1. A small pebble is dropped into the deep sea from a floating glacier mass. The pebble falls down, and is then likely to hit the sea bottom with
1. an accelerating velocity
2. a decelerating velocity
3. a uniform velocity
4. a pulsating velocity

2. The temperature at the centre of the Earth is estimated to be:
1. < 3000°C
2. > 4000°C
3. > 1000°C
4. 2000°C

3. Permanent ice sheet over Antarctica developed in a early Cenozoic as a result of
1. intense glaciation over the earth
2. separation of Antarctica from other continents leading to its thermal isolation
3. Complete stoppage of solar radiation
4. Extensive volcanism on earth

4. Which one of these depositional environment will be best for the preservation of fossils?
1. Bottom of river.
2. Deserts.
3. Shallow sea floor.
4. Deep sea floor.

5. After an earthquake, the epicenter is located by noting at various places
1. the difference in the arrival times of S & P waves
2. the intensity of the earthquake
3. number of buildings damaged
4. number of people dead

6. The epicenter of a deep focus earthquake is located
1. on the earth's surface
2. below a depth of 70 km
3. between 70-300 km
4. below 300 km.

7. If the earth's axis of rotation were not tilted, which one of the following statements would be TRUE?
1. Equal day and night at all places throughout the year
2. Duration of day and night will depend on latitude but will not change with time.
3. The poles will have daylight for six months.
4. There will be no seasons.

8. For an element having a radioactive isotope of 5×10^9 y half-life, its atomic weight in 5×10^6 years will
1. increase   2. decrease
3. remain constant
4. decrease to 1/1000th of its initial value.

9. On earth, both incoming and outgoing radiations show variations with latitude such that there is heat excess at the equator and deficit at high latitudes. However, neither the poles are getting colder not is the equator getting warmer with time because
1. the earth abledo is changing with time.
2. solar activity is changing with time.
3. atmospheric and oceanic circulations redistribute heat
4. of the build-up of atmospheric green house gases.

10. Himalayan mountains have formed primarily as a result of
1. compressive deformation between Indian and Asian tectonic plates.
2. relative uplift of sediments in the Tethys Ocean in an extensional setting
3. strike- slip deformation between Indian and Eurasian plates.
4. extrusion of volcanic material over a long period of time on the Tethys ocean floor.

11. Photosynthesis in water bodies is restricted to a certain depth. This is mainly because
1. temperature decreases with depth
2. light intensity decreases with depth
3. dissolved CO_2 is available only to a certain depth
4. nutrients are available only to a certain depth

12. The velocity of P (pressure) and S (shear) seismic waves depends on the compressibility, shear modulus and density of the medium. The inner core of the Earth is inferred to be liquid using seismic wave travel time. This is because
1. the density of the inner core is the highest.
2. the inner core has a very high compressibility.
3. both P and S waves pass through the inner core.
4. the S wave does not pass through the inner core.

13. One of the following chemicals used as food preservative is
1. sodium benzoate
2. sodium alkylbenzene sulfonate
3. ethylene glycol   4. aspartic acid

14. Qualitative analysis of Al^{3+} in presence of Fe^{3+} and Cr^{3+} is based on
1. reducing nature of Fe^{3+}
2. oxidizing nature of Cr^{3+}
3. amphoteric nature of Fe^{3+}
4. amphoteric nature of Al^{3+} and Cr^{3+}

15. Hydrolysis of *t*-butyl chloride in presence of aqueous alkali produces *t*-butyl alcohol.
The rate of hydrolysis depends on
1. concentration of *t*-butyl chloride
2. concentration of alkali
3. amount of water
4. concentration of both alkali and *t*-butyl chloride

16. The ionization potential (IP) of hydrogen atom is 13.6 eV. The estimated second IP of the helium atom (in eV) is
1. 6.8   2. 27.2
3. 54.4   4. 13.6

17. The following molecule has a non-zero dipole moment
1. CH_4 2. CO_2
3. NH_3 4. BF_3

18. The oxidation number of Cr in CrO_5 is
1. + 6   2. + 3
3. + 10   4. + 5

19. The unit of molar absorptivity is:
1. $L\ mol^{-1}\ cm^{-1}$ 2. $L^{-1}\ mol\ cm^{-1}$
3. $L\ mol\ cm^{-1}$ 4. $L\ mol\ cm$

20. An exothermic reaction will necessarily follow the condition
1. $\Delta H < 0$ 2. $\Delta H > 0$
3. $\Delta H = 0$ 4. $S\ \Delta = 0$

21. The electrical conductivity of a crystalline solid increases with temperature. The solid is a
1. superconductor   2. metal
3. semiconductor   4. semimetal

22. Sucrose is a disaccharide consisting of
1. glucose and glucose
2. glucose and galactose
3. glucose and fructose
4. glucose and mannose

23. The energy of a 200 nm photon is
1. 0.01 eV   2. 100 eV
3. 10 eV   4. 6.2 eV

24. Two protons are placed at a distance of about 10^{-13} cm from each other. The ratio of the strength of strong and electromagnetic forces between them is roughly
1. 10.   2. 1.
3. 10^3.   4. 10^{-5}.

