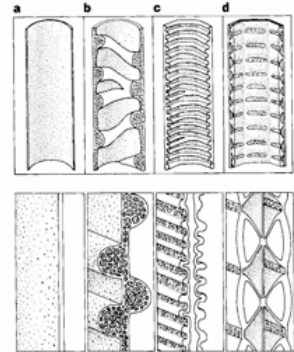


Circle the best single letter choice for each of the following questions before transferring your answers to your computer sheet.

1. Specialized cells such as those in the accompanying drawing, were fundamental in the development of terrestrial plants because they

- A. promote gaseous exchange
- B. produce gametes
- C. provide support and routes of transport of materials
- D. anchor the plant
- E. A and D only are correct



2. Biologists studying little brown bats (*Myotis lucifugus*) used mark-release-recapture to estimate the numbers of bats visiting an abandoned mine. On 8 August 2000 they caught and banded 228 *M. lucifugus*. One year later, 11 August 2001, they caught 211 bats, 103 that they had previously banded. These data allow the researchers to estimate the bat population size at

- A. 980
- B. 525
- C. 467
- D. 370
- E. 300

3. Use the formula $N_t = N_0 e^{rt}$ and the data below to determine how much the population of Nova Scotia will exceed that of Newfoundland in 25 years. (Assume no immigration or emigration and that other population factors remain the same as they are today).

	Population today (millions)	r
Newfoundland	0.51	0.0018
Nova Scotia	0.95	0.0021

- A. 267,800.
- B. 1,067,800.
- C. 467,800.
- D. 810,800.
- E. 367,800.

4. Which of the following characteristics can be used to recognize any mammal, fossil or living?

- A. a diaphragm
- B. mammary glands
- C. two occipital condyles
- D. heterodont teeth
- E. xenarthrous vertebrae

5. If 20 couples (20 men, 20 women) arrived on Easter Island in 1250 A.D. and, on average each couple had 3 children, what could the population be in 1400 A.D.?

Assume that there was no further immigration or emigration, and that each woman had her first child at 15 years of age, the second at 18 years of age and the third at 21 years of age.

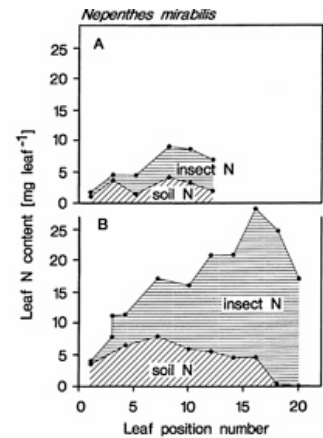
(Use the formula $N_t = N_0 e^{rt}$ where N_t is the number at 1400 A.D., N_0 is the number in 1250 A.D., r is the intrinsic rate of increase and g is generation time (sum of mother's age at each birth divided by the number of births; r is per individual change calculated from $r = (\text{new} - \text{original})/\text{original}/g$).

- A. 1,080
- B. 2,080
- C. 2,580
- D. 3,280
- E. 4,280



6. In this graph, panel A represents young leaves (pitcher unopened) and B represents older leaves (pitchers opened). The data indicate that

- A. insect N occurs only in open pitchers.
- B. soil N occurs only in closed pitchers.
- C. closed pitchers have less N than open pitchers.
- D. open pitchers have more insect N than closed pitchers.
- E. these plants do not need insect N.



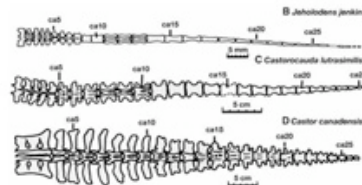
Both C and D were awarded as correct answers.



7. The diagrams and photo show the tail vertebrae of
- a jerbil, *Jeholodens* (top diagram),
 - the Mesozoic beaver, *Castrocauda* (middle diagram),
 - a Canadian beaver, *Castor* (bottom diagram)
 - a duck-billed platypus, *Ornithorhynchus* (photograph).

