollinators from having access to the flowers. When experimental pollination was carried out during the day, 40% of the flowers yielded fruit. When experimental pollination was carried out during the night, 80% of the flowers yielded fruit. However, when flowers were kept open to natural pollination during the day (covered at night), 35% of flowers produced fruit. 20% of flowers exposed to natural pollination during the night (covered during the day) produced fruit. Which of the following statements is NOT a plausible explanation of these results ?

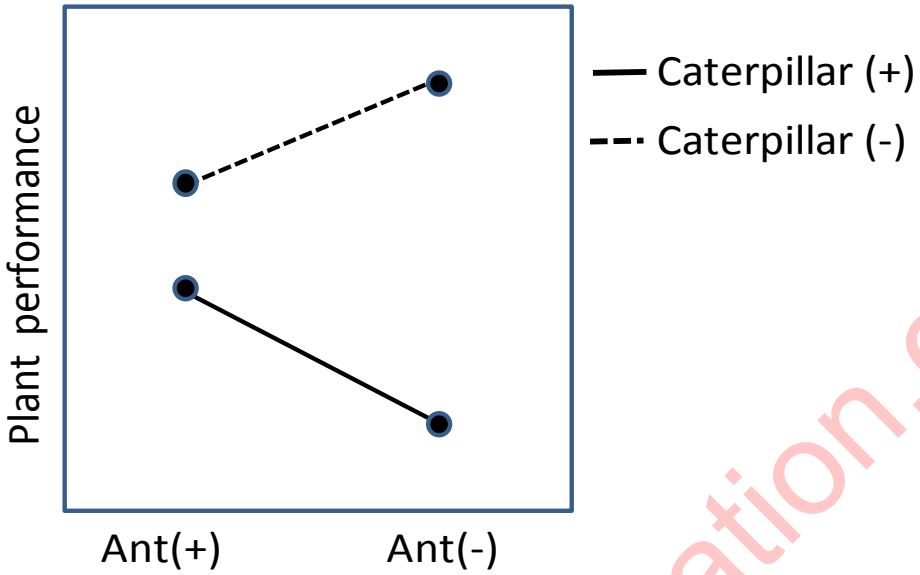
(A) night pollinators are low in abundance
(B) night pollinators are abundant
(C) night pollinators are low in pollination efficiency
(D) pollinators are active during the day

Q.46 Sex is determined by temperature in many reptiles, including crocodiles and turtles. While lower temperatures produce males in turtles, the pattern is the opposite in crocodiles. Due to climate change, there is an increase in temperatures which results in a change in sex ratios. In small populations, this change in demography is likely to negatively impact the population growth of:

(A) crocodiles more than turtles
(B) neither of the two species
(C) both species equally
(D) turtles more than crocodiles

Q.47 An unbiased coin is tossed four times. What is the probability of getting at least three "heads" in a row? (Use decimal notation, not fractions or percentage)

Q.48 In a study of interactions between plants, ants and caterpillars, the following experimental treatments were imposed: i) Control (both ants and caterpillars are present); ii) Ant removal; iii) Caterpillar removal; iv) Ant and caterpillar removal. Plus (+) indicates presence and minus (-) indicates absence on plants. The results for plant performance (growth) from this experiment are shown in the figure below. Plant performance in all treatments were significantly different from each other. Based on these results, which of the following inferences is correct?



(A) In the absence of caterpillars, ants negatively affected plant performance
(B) In the absence of ants, caterpillars positively affected plant performance
(C) In the presence of caterpillars, ants negatively affected plant performance
(D) In the presence of ants, caterpillars positively affected plant performance

Q.49 Both males and females of a fish species show variation in colour. A population of this species consists of 40% blue females, 20% red females, 20% blue males and 20% red males. A researcher catches one fish at random from this population. Given that a male fish is caught, the probability that it is blue is _____. (Use decimal notation, not fractions or percentage)

Q.50 Assume that an asexually propagating fungus has three colors of colonies, white, black and red. Such variability in color may have originated due to:

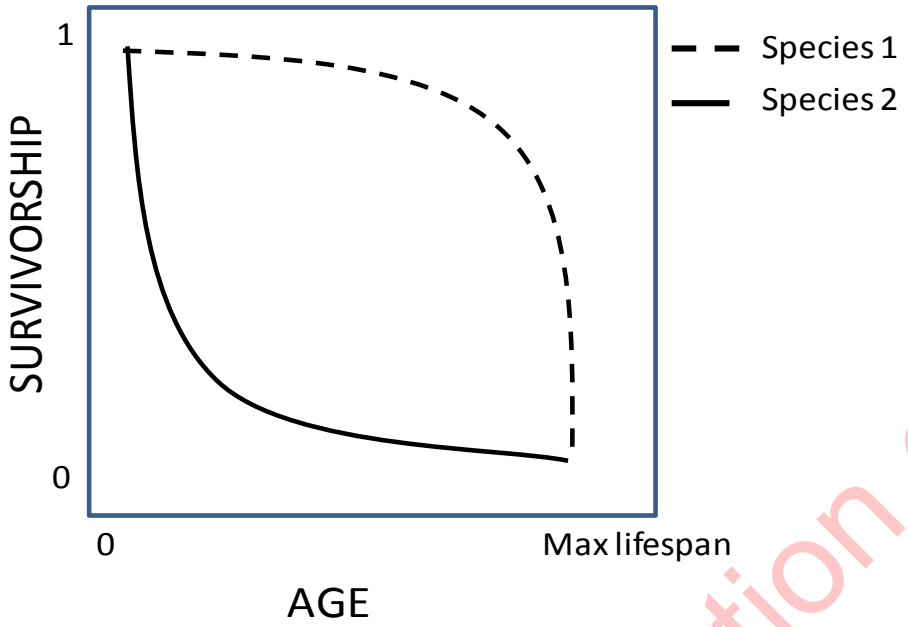
(A) germline mutation
(B) heterokaryosis
(C) genetic linkage
(D) sexual cross-over