25. The volume of a thermodynamic system increases irreversibly by an incremental amount δV. If P is the pressure, the work done *on* the system is
1. $\delta W = P\,\delta V$ 2. $\delta W = -P\,\delta V$
3. $\delta W < -P\,\delta V$ 4. $\delta W > -P\,\delta V$

26. A thermodynamic system is classified as closed if it can
1. exchange energy with its surroundings , but not matter
2. exchange both energy and matter with its surroundings
3. exchange neither energy nor matter with its surroundings
4. exchange only matter, but not energy, with its surroundings

27. Let T be a normal operator on a complex inner product space. Then T is self adjoint if and only if :
1. All eigen values of T are distinct.
2. All eigen values of T are real.
3. T has repeated eigen values.
4. T has at least one real eigen value.

28. A 2 x 2 real matrix A is diagonalizable if and only if :
1. $(trA)^2 < 4\ Det\ A$.   2. $(tr\ A)^2 > 4\ Det\ A$.
3. $(tr\ A)^2 = 4\ Det\ A$.   4. $Tr\ A = Det\ A$.

29. Let A be a 3 x 3 complex matrix such that $A^3 = I$ (= the 3 x 3 identity matrix). Then :
1. A is diagnonalizable.
2. A is not diagonalizable.
3. The minimal polynomial of A has a repeated root.
4. All eigenvalues of A are real.

30. A population consists of 10 students. The marks obtained by one student is 10 less than the average of the marks obtained by the remaining 9 students. Then the variance of the population of marks (σ^2) will always satisfy
1. $\sigma^2 \geq 10$ 2. $\sigma^2 = 10$
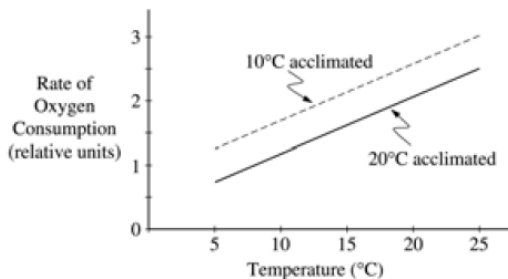3. $\sigma^2 \leq 10$ 4. $\sigma^2 \geq 9$

31. During protein synthesis, L-amino acid binds to t-RNA through
1. α-amino group.
2. hydrophobic side chain.
3. α–carboxyl group.
4. carboxyl group of the side chain.

32. The peptide bond is planar
1. due to restriction caused by rotation around cα–N bond
2. due to restriction around cα–c′ bond
3. due to delocalization of the lone pair of electrons of the nitrogen onto carbonyl oxygen
4. because amide protons and carbonyl oxygen are involved in hydrogen bonding.

33. Hydrogen bond length will NOT be
1. independent of the nature of donor and acceptor atoms.
2. dependent on donor and acceptor atoms.
3. dependent on the solvent in which the molecule is dissolved.
4. dependent on the other atoms bonded with the donor and acceptor atom.

34. Why a DNA duplex melts at a specific temperature (Tm) on heating?
1. Loss of base stacking energy
2. The double helix is intrinsically unstable
3. The single helix is more stable as compared to the double helix
4. The DNA double helix is a co-operative structure stabilized by hydrogen bonds and base pairing

35. Lipid bilayers can be formed by phospholipids which have variable head groups and fatty acyl chains. The fluidity of the membrane will depend on
1. only the nature of head groups.
2. only the length of the fatty acid chains irrespective of the extent of unsaturation.
3. only unsaturation irrespective of the length of the fatty acid chains.
4. length and degree of unsaturation of fatty acid chains.

36. Which one of the following RNA molecules is involved in regulation of gene expression?
1. miRNA   2. rRNA
3. 5S RNA   4. tRNA

37. In which organelle is NADP+ the final electron acceptor?
1. Only chloroplast   2. Only mitochondrion
3. Lysosome
4. Both chloroplast and mitochondrion

38. When the K'q = 1, ΔG° is equal to
1. –1.   2. 0.
3. +1.   4. 10.

39. Consider the following computer Program, if each cycle takes 1 Sec, then what would be total time taken by program to complete-

```
        START
        N=20
IF      N>10
        N=N-1
WHEN    N=10
        N=20
IF      N<10
        N=N-1
        N=10
        STOP
```
1. 1 sec   2. 20 sec
3.400 sec   4. Infinite

40. Fill the values of x and y in 1xy1 for Decimal number 15 in Binary codes-
1. x=0,y=0   2. x=0,y=0
3. x=1,y=1   4. x=1,y=0

41. A microarray is a large collection of specific DNA oligonucleotides spotted in a defined pattern on a microscope slide. What is the most useful experiment that can be done with such a tool?
(1) Predicting the presence of specific metabolites in a cell
(2) Comparing newly synthesized nuclear RNA with cytoplasmic RNA to locate introns
(3) Comparing RNA produced under two different physiological conditions to understand patterns of gene expression
(4) Comparing proteins produced under two different physiological conditions to understand their function

42. In vertebrate genes, transcription regulatory regions that contain CpG islands are inactivated by which CpG modification?
(1) Methylation   (2) Myristylation
(3) Phosphorylation   (4) Acetylation

43. All of the following are proteins within the core nucleosome particle EXCEPT
(1) H1   (2) H2A
(3) H2B   (4) H3

44. In a study of arginine biosynthesis in yeast, four mutant haploids requiring arginine (Arg⁻) were isolated. The Arg⁻ haploids were fused in pairwise combinations to form diploids, whose requirement for arginine was tested. The results of the tests were that all diploid combinations yielded arginine prototrophs. How many different Arg genes are represented among the four mutants?
(1) One   (2) Two
(3) Three   (4) Four

45. A set of genes from *Bacillus subtilis* that encode the proteins required for sporulation have conserved DNA sequences −35 and −10 nucleotides before the site of transcript initiation, although the sequence at −35 is different from that seen in most other genes from that species. Which of the following best explains this difference?
(1) A novel sigma factor is required for transcription initiation at these genes.
(2) The −35 sequence is the binding site for a repressor of transcription.
(3) The replication of these genes requires a specifically modified DNA polymerase.
(4) Translation of the mRNAs transcribed from these genes requires specific ribosomes that recognize a modified Shine-Dalgarno sequence.