The appearance of these tails demonstrates a close evolutionary relationship between

- A. *Jeholodens* and *Ornithorhynchus*.
- B. *Castor* and *Castrocauda*.
- C. *Ornithorhynchus* and *Castor*.
- D. *Castrocauda* and *Ornithorhynchus*.
- E. None of A, B, C or D is correct.



8. Which of the following traits characterize a K-selected species?

- A. large size
- B. very fertile (many young per reproductive event)
- C. short-lived
- D. carnivorous
- E. A and D only are correct



9. This image shows the skulls of four different mammals.

These animals belong to **This question was omitted.**



- A. the same order.
- B. two different orders.
- C. three different orders.
- D. four different orders.
- E. three different families.



10. In this same image, the four mammal skulls illustrate

- A. adaptive radiation.
- B. convergent evolution.
- C. parallel evolution.
- D. divergent evolution.
- E. B and D only are correct.

This question was omitted.

11. Early reproduction by an individual can mean

- A. a high r value.
- B. a high R value.
- C. high fecundity.
- D. getting more genes into the next generation.**
- E. A and C only are correct.



12. In most mammals, females invest more in reproduction than males because of

- A. egg size.
- B. the presence of a diaphragm.
- C. homeothermy.
- D. pregnancy.**
- E. A and D only are correct.



13. The Beothuk people are extinct because they

- A. lived in Newfoundland.
- B. were killed by settlers.**
- C. were few in number.
- D. had low fecundity.
- E. All of A, B, C and D are correct.



14. Which of the following observations support the notion that "Dinosaurs live on as modern birds"?

- A. Some dinosaurs had feathers.**
- B. Dinosaurs had furcula.
- C. Dinosaurs had beaks.
- D. Dinosaurs laid eggs
- E. A and B only are correct



15. Populations of barn door skates (*Dipturus laevis*) are very low because they have been

- A. a popular seafood choice in restaurants.
- B. infertile.
- C. victims of bycatch.
- D. affected by climate change.
- E. All of A, B, C and D are correct.



16. In biological language, a "niche" is

- A. an organism's place in nature.
- B. a representation of K for a species.
- C. a bird's nest.
- D. an organism's food.
- E. None of A, B, C or D is correct.

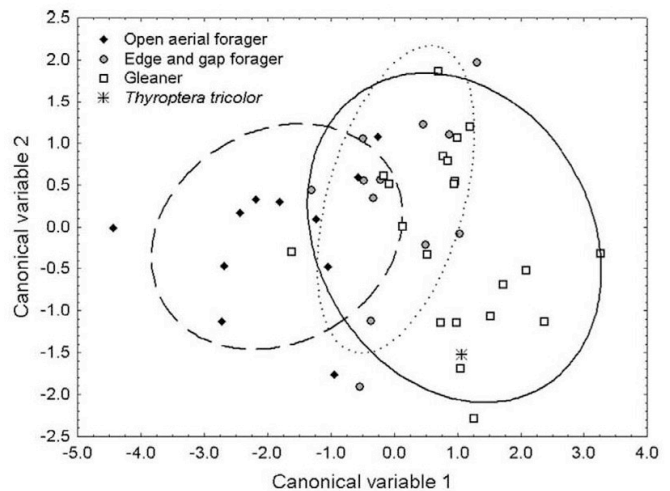


17. The principle of competitive exclusion is illustrated by

- A. bluegill sunfish.
- B. mosquito and midge larvae in pitcher plants.
- C. paramecia in Gause's experiment.
- D. lions and baboons.
- E. African elephants (*Loxodonta Africana*) and buffalo (*Syncercus caffer*).

18. This figure illustrates how different kinds of bats (open aerial foragers, edge and gap foragers, gleaners and *Thyroptera tricolor*) take different prey. One could conclude from these data that these bats

- A. take different prey.
- B. occupy different niches.
- C. compete for limited resources.
- D. show broad overlap in diet.
- E. use different roosts.



