

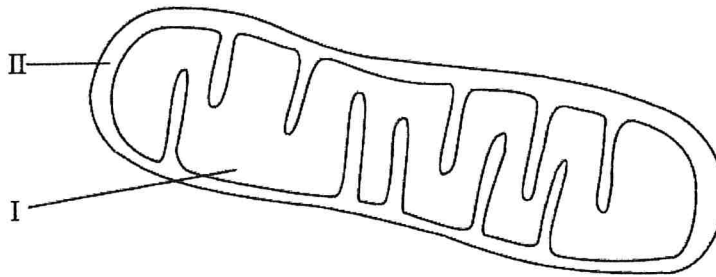
British Biology Olympiad 2009 Round 1

1. Which of the following is present in eukaryotic cells, but is NOT found in prokaryotic cells?
  - A. Rigid cell walls.
  - B. Membrane bound organelles.
  - C. Ribosomes.
  - D. DNA.
  - E. RNA. (B)
  
2. Which of the following organelles has protein-phospholipid membranes, energy-conversion enzymes, and ribosomes similar to those found in bacteria?
  - A. Lysosome
  - B. Peroxisome
  - C. Rough endoplasmic reticulum
  - D. Centriole
  - E. Mitochondrion (E)
  
3. An enzyme was extracted from *Sulfolobus acidocaldarius* (a bacterium living in acidic hot springs with temperatures up to boiling). What is likely to cause the fastest denaturation of this enzyme?
  - A. Heating the enzyme to 80 °C
  - B. Placing the enzyme in a very high substrate concentration
  - C. Storing the enzyme in a refrigerator at 4 °C
  - D. Storing the enzyme in oxygen-free (anaerobic) conditions
  - E. Dissolving the enzyme in a solution with a very high pH (E)
  
4. Which of the following macromolecules contain nitrogen atoms?

I. DNA.    II. Starch.    III. Protein.

  - A. I only.
  - B. II only.
  - C. III only.
  - D. I and III only.
  - E. I, II and III. (D)
  
5. In which stage of meiosis does the chromosome number become haploid?
  - A. During pairing of chromosomes in the first division of meiosis
  - B. During pairing of chromosomes in the second division of meiosis
  - C. When chromosomes move to opposite ends of the cell during the first division of meiosis
  - D. When chromosomes move to opposite ends of the cell during the second division of meiosis
  - E. During the S phase when DNA replication occurs (C)

6. The diagram below shows a mitochondrion as seen under the electron microscope.



What movement of protons occurs as a result of electron transport in the mitochondrion?

- A. From I to II across a concentration gradient.
  - B. From I to II down a concentration gradient.
  - C. From II to I against a concentration gradient.
  - D. From II to I down a concentration gradient (D)
7. A diploid cell contains the alleles R and r on one pair of homologous chromosomes and the alleles S and s on another pair of homologous chromosomes. How many combinations of these alleles could appear in the gametes after meiosis?
- A. 1
  - B. 2
  - C. 4
  - D. 8
  - E. 16 (C)
8. Glycolysis leads to the production of \_\_\_\_\_ and two molecules of ATP. In the absence of oxygen, respiration leads to the production of \_\_\_\_\_. Glycolysis plus the Krebs/citric acid cycle can convert the carbons of glucose to \_\_\_\_\_, storing the energy as ATP. Other products of the Krebs cycle are \_\_\_\_\_ and \_\_\_\_\_.
- Which is the correct sequence of words which will fill the spaces?
- A. lactic acid, pyruvate, CO<sub>2</sub>, NADH, FADH<sub>2</sub>
  - B. pyruvate, lactic acid, CO<sub>2</sub>, NADH, FADH<sub>2</sub>
  - C. CO<sub>2</sub>, NADH, FADH<sub>2</sub>, lactic acid, pyruvate
  - D. O<sub>2</sub>, lactic acid, pyruvate, FADH<sub>2</sub>
  - E. glucose, lactic acid, CO<sub>2</sub>, NADH, FADH<sub>2</sub> (B)
9. How does cyanide (CN) cause the death of living organisms?
- A. By stopping photosynthesis
  - B. By breaking down protein molecules
  - C. By breaking down phospholipids in membranes
  - D. By stopping the electron flow through the electron transport chain
  - E. By stopping utilisation of energy reserves (D)

10. Which region is the most acidic in a chloroplast and a mitochondrion?

	<b>chloroplast</b>	<b>mitochondrion</b>
A	stroma	intermembrane space
B	intermembrane space	intermembrane space
C	stroma	matrix
D	inside of thylakoid	matrix
E	inside of thylakoid	intermembrane space