46. Acetyl CoA, the cytoplasmic substrate for fatty acid synthesis, is formed in mitochondria. The inner mitochondrial membrane is impermeable to acetyl CoA. Which of the following compounds is the form in which the carbon of acetyl CoA is transported to the cytoplasm?
(1) Malate   (2) Acetate
(3) Citrate   (4) Pyruvate

47. Which of the following groups of enzymes are unique to the Calvin cycle?
(1) Ribulose bisphosphate carboxylase, phosphoribulokinase, and sedoheptulose 1,7-bisphosphatase
(2) Ribose 5-phosphate isomerase, epimerase, and aldolase
(3) Glyceraldehyde 3-phosphate dehydrogenase, phosphofructokinase, and phosphoenolpyruvate carboxylase
(4) Phosphoglycolate phosphatase, glycerol kinase, and serine synthetase

48. Which of the following best describes the hyperchromicity of DNA?
(1) The shift in UV absorbance to longer wavelengths upon denaturation
(2) The shift in UV absorbance to shorter wavelengths upon hydrolysis
(3) The increase in absorbance at 260 nm upon annealing
(4) The increase in absorbance at 260 nm upon denaturation

49. Isopentenyl pyrophosphate is a precursor of which of the following?
I. Cholesterol
II. Farnesyl groups on proteins
III. Steroid hormones
(1) I only
(2) I and II only
(3) I and III only
(4) I, II, and III

50. Cytokinesis in animal cells is caused by
(1) the sliding movements of a band of microtubules around the circumference of the cell
(2) the contraction of a band of actin filaments around the circumference of the cell
(3) the movement of the mitotic spindle fibers
(4) endocytosis of the plasma membrane around the equator of the cell

51. The synthesis of mRNA's that encode the proteins of eukaryotic ribosomes occurs in the
(1) cytoplasm
(2) nuclear envelope
(3) nucleolus
(4) euchromatin

52. Which of the following is NOT a consequence of increased cellular levels of cAMP?
(1) Activation of a kinase cascade
(2) Activation of the transducin G-protein
(3) Increased phosphorylation of glycogen phosphorylase
(4) Inhibition of glycogen synthesis

53. The oxygen consumption of marine crabs acclimated to either 10°C or 20°C was measured at environmental temperatures of 5°C to 25°C to produce the following graph.

Which of the following can be correctly concluded from the information in the graph?
(1) Acclimation temperature does not affect the rate of oxygen consumption.
(2) Crabs have higher rates of oxygen consumption when measured at 10°C than when measured at 20°C.
(3) Oxygen consumption is higher in the 10°C-acclimated crabs than in the 20°C-acclimated crabs at each test temperature.
(4) Acclimation to a high temperature induces a high rate of oxygen consumption at all test temperatures.

54. The outermost tissue of a tree trunk that is 6 feet in diameter would most likely be
(1) epidermis   (2) cork
(3) cortex   (4) xylem

55. Which of the following is the tissue that is most important in plant survival during droughts and why?
(1) Vascular tissue, because the phloem keeps the plant supplied with water
(2) Vascular tissue, because the xylem can store considerable amounts of water
(3) Ground tissue, because water can be stored in the sclerenchyma for use during droughts
(4) Ground tissue, because the parenchymal tissue provides hormonal cues to stop water loss

56. Which of the following cells or tissues are characteristically found in the roots, but not the stems, of angiosperms?
(1) Parenchyma and collenchymas
(2) Epidermis and cork
(3) Pericycle and endodermis
(4) Vessel elements and tracheids

57. Cyclins are proteins involved in regulation of
(1) cell-cycle protein kinases
(2) circadian rhythms
(3) synthesis of cAMP
(4) Caspaces

58. A piece of prospective belly epidermis of a newt neurula-stage embryo is grafted to the prospective mouth region of a frog neurula, replacing the frog epidermal tissue at that spot. The grafted embryo continues to develop and forms a newt mouth and teeth at the position of the graft. This result is consistent with which of the following?
(1) Newt tissue develops autonomously according to its original fate, despite its new location in the frog embryo.
(2) Newt tissue dedifferentiates whenever it is grafted.
(3) Tissues of the frog neurula induce the newt tissue to express frog-specific genes that it would not normally express.
(4) The frog tissues of the neurula induce the newt tissue to form mouthparts.

59. Some chemoautotrophic bacteria living around deep-sea vents obtain their energy by converting
(1) alcohols to aldehydes
(2) hydrogen sulfide to elemental sulfur
(3) carbon dioxide and hydrogen to methane
(4) iron oxides to iron

60. The ability of a desert rodent's kidneys to form highly concentrated urine is largely attributable to
(1) a high glomerular filtration rate
(2) the production of a very salty ultrafiltrate in the glomerulus
(3) the ability of cells lining the proximal convoluted tubule to absorb water
(4) long loops of Henle that pass through tissues of increasing salt concentrations

61. In a plant growing vigorously under normal conditions without water stress, in which tissue would you expect to find the lowest (most negative) water potential?
(1) Root epidermal cell
(2) Root cortical parenchyma
(3) Root endodermis
(4) Leaf mesophyll parenchyma

62. In organisms with closed circulatory systems, fluid leaves the blood of capillary networks at the arterial end and returns to blood at the venous end for which of the following reasons?
(1) Osmotic pressure increases prior to dehydration.
(2) Osmotic pressure difference dominates at the arterial end; hydrostatic pressure difference dominates at the venous end.
(3) Hydrostatic pressure difference dominates at the arterial end; osmotic pressure difference dominates at the venous end.
(4) Hydrostatic pressure drops during diastole.