Q.51 Shannon's index of diversity is calculated using the equation below, where p_i is the proportion of the i^{th} species and ln is natural logarithm. For a community with a given number of species, which of the following statements is true?

$$H = -\sum_{1}^{n} p_i \ln(p_i)$$

(A) Shannon's index will be highest if all species have equal abundance
(B) Shannon's index will be highest if one species is highly dominant
(C) Shannon's index will be highest if there are many rare species
(D) The relative abundance is irrelevant to Shannon's index

Q.52 The schematic below shows the relationship between survivorship with age (relative to maximum lifespan) in Species 1 (dashed line) and Species 2 (solid line). Which of the following inferences is compatible with this figure?



(A) Species 1 is a mouse, Species 2 is an elephant
(B) Species 1 is a rat, Species 2 is a tree shrew
(C) Species 1 is a whale, Species 2 is a mouse
(D) Species 1 is a whale, Species 2 is an elephant

Q.53 A team of conservation biologists, surveying a population of frogs on an island, captured and marked 312 individuals in the first sample. In a second sampling, 3 days later, the team caught 140 individuals of which 26 were previously marked. The total number of frogs on the island is estimated to be _____. (Use decimal notation, not fractions or percentage)

Q.54 The following equation represents a hypothetical relationship between fitness (w) and shoot:root ratio (r) in individuals of a plant species: $w = 10r-10r^2$. At what value of shoot:root ratio (r), do these plants achieve maximum fitness? (Use decimal notation, not fractions or percentage)

Q.55 The relative abundance of C3 relative to C4 plant species increases with latitude because of the associated temperature gradient. A study in North America found that at 42° North, C3 plants become more abundant than C4 plants. Given an increase in mean global temperatures by 10°C and no other changes in environmental conditions, the latitude at which C3 plants become more abundant:

(A) will move Northwards towards the polar region
(B) will move Southwards towards the equator
(C) will move South of the equator
(D) will not change in response to temperature

END OF THE QUESTION PAPER

Q. No	Type	Section	Key	Marks
1	MCQ	GA	C	1
2	MCQ	GA	A	1
3	MCQ	GA	C	1
4	MCQ	GA	A	1
5	MCQ	GA	A	1
6	MCQ	GA	D	2
7	MCQ	GA	D	2
8	MCQ	GA	B	2
9	MCQ	GA	D	2
10	MCQ	GA	C	2
1	MCQ	EY	C	1
2	MCQ	EY	C	1
3	MCQ	EY	B	1
4	MCQ	EY	A	1
5	MCQ	EY	C	1
6	NAT	EY	7.99 : 8.10	1
7	MCQ	EY	A ; B	1
8	MCQ	EY	C	1
9	MCQ	EY	A	1
10	MCQ	EY	D	1
11	MCQ	EY	D	1
12	MCQ	EY	A ; D	1
13	MCQ	EY	B	1
14	MCQ	EY	B	1
15	MCQ	EY	A	1
16	NAT	EY	9.9 : 10.1	1
17	MCQ	EY	B	1
18	MCQ	EY	D	1
19	NAT	EY	1.9 : 2.1	1
20	MCQ	EY	B	1
21	MCQ	EY	C	1
22	MCQ	EY	C	1
23	MCQ	EY	B	1
24	MCQ	EY	A	1
25	MCQ	EY	A	1
26	MCQ	EY	C	2
27	MCQ	EY	D	2
28	MCQ	EY	C	2
29	MCQ	EY	D	2
30	MCQ	EY	B	2
31	MCQ	EY	C	2
32	MCQ	EY	D	2
33	MCQ	EY	B	2
34	MCQ	EY	B	2
35	MCQ	EY	A	2
36	MCQ	EY	A	2
37	MCQ	EY	C	2
38	MCQ	EY	A	2
39	NAT	EY	0.17 : 0.19	2

40	MCQ	EY	A	2
41	MCQ	EY	B	2
42	MCQ	EY	B	2
43	MCQ	EY	A	2
44	MCQ	EY	D	2
45	MCQ	EY	B	2
46	MCQ	EY	A	2
47	NAT	EY	0.175 : 0.20	2
48	MCQ	EY	A	2
49	NAT	EY	0.49 : 0.51	2
50	MCQ	EY	B	2
51	MCQ	EY	A	2
52	MCQ	EY	C	2
53	NAT	EY	1660 : 1700	2
54	NAT	EY	0.45 : 0.55	2
55	MCQ	EY	A	2