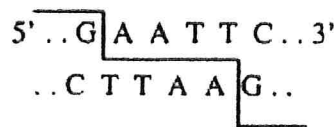
(E)

11. A researcher wants to introduce a human DNA fragment into a plasmid from *E. coli* using the restriction enzyme *EcoRI*. The plasmid contains a gene that confers resistance to ampicillin. It also contains the *lacZ* gene, whose product hydrolyses a molecule called X-gal to a blue product. Within the *lacZ* gene is a single copy of the restriction site recognised by *EcoRI*. Some bacteria, initially sensitive to ampicillin and unable to hydrolyse X-gal, were transformed with recombinant and non-recombinant plasmids, incubated with X-gal and tested for ampicillin resistance. Which of the following would characterise a colony of bacteria that took up one non-recombinant plasmid?

- A. Ampicillin-sensitive, blue
- B. Ampicillin-resistant, blue
- C. Ampicillin-sensitive, white
- D. Ampicillin-resistant, white

(B)

12. The restriction enzyme *EcoRI* cuts double-stranded DNA as follows:



Which of the following fragments could bind to an *EcoRI* restriction cut site?

- |                    |                    |                    |                    |
|--------------------|--------------------|--------------------|--------------------|
| (A)                | (B)                | (C)                | (D)                |
| .. CG<br>.. GCAATT | AATTCG ..<br>GC .. | .. TGAATT<br>.. AC | GT ..<br>TTAACA .. |

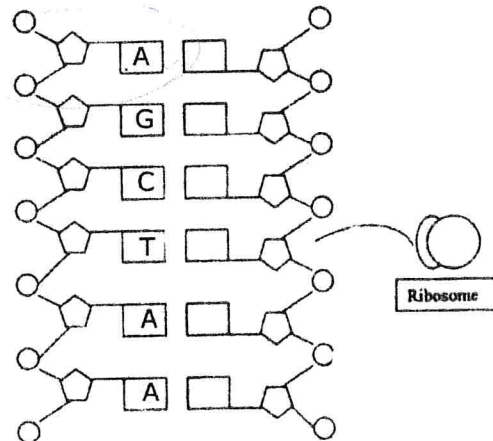
(B)

13. Give the letter of the structure in which the Golgi apparatus would be most highly developed.

- A. Salivary gland cells
- B. Red blood cells
- C. Skeletal muscle fibres
- D. Kidney tubule cells
- E. Motor nerve cells

( A.)

14. The diagram below represents a function of the nucleic acid DNA. Based on the diagram, what is the most likely nucleotide sequence of the messenger RNA?



- |   |   |   |   |   |
|---|---|---|---|---|
| A | U | T | T | T |
| G | C | C | C | U |
| C | G | G | G | G |
| T | A | A | U | A |
| A | U | T | T | A |
| A | U | T | T | T |

- A.            B.            C.            D.            E.            (B)

15. Which of the following combinations of statements concerning enzymes is correct?

1. Hydrolases generate hydrogen
2. Oxidases generate H<sub>2</sub>O
3. Dehydrogenases oxidise their substrates
4. Isomerases transfer atoms from one part of a molecule to another
5. Restriction endonucleases are ligases

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

16. Which combination of statements is correct?

1. The citric acid cycle (Krebs/TCA cycle) does not exist as such in plants and bacteria, because its functions are performed by the glyoxylate cycle.
2. The citric acid cycle oxidizes the acetyl CoA derived from fatty acid degradation.
3. The citric acid cycle produces most of the CO<sub>2</sub> in anaerobic organisms.
4. The citric acid cycle provides succinyl CoA for the synthesis of carbohydrates.
5. The citric acid cycle provides carbon skeletons for amino acid synthesis

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

17. Which of the following has the correct base pairing between DNA (represented by the top strand), and mRNA (represented by the bottom strand):

A. DNA 5' A U C G 3'  
mRNA 3' T A G C 5'

B. DNA 5' A U C G 3'  
mRNA 5' T A G C 3'

C. DNA 5' A T C G 3'  
mRNA 3' U A G C 5'

D. DNA 5' A U C G 3'  
mRNA 3' G C T A 5'

E. DNA 5' A T C G 3'  
mRNA 3' G C U A 5'

(C)