19. Processing chain commensualism is exemplified by

- A. pitcher plants and rotifers.
- B. the moths that eat pitcher plants.
- C. midges and mosquitoes living in pitchers.
- D. lions and their prey.
- E. psychrophilic organisms.



20. Triple covalent bonds in atmospheric nitrogen result in this element being relatively

- A. abundant in air.
- B. soluble in water.
- C. unavailable to plants.
- D. available in fertilizers.
- E. A and C only are correct.

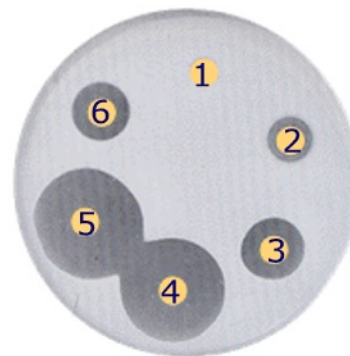


21. Transposons contribute to the incidence of antibiotic-resistant bacterial infections by

- A. moving copies of antibiotic resistance genes around.
- B. causing mutations leading to antibiotic resistance.
- C. providing energy to drive efflux pumps, thereby reducing intracellular antibiotic concentrations.
- D. killing all but the most resistant cells.
- E. making the bacterial growth rate exponential.

22. Which of the following statements is the **correct** interpretation of the Petri plate shown here?

- A. The bacterium labelled **2** is more resistant to antibiotic than the bacterium labelled **5**.
- B. The bacterium is more resistant to the antibiotic labelled **5** than the antibiotic labelled **2**.
- C. The bacterium is more resistant to the antibiotic labelled **2** than the antibiotic labelled **4**.
- D. The bacterium labelled **4** is more resistant to antibiotic than the bacterium labelled **6**.
- E. None of A, B, C or D is correct.



23. One key to the development of resistance is generation time. In bacteria this can be

- A. 60 seconds.
- B. 60 minutes.
- C. 60 hours.
- D. 60 days.
- E. 60 months



24. Which of the following statements about the history of life on Earth is **correct**?

- A. After the Earth formed it took only 2 billion years for life to develop.
- B. The development of prokaryotes was triggered by O₂ in the atmosphere.
- C. Dinosaurs and *Homo sapiens* co-existed for about 1 million years.
- D. Life developed about 4 billion years ago.
- E. None of A, B, C or D is correct.

25. Which of the following was a finding of the Miller-Urey experiment?

- A. Proteins could be synthesized by catalytic RNA.
- B. O₂ was required for abiotic synthesis of macromolecules.
- C. L-alanine could be synthesized without D-alanine being formed.
- D. DNA could be synthesized in the absence of enzymes.
- E. Amino acids could be synthesized abiotically.

26. Which of the following statements about chirality is **correct**?

- A. Homochirality is a normal consequence of the chemical synthesis of macromolecules.
- B. Both chiral forms of Thalidomide cause birth defects.
- C. NO_2 can be considered a chiral partner of CO_2 .
- D. Homochirality may be explained by the specificity of enzymes for substrate.
- E. C and D only are correct.

27. Which of the following statements does not apply to RNA molecules?

- A. Ribozymes are biological catalysts.
- B. The presence of a second, complementary strand, makes RNA easy to repair.
- C. Ribosomes contain RNA.
- D. Some ribozymes act to decrease the abundance of specific mRNA molecules.
- E. RNA molecules can fold by complementary base-pairing into elaborate shapes.

28. Which of the following statements about extrasolar planets is **correct**?

- A. Although we have looked, the only known planets are those orbiting our Sun.
- B. The planets that have been detected tend to be massive, and very close to the parent star.
- C. The Transit Method of detection measures changes in the brightness of stars.
- D. Given our current technology, it would take about 5 years to reach the nearest star that has a planetary system.
- E. B and C only are correct.