63. Which of the following mineral nutrients is directly involved in light absorption during photosynthesis?
(1) Zn^{2+} (2) Mn^{2+}
(3) Cu^{2+} (4) Mg^{2+}

64. Most of the dry mass of a plant is derived from
(1) minerals from the soil
(2) carbon from the soil
(3) carbon from the atmosphere
(4) oxygen from the atmosphere

65. Chlorophylls *a* and *b* are two pigments primarily responsible for the capture and processing of solar energy in the light reactions of photosynthesis. Which of the following best explains why having both chlorophyll *a* and *b* benefits a plant more than having one?
(1) Chlorophylls *a* and *b* have slightly different absorption spectra; this expands the range of wavelengths of light that can be captured for photosynthesis.
(2) Chlorophyll *a* is primarily involved in electron transfer; chlorophyll *b* is mainly involved in the capture of light energy.
(3) Chlorophyll *a* captures all the solar energy; chlorophyll *b* serves to protect chlorophyll *a* from overexcitation.
(4) Chlorophyll *b* captures all the solar energy; since chlorophyll *a* is a precursor to chlorophyll *b*, a pool of chlorophyll *a* must be maintained.

66. The Calvin cycle, the "dark reactions" or carbon fixation reactions of photosynthesis, cannot occur at night in a living plant. Which of the following best describes why this is true?
(1) The stomata are incapable of opening at night, thus CO2 cannot enter the leaf.

(2) The reactions of the Calvin cycle are dependent on light reactions for high-energy compounds.
(3) Several enzymes necessary for Calvin cycle activity have been degraded during the day and must be replaced.
(4) Light is required to transport the water necessary for the cycle.

67. If the egg cell of a megagametophyte of a flowering plant has a marker gene designated as *X* and the sperm cell of a compatible pollen grain has a marker gene designated as *Y*, which of the following represents the endosperm that will result from fertilization in most flowering plants?
(1) *XX*   (2) *YY*
(3) *XY*   (4) *XXY*

68. Ca^{2+} is important in skeletal muscle contraction because it
(1) activates the myosin ATPase by binding to it
(2) binds to troponin to remove a constant inhibition of cross-bridge attachment
(3) prevents the formation of bonds between the myosin cross bridges and the actin filament
(4) is required to detach the myosin head from the actin filament

69. Which of the following structures present in the embryos of higher plants develops into the primary root of the seedling?
(1) Epicotyl   (2) Hypocotyl
(3) Cotyledon   (4) Radicle

70. Which of the following statements about the motility of *Paramecium* is true?
(1) *Paramecium* employs a pseudopod.
(2) *Paramecium* has no structures for motility.
(3) *Paramecium* uses a single flagellum.
(4) *Paramecium* uses cilia.

71. In the cellular slime molds, the aggregation of myxamoebas is initiated by
(1) low light intensities
(2) high pH
(3) uptake of chloride ion
(4) secretion of cyclic AMP

72. A unicellular eukaryote that contains chlorophyll *a* (but no chlorophyll *b*), that functions as one of the major photosynthetic autotrophs in open-ocean ecosystems, and that has cell walls that contain silica is a
(1) red alga
(2) green alga
(3) dinoflagellate

(4) euglenoid

73. Dikaryotic hyphae are a kind of fungal tissue that
(1) contain two chromosomes
(2) form after plasmogamy and before karyogamy
(3) are only a short stage of the life cycle of the Basidiomycota
(4) are formed by the fusion of two nuclei

74. Saprophytic fungi obtain their nutrition by
(1) taking food into their gastrovascular cavity, and then digesting and absorbing it
(2) making food by chemosynthesis
(3) secreting digestive enzymes into the environment and then absorbing the digestive products
(4) using their amoeboid cells in phagocytosis

75. An animal with a coelom, jointed appendages, and metameric segmentation would be classified in the phylum
(1) Mollusca   (2) Cnidaria
(3) Platyhelminthes   (4) Arthropoda

76. Which of the following animal phyla is diploblastic, that is, exhibits only two embryonic germ layers?
(1) Rotifera   (2) Mollusca
(3) Nematoda   (4) Cnidaria

77. Which of the following describes members of both the Bryophyta and the Pteridophyta?
(1) The absence of true roots
(2) The absence of swimming sperm
(3) The absence of meristematic growth
(4) The presence of chlorophyll

78. In sporophytes of some mosses, a ring of peristome teeth regulates
(1) sperm release   (2) spore dispersal
(3) spore germination
(4) asexual reproduction

79. Which of the following characterizes dicotyledonous plants?
(1) Their flowers always have superior ovaries.
(2) Their seeds usually contain two embryos.
(3) Their stems have scattered vascular bundles.
(4) Their flowers usually have parts in multiples of four or five.