18. The cytoskeleton is involved in which of the following?

1. Chromatid separation
2. Phagocyte motility via pseudopodia
3. Mitotic spindle formation
4. Erythrocyte shape

A. all of them    B. 1, 2, 3    C. 2, 3 & 4    D. 1, 2 & 4    E. 1, 3 & 4    (A)

19. All of the following mechanisms have been shown experimentally to contribute to the formation of cancer cells EXCEPT

- A. abnormally high energy reserves in cancer cells that cause them to divide too quickly
- B. mutations that cause excess production of growth factors by cancer cells
- C. mutations that reduce the need for growth factors in cancer cells
- D. mutations that inactivate genes that normally inhibit cell division
- E. viruses that carry genes that transform normal cells into cancer cells

(A)

20. Which combination of the following statements about cell organelles is correct?

1. Cilia movement is energy dependent
2. Centrioles and basal bodies are identical
3. Microtubules increase the external surface area of cells
4. Microvilli are supported by actin

A. 1, 2 & 3    B. 2, 3 & 4    C. 1, 2 & 4    D. 1, 3 & 4    E. all of them    (C)

21. How does heart muscle contraction differ from the contraction of other muscles in the human body?

- A. It is stimulated to contract by nerves but not hormones.
- B. It is stimulated to contract by hormones but not nerves.
- C. It can contract without stimulation from nerves or hormones.
- D. Nerves speed up its rate of contraction but hormones slow it down.
- E. Hormones speed up its rate of contraction but nerves slow it down. (C)

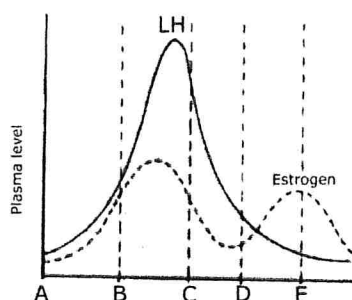
22. Which of the following combinations of statements is correct?

The basal metabolic rate of a man:

- 1. is never greater than 4200kj/day
- 2. can be determined 2 hours after his last meal
- 3. falls during prolonged starvation
- 4. falls immediately after feeding
- 5. rises during fever

A. 1 & 2, B. 3 & 4, C. 2 & 4, D. 3 & 5, E. 2, 3 & 4. (D.)

23. The graph below shows plasma hormone levels as a function of time.



At which of the lettered points on the time axis does ovulation take place? (C)

24. The % saturation of haemoglobin entering the right atrium would be reduced by:

- A. an increase in breathing rate
- B. an increase in pH in muscle tissues
- C. an increase in cardiac output
- D. an increase in lactic acid concentration in the muscles
- E. an increase in atmospheric oxygen concentration (D)

25. All of the following are autoimmune diseases except:

- A. multiple sclerosis
- B. insulin-dependent diabetes mellitus
- C. insulin-independent diabetes mellitus
- D. rheumatoid arthritis
- E. lupus (C)

26. The dental formulae for 3 mammals are as follows:

$$\text{I. } \begin{array}{cccc} \underline{2} & \underline{1} & \underline{2} & \underline{3} \\ 2 & 1 & 2 & 3 \end{array}$$

$$\text{II. } \begin{array}{cccc} \underline{2} & \underline{0} & \underline{3} & \underline{3} \\ 1 & 0 & 2 & 3 \end{array}$$

$$\text{III. } \begin{array}{cccc} \underline{3} & \underline{1} & \underline{4} & \underline{2} \\ 3 & 1 & 4 & 3 \end{array}$$

Which is the correct sequence if the mammals are a bear, man and a rabbit?

- A. I. bear    II. man    III. rabbit
- B. I. man    II. rabbit    III. bear
- C. I. bear    II. rabbit    III. man
- D. I. man    II. bear    III. rabbit
- E. I. rabbit    II. man    III. bear (B)

27. The elephant seal is a diving mammal that can reach depths of 1.5km and can stay submerged for as long as two hours. All of the following are possible adaptations of the seal to its environment except:

- A. increased concentration of myoglobin in muscles
- B. a large volume of blood per kg of body mass
- C. swimming with little muscular effort and using buoyancy changes
- D. increase in heart rate during a dive
- E. restricted blood supply to muscles during a dive (D)

28. In women, oestrogens have which of the following effects?

- 1. They facilitate the growth of ovarian follicles
- 2. They cause cyclical changes in the vagina and endometrium
- 3. They cause cervical mucus to become thinner and more alkaline
- 4. They cause proliferation of ducts in the breast.