0.5 marks for B or C.

29. One explanation for the Fermi Paradox is that

- A. distances between advanced civilizations is very great.
- B. our galaxy probably contains millions of advanced civilizations.
- C. the lifetime of civilizations is probably very long.
- D. the parameter f_i is probably much higher than current estimates.
- E. Mars probably supported life a few billion years ago.

30. Which of the following statements from the Drake Equation lecture is **correct**?

1. Radio waves travel the speed of light.
2. The "Habitable Zone" of our Solar System includes Venus, Earth and Mars.
3. In our Solar System liquid water is present only on Earth and Mars.
4. In the Drake Equation, N denotes the number of advanced civilizations in our Galaxy.
5. The Lifetime parameter (L) of the Drake Equation refers to how long an intelligent species has existed (so for Humans about 150,000 years).

- A. 1, 2, 3, 5
- B. 2, 3, 4,
- C. 2, 4, 5
- D. 1, 4,
- E. 1, 4, 5

E is not correct. The Lifetime Parameter is very specific. It is defined as how long an intelligent civilization has had the technology to be able to send and detect radio waves. So for humans that is only a few decades.

31. For a process to be spontaneous

- A. it must be exothermic.
- B. the free energy change of the system must be negative.
- C. the entropy of the system must decrease.
- D. the entropy of the system must increase.
- E. the system must go to a state of greater disorder.

32. Within a cell, the hydrolysis of ATP in a biochemical reaction

- A. produces more heat than if ATP is simply hydrolyzed in a beaker of water.
- B. can occur only in the absence of an enzyme.
- C. is required only for exergonic reactions which do not proceed spontaneously.
- D. results in transfer of a phosphate group to a substrate making it unstable.
- E. None of A, B, C or D is correct.

33. Which of the following statements about energy and thermodynamics is **correct**?

- A. Energy conversions can never be 100% efficient.
- B. All living organisms are open systems.
- C. The Earth can be considered a closed system.
- D. The total amount of energy in the universe is constant.
- E. All of A, B, C and D are correct.

Part marks were not awarded for this question.

34. Although propane is thermodynamically unstable, the reason that it is kinetically stable is because

- A. it contains an abundance of oxygen and little hydrogen.
- B. its breakdown is exergonic ($-\Delta G$).
- C. it has a high activation energy (E_A).
- D. it is highly electronegative.
- E. All of A, B, C and D are correct.

35. Which of the following reactions shows a ΔG that is **NOT** correct?

- A. Acetyl CoA \rightarrow CO₂ ($\Delta G < 0$)
- B. Glucose \rightarrow pyruvate ($\Delta G < 0$)
- C. ATP \rightarrow ADP + Pi ($\Delta G < 0$)
- D. FAD⁺ \rightarrow FADH₂ ($\Delta G < 0$)
- E. CH₄ \rightarrow CHOOH ($\Delta G < 0$)

36. The active site of an enzyme

- A. forces substrate molecules into their transition state conformation.
- B. is never altered by a change to the overall conformation of the enzyme.
- C. cannot be identified given just the primary amino acid sequence of an enzyme.
- D. is the site of binding for non-competitive inhibitors.
- E. can usually process about 1-10 molecules of substrate per minute.

Both A and C were awarded as correct answers.

37. Allosteric regulation

- A. is required for the competitive inhibition of enzyme action.
- B. is triggered by an increases in enzyme abundance.
- C. does not alter the kinetics of the enzyme.
- D. allows for rapid, reversible control of enzyme activity.
- E. A and D only are correct.