80. All of the following allow hermaphroditic animal species to avoid inbreeding EXCEPT
(1) functioning as only one sex during mating
(2) releasing eggs and sperm simultaneously

(3) being protandrous
(4) being protogynous

81. All of the following occur during the cleavage stage of animal development EXCEPT
(1) an increase in the nuclear-to-cytoplasmic ratio of the cells
(2) an increase in the number of blastomeres
(3) an increase in the mass of the embryo
(4) an increase in the surface-to-volume ratio of the cells

82. Plants that utilize photosynthesis via the C4 pathway differ from those that use the C3 pathway in that at higher temperatures the C4 plants
(1) are less productive per unit area of leaf
(2) are more productive per unit area of leaf
(3) can tolerate lower light conditions better
(4) carry on high levels of photorespiration

83. A lateral root forms on the primary root of a typical herbaceous dicot by
(1) continued growth of a root hair on an epidermal cell
(2) lateral outgrowth of xylem
(3) lateral outgrowth from the root apical meristem
(4) activation of an area in the pericycle to form an apical meristem

84. The leaves of grasses can continue to elongate following mowing or grazing due to actively growing tissue at the base of the leaf blades and sheaths called
(1) apical meristems
(2) lateral cambium
(3) intercalary meristems
(4) axillary buds

85. The amount of energy entering a food chain depends on the
(1) direction of energy flow in the system
(2) efficiency of energy recycling in the system
(3) biomass of carnivores and their efficiency in locating and capturing animal prey
(4) biomass of autotrophs and their efficiency in transforming solar energy into chemical energy

86. Two plant species co-occur in a prairie. Species X always occurs near species Y. However, species Y often occurs in isolation from species X and produces more seeds when alone than when growing next to species X. Which of the following interactions between species X and Y could generate this pattern?
(1) Competition, in which Y is superior to X in accumulating resources

(2) Mutualism, in which both *X* and *Y* benefit by exchanging resources

(3) Parasitism, in which *X* benefits from resources produced by *Y* and reduces the growth of *Y* by doing so

(4) Commensalism, in which *X* benefits from resources produced by *Y* but does not affect the growth of *Y* by doing so

87. In the endosymbiont hypothesis for the origin of eukaryotic cells, which of the following is proposed as the role of cyanobacteria?
(1) They become the chlorophyll of plant cells.
(2) They are the ancestor of mitochondria.
(3) They are the ancestor of the chloroplasts.
(4) They lose their DNA and become the vacuoles of plant cells.

88. The process of speciation can be prevented by
(1) genetic differentiation
(2) geographical barriers
(3) inhibition of gene exchange
(4) gene flow

89. Small body size often allows animals to exploit desert habitats because it
(1) decreases the ratio of surface area to volume and hence the tendency to lose water
(2) promotes heat gain
(3) enhances thermal inertia
(4) enables exploitation of favorable microhabitats

90. All of the following are strategies used by potential prey to avoid predation EXCEPT
(1) mimetic coloration   (2) erratic flight
(3) cryptic coloration   (4) lekking

91. The amount of genotypic variation in a natural population can be increased by all of the following EXCEPT
(1) mutation   (2) recombination
(3) immigration   (4) inbreeding

92. The graph above illustrates a simplified description of the effect of disturbance on species diversity. Which of the following best explains the graph?
(1) Productivity is enhanced at intermediate levels of disturbance.
(2) Stabilizing selection occurs at intermediate levels of disturbance.
(3) The interaction of physical factors and biological competition increases diversity at intermediate levels of disturbance.
(4) Directional selection is enhanced by increased disturbance.

93. Plants having C4 metabolism are common in all of the following regions EXCEPT
(1) taiga
(2) warm deserts
(3) tropical grasslands
(4) tropical agricultural areas
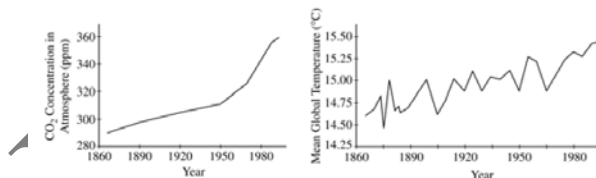
94. The graphs above show that the relationship between atmospheric CO_2 and mean global temperature is
(1) a positive correlation
(2) an inverse relationship
(3) a cause-and-effect relationship
(4) evidence of an impending ice age

95. Which of the following is NOT a hypothesis explaining the advantage of group living?
(1) Vigilance effect
(2) Dilution effect
(3) Group foraging
(4) Parasite avoidance
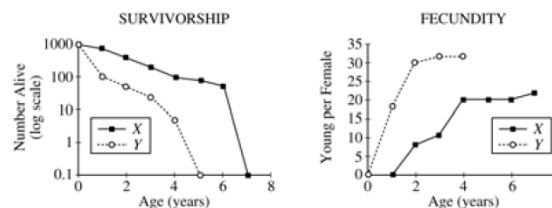
96. The graphs above show the survivorship and fecundity curves for two congeneric species, *X* and *Y*, that are found in different habitats. Of the two species, *Y* is more likely to
(1) come from a disturbed habitat in early succession
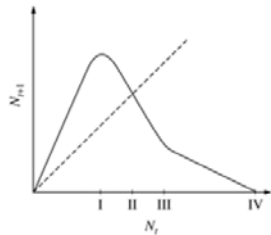(2) have a longer generation time
(3) have a lower fecundity
(4) have a longer life span

97. If average family size for the human population could be immediately reduced to two children per couple, the population would
(1) remain constant
(2) begin an immediate decline
(3) continue to increase for 20 to 40 years
(4) continue to increase indefinitely