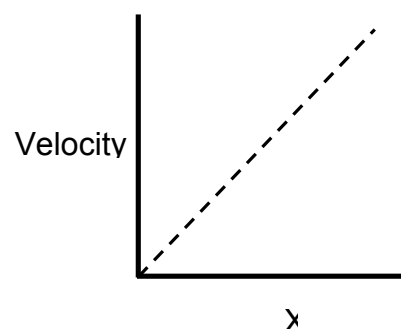
38. The most likely mechanism whereby a bacterium may become resistant to Penicillin is by

- A. a mutation which alters the active site of the enzyme Transpeptidase.
- B. developing a novel set of enzymes for DNA synthesis.
- C. making the plasma membrane impermeable to penicillin uptake.
- D. altering the RNA component of the ribosome.
- E. Bacteria cannot become resistant to antibiotics.

Both A and C were awarded as correct answers.

39. What are the experimental conditions which were used to produce this graph which shows the rate of an enzyme catalyzed reaction?

- A. X is substrate concentration and enzyme concentration is constant and low.
- B. X is competitive inhibitor and both enzyme and substrate concentration are low.
- C. X is non-competitive inhibitor and enzyme is low and substrate is very high.
- D. X is enzyme concentration and substrate concentration is very high.
- E. X is substrate concentration and no enzyme is present (control experiment).



40. Desaturases

- A. are induced in bacteria by a shift to high temperatures.
- B. introduce trans-double bonds into the fatty acids which make of plant membranes.
- C. are found only in mammals.
- D. increase the amount of cholesterol in a membrane.
- E. maintain correct membrane fluidity at a range of temperatures.

41. Which one of the following proteins does **NOT** have distinct regions of about 19-21 primarily hydrophobic amino acids ?

- A. Cystic Fibrosis Transmembrane Conductance Regulator (CFTR)
- B. Uncoupling protein 1 (UCP1)
- C. Phosphofructokinase
- D. Efflux pump protein
- E. Cytochrome oxidase

42. Unlike simple diffusion, facilitated (carrier-mediated) diffusion displays saturation kinetics because

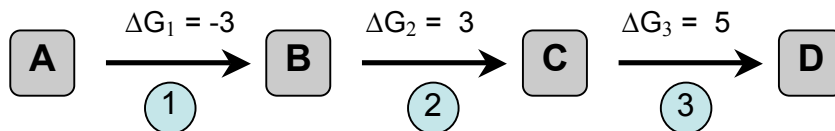
- A. facilitated diffusion requires ATP.
- B. at high concentrations diffusion is limited by the availability of transport proteins.
- C. diffusion is always proportional to concentration of transporting substrate.
- D. transport is often non-competitively inhibited by a similar substrate molecule.
- E. the hydrophobic core of the membrane will prevent transport.

0.5 marks for C. C. by itself is a correct statement BUT not given the stem of the question.

43. The energy required for co-transport and oxidative phosphorylation comes from

- A. ATP hydrolysis.
- B. the proton motive force (PMF).
- C. oxidation of NADH.
- D. Spontaneous combustion.
- E. 38 ATP

44. Above is a biosynthetic pathway in which substrate A is converted into product D using enzymes 1, 2 & 3. Which of the following statements about this pathway is **correct**? (where $\Delta G_1 = -3$ $\Delta G_2 = +3$ $\Delta G_3 = +5$)



- A. Intermediate C is encoded by a gene.
- B. Conversion of C into D is exothermic.
- C. The pathway is anabolic.
- D. Energy is not required to convert C into D.
- E. Product D is likely an allosteric activator of enzyme 1.

45. *Pyruvate Dehydrogenase Deficiency* is treated by putting patients on a ketogenic diet because

- A. it decrease the levels of citrate and oxaloacetate which are both potentially toxic to the cell.
- B. fats, which contain more C-H bonds, contain more energy than glucose.
- C. respiratory metabolism of fatty acids bypasses the pyruvate to acetyl CoA conversion step.
- D. proteins contain more calories per gram than carbohydrates.
- E. ketones can be more readily metabolized by glycolysis than pyruvate or acetyl CoA.

46 Which of the following statements about Glycolysis is **correct**?

- A. ATP is synthesized both by substrate-level phosphorylation and oxidative phosphorylation.
- B. The final product contains the same amount of free energy as the starting substrate.
- C. It requires the consumption of ATP.
- D. It occurs in the mitochondrial matrix.
- E. It does not occur in anaerobic organisms.

47. *Cytochrome c Deficiency* is a disorder which mimics (is similar to) hypoxia (low oxygen). Evidence that a patient has *Cytochrome c Deficiency* is a

- A. higher than normal rate of respiration (measured as O₂ consumption).
- B. lower than normal mitochondrial NAD⁺/NADH ratio.
- C. high rate of oxaloacetate conversion to citrate in the mitochondrion. 0.5 marks for B or D were awarded.
- D. higher than normal ratio of lactate/acetyl CoA.
- E. B and D only are correct.

48. Which of the following compounds would you think could likely serve as an ACTIVATOR of the enzyme Phosphofructokinase?

- A. Succinate
- B. Acetyl CoA
- C. ADP
- D. Pyruvate
- E. NADH

49. Mitochondrial heat production will be higher than normal when

- A. the rates of electron transport are low.
- B. rates of ATP production are high.
- C. expression of uncoupling proteins is high.
- D. NADH levels are low.
- E. a competitive inhibitor binds to the cytochrome complex (complex 1).

50. Anaerobic fermentation converts pyruvate into a molecule with greater potential energy, lactate. Given that this consumes energy, why does anaerobic fermentation exist?

- A. It is essential for the production of lactate which is needed for protein synthesis.
- B. It is required to regenerate NAD⁺ for Glycolysis under low O₂ conditions.
- C. Under low O₂ conditions, lactate is required for the Krebs Cycle.
- D. Lactate is required to maintain proper muscle structure and function
- E. B and C only are correct.

Lab Questions Q51 to Q56 continue on the next page.

*La/999 people need not do these lab questions.
Leave them blank as in the Oct test.*

Lab Questions (La/999 may skip Q51 to Q56)

51. In the experiment on chromatography, carotenoids travelled a(n) _____ distance compared with chlorophylls because carotenoids are _____ soluble than chlorophylls.

- A. equal; equally
 - B. longer; more**
 - C. shorter; less
 - D. shorter; more
 - E. longer; less
-

52. A spectrophotometer can be used to measure the

- A. efficiency of photosynthesis
 - B. size of the separated photosynthetic pigments
 - C. amount of oxygen evolved during photosynthesis
 - D. wavelength of light that is absorbed by the pigment**
 - E. amount of energy in a photon
-

53. Which of the following statements about fermentation is **false**?

- A. CO₂ is one of the end products of yeast fermentation.
 - B. The end products can influence the rate of fermentation.
 - C. Yeast is a unicellular organism widely used for its fermentation abilities.
 - D. Sodium Dodecyl Sulphate (SDS), is commonly used to increase the rate of yeast fermentation.**
 - E. Yeast can break down glucose in the absence of oxygen.
-

54. A(n) _____ in the concentration of ethanol will cause _____ in the rate of fermentation in yeast.

- A. decrease; a decrease
 - B. increase; an increase
 - C. increase; no change
 - D. increase; a decrease**
 - E. decrease; no change
-

55. From published literature, you would predict that the pulse rate of a black worm would be _____ by the addition of _____.

- A. increased; nicotine**
 - B. decreased; caffeine
 - C. increased; alcohol
 - D. increased; potassium chloride
 - E. None of the above. Pulse rate is controlled by nerves, not chemicals.
-

56. What is the primary reason for including a control within the design of your experiment?

- A. To accumulate more facts to report to other scientists
 - B. To provide more data to allow more sophisticated statistical analysis.
 - C. To test the effect of more than one variable.
 - D. To demonstrate how the experiment was performed incorrectly.
 - E. To ensure that results are due to a difference in only one variable.**
-