98. The figure above illustrates the relationship between population density in the present generation (N_t) and population density in the next generation (N_{t+1}). The dashed reference line has a slope of 1. Which of the following represents equilibrium density of this population?
(1) I   (2) II
(3) III   (4) IV

99. Reproductive value (V_x) calculated from population life-table data provides a measure of the
(1) contribution of an individual of age x to the future growth of the population relative to a newborn's contribution
(2) average number of offspring produced by a female during age interval x
(3) proportion of available resources allocated to reproduction in individuals in population x
(4) probability of offspring surviving to age class x

100. Life-history characteristics associated with K-selected organisms include
(1) rapid reproductive rates, short generation times and large body size
(2) repeated reproduction, few progeny, and large body size
(3) inhabiting early successional state communities, rapid maturation rates, and numerous large offspring
(4) inhabiting climax communities, many small offspring, and short life span

$$\frac{dN}{dt} = rN\left(\frac{K-N}{K}\right)$$

101. The logistic equation above is used to describe the rate of change of a population, N, with time, t, where r is the intrinsic rate of increase and K is the carrying capacity. Which of the following statements is true for this equation?
(1) For a given population, r is variable.
(2) For a given environment, K is variable.
(3) As N approaches K, dN/dt approaches 0.
(4) As N approaches K, dN/dt approaches K.

102. Which of the following biomes is characterized by a wet, mild winter and a warm, dry summer?
(1) Taiga
(2) Tundra
(3) Chaparral
(4) Tropical rain forest

103. If a species is a keystone predator, then its removal from a community should
(1) decrease population size of the predator's preferred prey
(2) decrease species diversity in the prey community
(3) decrease productivity of the predator's preferred prey
(4) increase species diversity in the prey community
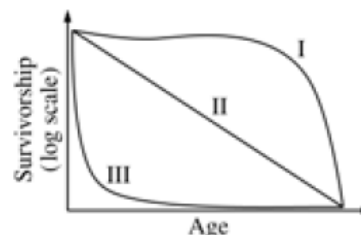
104. The diagram above depicts three general types of survivorship curves. Only the form of the curve is important, not its absolute scale. Which of the following statements is LEAST likely to be true?
(1) Nearly constant mortality results in a Type II curve.
(2) A fish that lays vast numbers of eggs exhibits a Type III curve.
(3) Currently, human populations in the India generally exhibit a Type I curve.
(4) A species with high juvenile mortality and high adult survivorship results in a Type I curve.

105. All of the following may be considered as sites for secondary succession EXCEPT
(1) an abandoned agricultural field
(2) a bare rock shelf on a mountainside
(3) a forest gap resulting from a tree fall
(4) a hurricane-damaged forest
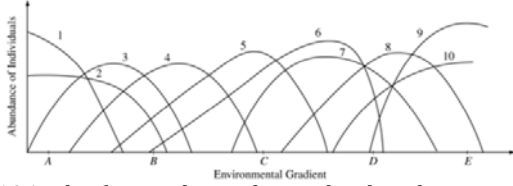
106. The figure above shows the distribution of 10 plant species that grow along a regular environmental gradient, such as depth of the water table in a river valley. All other environmental factors are similar. This figure demonstrates that
(1) species richness increases along the gradient from A to E
(2) species richness decreases along the gradient from A to E
(3) discrete communities are formed at sites A, C, and D
(4) no discrete communities are formed along the gradient

107. Acid rain damage depends on the buffering capacity of the soils in a given region. Damage has been greatest where the soil layer is
(1) thin and contains little calcium and magnesium
(2) thin and contains abundant calcium and magnesium
(3) thin and contains abundant calcium but little magnesium
(4) thick and contains abundant calcium and magnesium

108. Nitrogen is a major environmental pollutant of groundwater in many parts of the world. What is the major cause of this nitrogen accumulation in groundwater?
(1) Excessive use of nitrogen fertilizers
(2) Destruction of nitrifying bacteria, which results in soil nitrogen remaining as NH^{4+}
(3) Excess soil moisture, which causes ammonification or denitrification
(4) Presence of sandy-textured soil

109. The phosphoglucomutase (*Pgm*) locus in California populations of Nuttall's white-crowned sparrow has allelic frequencies of 0.8 and 0.2, respectively, for the alleles *Pgm-A* and *Pgm-B*. What is the probability that two heterozygous individuals will mate, given that *Pgm* is in Hardy-Weinberg equilibrium?
 (1) 0.01   (2) 0.10
(3) 0.16   (4) 0.32

| | GENOTYPES | | | |
	RR	Rr	rr	Total
Initial frequency	p^2	$2pq$	q^2	$p^2 + 2pq + q^2$
Adaptive value	1	1	$1-s$	
Frequency after selection	p^2	$2pq$	$q^2(1-s)$	$1-sq^2$
Relative genotype frequency after one generation of selection	$\dfrac{p^2}{(1-sq^2)}$	$\dfrac{2pq}{(1-sq^2)}$	$\dfrac{q^2(1-s)}{(1-sq^2)}$	1

110. For a trait controlled by a single-locus, two-allele system with complete dominance, p is the gene frequency of R, the dominant allele, q is the gene frequency of r, the recessive allele, and s is the selection coefficient against the recessive homozygote. The table above indicates the effects of natural selection on genotype frequencies over one generation. After one generation of such selection, the relative frequency of the recessive allele, r, will be equal to

1. $\dfrac{\frac{1}{2}(2pq)+q^2(1-s)}{}$

2. $\dfrac{\frac{1}{2}(2pq)+q^2(1-s)}{(1-sq^2)}$

3. $\dfrac{q^2(1-s)}{(1-sq^2)}$

4. $\dfrac{\frac{1}{2}(2pq)+p^2}{(1-sq^2)}$

111. Sewall Wright's metaphor of evolution on an adaptive landscape describes a population as occupying a field of genotypes graded by contours delimiting gene combinations of equal fitness. The evolutionary mechanism most likely to move a population consistently "uphill" toward adaptive peaks on this landscape is
(1) chance
(2) directed mutation
(3) natural selection
(4) gene flow between populations

112. When exposed to a cold environment for several weeks, many small mammals dramatically increase their capacity for heat production primarily by means of
(1) decreased insulation
(2) increased insulation
(3) shivering thermogenesis
(4) nonshivering thermogenesis

113. Plant species A has a diploid number of 12, while species B has a diploid number of 16. Which of the following would be the diploid number of an allotetraploid derived from a hybrid between these two species?
(1) 14   (2) 28
(3) 40   (4) 44

114. If two parents that are heterozygous (*Aa*) at a single locus give rise to offspring that are 25 percent *AA*, 50 percent *Aa*, and 25 percent *aa*, then all of the following are true EXCEPT:
(1) The parents are diploid organisms.
(2) The *a* allele is recessive lethal.
(3) The alleles assort independently.
(4) The gametes combine at random.
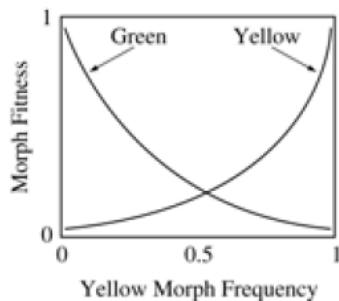
115. In a certain species of lizard, there are two color morphs associated with a single locus (*Y*) having two alleles (*Y*, *y*): yellow (*yy*) and green (*YY*, *Yy*). The fitness of the morphs is frequency-dependent, as indicated in the graph above. If the frequency of the yellow morph in a population is 0.70 and individuals are randomly mating, then the expected equilibrium population due to natural selection is
(1) monomorphic for yellow morphs
(2) monomorphic for green morphs
(3) polymorphic with a stable ratio of about 1:1 of yellow to green morphs
(4) polymorphic with oscillating frequencies of yellow and green morphs

116. The fitness of a genotype is higher when it is rare in a population than when it is common. Which of the following types of selection is most likely operating?
(1) Density-independent selection
(2) Frequency-dependent selection
(3) Directional selection
(4) Stabilizing selection

117. The mating system in which a female defends a large, multipurpose territory within which several males defend smaller, exclusive territories is known as
(1) polygynandry
(2) resource defense polygyny
(3) resource defense polyandry
(4) harem defense polygyny

118. One theory of the evolution of cooperation in animals states that under conditions of low resource availability, some members of a population are willing to sacrifice their own efforts to reproduce to ensure that the population as a whole will not exhaust all its resources and go extinct. Which level of selection is described in this model?
(1) Directional selection
(2) Individual selection
(3) Disruptive selection
(4) Group selection

119. Charles Darwin discussed all of the following EXCEPT:
(1) Natural selection tends to remove those organisms that are poorly adapted to their environments.
(2) Individuals in a population compete with one another for limited resources.
(3) Gene mutations are the source of variation for evolution.
(4) Organisms tend to produce more offspring than can survive in each generation.

120. When numbers of organisms and amounts of living material in successively higher trophic levels are compared, the values usually take the form of a pyramid, with the largest numbers and greatest biomass in the producer trophic level. However, in some marine ecosystems, the consumer trophic levels contain significantly greater amounts of living material than does the primary-producer trophic level. The best explanation for this is which of the following?
(1) The main primary producers in marine ecosystems are microscopic algae with extremely high rates of population turnover.
(2) Most consumers in marine ecosystems are filter feeders that must maintain large basketlike structures for extracting food from the water.
(3) The increased availability of solar radiation in marine ecosystems means that fewer primary producers are required to support Marine food chains.
(4) Marine zooplankton often produce large extensions of their bodies in order to increase buoyancy.

121. Two populations of sunflowers, *A* and *B*, differ in the heritability of the oil content in their seeds; H2 equals 0.40 in population *A*, while H2 equals 0.70 in population *B*. Which of the following statements about these sunflower populations is correct?
(1) Population *A*'s seeds have a lower oil content than those of *B*.
(2) The variability in seed oil content is higher in population *B* than in *A*.
(3) Population *A* grows in a more diverse and unstable environment than does *B*.
(4) Proportionately more phenotypic variation is environmental variation in population *A* than in *B*.

122. From an evolutionary point of view, plant tendrils derived from leaves and those derived from stems are examples of
(1) analogous structures resulting from convergence only
(2) homologous structures resulting from convergence only
(3) analogous structures resulting from divergence only
(4) homologous structures resulting from divergence only

123. Which of the following is characteristic of allopatric speciation?
(1) Large populations
(2) Asexually reproducing populations
(3) Geographic isolation
(4) Isolation through adaptation of alleles

1 *Tyrannosaurus* (dinosaur)
2. Lobe-finned fishes
3. Great apes
4. *Eohippus* (horse)
5. Trilobites

124. Which of the following represents the proper sequence, from the earliest in the fossil record to the latest, of the animals listed above?
(1) 1, 2, 5, 4, 3   (2) 2, 5, 1, 3, 4
(3) 2, 5, 1, 4, 3   (4) 5, 2, 1, 4, 3

125. Invasion of the land by vascular plants most likely began in which of the following periods?
(1) Precambrian
(2) Silurian
(3) Pennsylvanian
(4) Cretaceous

126. Which of the following represents the most reduced form of carbon?
(1) R-CH$_3$ (2) R-COOH
(3) R-CHO   (4) R-CH$_2$OH

127. The *K*m (Michaelis constant) of an enzyme for a substrate is defined operationally as
(1) half the substrate concentration at which the reaction rate is maximal
(2) the substrate concentration at which the reaction rate is half maximal
(3) the dissociation constant of the enzyme substrate complex
(4) the dissociation constant of the enzyme product complex

128. The reversible reaction in which dihydroxyacetone phosphate and glyceraldehyde 3-phosphate combine to form fructose 1,6-bisphosphate is best characterized as
(1) an aldol condensation
(2) a Grignard reaction
(3) a free-radical reaction
(4) a hydrolytic reaction

129. Dinitrophenol (DNP) uncouples mitochondrial electron transport from oxidative phosphorylation by
(1) dissipating the proton gradient
(2) inhibiting cytochrome oxidase
(3) dissociating the F$_0$ and F$_1$ units of the ATP synthase complex
(4) binding irreversibly to ubiquinone

130. Most of the dry mass in the trunk of a tree was originally derived from
(1) the soil
(2) light energy
(3) amino acids
(4) CO$_2$

131. Which of the following cell compartments is associated with a protein skeleton composed of lamins?
(1) Chloroplast
(2) Basement membrane
(3) Mitochondrion
(4) Nucleus

132. Initiation of mitogenesis by epidermal growth factor and depolarization of the membrane of a skeletal muscle cell by acetylcholine are similar in that each
(1) involves, as an essential early step, an ion flux across the plasma-membrane receptor of the responding cell
(2) requires a ligand-mediated conformational change in a plasma-membrane receptor of the responding cell
(3) requires activation of a G protein on the cytoplasmic face of the plasma membrane in the responding cell
(4) is mediated by phosphorylation of the ligand receptor in the responding cell

133. The principal site of peptide neurohormone biosynthesis is the
(1) nucleus
(2) rough ER
(3) dendrite
(4) postsynaptic density

134. A previously unknown organism that lacks a nuclear membrane and mitochondria has just been discovered. Which of the following would this organism most likely possess?
(1) Lysosomes
(2) Cilia
(3) Ribosomes
(4) Endoplasmic reticulum

135. Drugs that either stabilize or depolymerize microtubules can be used in cancer chemotherapy. Which of the following is correct concerning such drugs?
(1) They stimulate the immune system.
(2) They prevent chromatin condensation.
(3) They prevent movement of tumor cells into other tissues.
(4) They interfere with mitosis.

136. If the genetic code consisted of four bases per codon rather than three, the maximum number of unique amino acids that could be encoded would be
(1) 16   (2) 64
(3) 128   (4) 256

137. In humans, the Barr body is an
(1) active X chromosome in females
(2) active X chromosome in males
(3) inactive Y chromosome in males
(4) inactive X chromosome in females

138. Which of the following types of molecules is always found in virions?

(1) Lipid   (2) Protein
(3) Carbohydrate   (4) DNA

139. An RNA-dependent RNA polymerase is likely to be present in the virion of a
(1) DNA virus that multiplies in the cytoplasm
(2) DNA virus that multiplies in the nucleus
(3) minus-strand RNA virus
(4) plus-strand RNA virus

140. In *E. coli*, the inability of the *lac* repressor to bind an inducer would result in
(1) no substantial synthesis of β-galactosidase
(2) constitutive synthesis of β-galactosidase
(3) inducible synthesis of β-galactosidase
(4) synthesis of β-galactosidase only in the absence of lactose

MODEL PAPER 14 ANSWER KEY

1	3	21	3	41	3	61	4	81	3	101	3	121	4
2	2	22	3	42	1	62	3	82	2	102	3	122	1
3	1	23	4	43	1	63	4	83	4	103	2	123	3
4	3	24	-	44	4	64	3	84	3	104	4	124	4
5	1	25	2	45	1	65	1	85	4	105	2	125	2
6	4	26	3	46	3	66	2	86	3	106	4	126	1
7	4	27	2	47	1	67	4	87	3	107	1	127	2
8	3	28	-	48	4	68	2	88	4	108	1	128	1
9	3	29	-	49	4	69	4	89	4	109	2	129	1
10	1	30	-	50	2	70	4	90	4	110	2	130	4
11	2	31	3	51	4	71	4	91	4	111	3	131	4
12	4	32	3	52	2	72	4	92	3	112	4	132	2
13	1	33	4	53	3	73	2	93	1	113	2	133	2
14	-	34	4	54	2	74	3	94	1	114	2	134	3
15	1	35	4	55	5	75	4	95	4	115	1	135	4
16	3	36	1	56	3	76	4	96	1	116	2	136	4
17	3	37	1	57	1	77	4	97	3	117	3	137	4
18	3	38	2	58	4	78	2	98	2	118	4	138	2
19	1	39	4	59	2	79	4	99	1	119	3	139	3
20	1	40	3	60	4	80	2	100	2	120	1	140	1