- A. 1 & 2,    B. 1 & 3,    C. 1, 2 & 3    D. 1, 2, 3 & 4    E. 1, 3 & 4 (D)

29. The cerebellum is important in controlling

- A. muscular contraction
- B. muscle strength
- C. stretch reflexes
- D. posture
- E. 3-D recognition (D)

30. The digested products of dietary fat are absorbed chiefly in the

- A. stomach
- B. duodenum
- C. ileum
- D. caecum
- E. colon (B)

31. The effect of antidiuretic hormone (ADH) on the kidney is to:

- A. increase the permeability of the distal nephron to water
  - B. increase the glomerular filtration rate
  - C. increase the excretion of  $\text{Na}^+$
  - D. increase the excretion of water
  - E. increase the diameter of the renal artery
- (A)

32. Homeostatic mechanisms aim to regulate the core body temperature of most mammals at  $37^\circ\text{C}$ . If the core temperature changes above or below this level, these mechanisms are used to restore the original condition. What kind of responses are going to increase body temperature?

- I. Shivering.    II. Sweating.    III. Constriction of blood vessels in the skin.
- A. I only.    B. II only.    C. III only.    D. I and III only.    E. I, II and III.
- (D)

33. A sample of human blood is taken, and it is found that all of the cells are alive. The blood is then frozen at  $-20^\circ\text{C}$ . One day later the blood is thawed and heated to  $37^\circ\text{C}$  and it is found that no cells in the blood are living. Why have the cells died?

- A. The cold temperature inhibited important respiratory enzymes and therefore prevented the cells from releasing energy (ATP).
  - B. As the water in the cells froze it expanded, fracturing the cells and hence killing them.
  - C. As the serum cooled, ions such as sodium precipitated out, causing an osmotic imbalance between the cells and the serum.
  - D. Human cells cannot be expected to survive longer than several hours outside the body, under any conditions.
  - E. Cooling the cells down caused their cell membranes to solidify, thus preventing vital cellular processes and the exchange of compounds.
- (B)

34. Which of the following are characteristics of arteries?

- 1. Always carry blood away from the heart.
- 2. Carry blood to and from the heart.
- 3. Always carry oxygenated blood.
- 4. May carry either oxygenated blood or deoxygenated blood.
- 5. They have thick walls and valves.

- A. 1 only.
  - B. 2 & 3 only.
  - C. 1 & 4 only.
  - D. 1, 3 & 5 only.
  - E. 2, 4 & 5 only.
- (C)



35. The digestive systems of dogs are generally shorter than those of similar sized herbivores because:
- A. plant material requires more digestion than meat.
  - B. dogs have been domesticated.
  - C. commercial pet food does not require digestion.
  - D. dogs eat greater volumes of food than herbivores and so do not need to extract as many nutrients from it.
  - E. the bacteria in the digestive tracts of dogs are more highly evolved than those in herbivores. (A)
36. Which of the following normally contains the highest concentration of oxygen in humans?
- A. Cells near to the lungs.
  - B. Inhaled air.
  - C. Air in the alveoli.
  - D. Blood entering the lungs.
  - E. Blood leaving the lungs. (B)
37. Secretions into the digestive tract may perform which of the following functions in humans?
- 1. Alteration of the pH of the gut contents.
  - 2. Emulsification of hydrophobic molecules such as lipids.
  - 3. Release of bacteria which facilitate digestion of macromolecules.
  - 4. Release of digestive enzymes.
- A. 2 & 4 only.
  - B. 1, 2 & 3 only.
  - C. 1, 2 & 4 only.
  - D. 2, 3 & 4 only.
  - E. 1, 2, 3 & 4. (C)
38. It is often commented that when the air is 30°C and has a relative humidity value of 95% that it "feels" much hotter than when the air is 30°C and has a relative humidity value of 50%. The reason for this is:
- A. high humidity disrupts the ability of the body to accurately detect external heat.
  - B. that at 95% relative humidity the air holds more warm water vapour than at 50% humidity, and so the air feels warmer to the skin.
  - C. high humidity interferes with heat loss by evaporation which is an important cooling mechanism in humans.
  - D. in high humidity, humans have greater difficulty in obtaining oxygen from the water-saturated air, and hence feel more uncomfortable or warmer.
  - E. that the body regulates its temperature in an energy demanding and dependent way, and so in humid conditions a greater amount of heat is produced by metabolic activity. (C)

39. The typical lifespan of a red blood cell is:

- A. 1 day
- B. 10 days
- C. 120 days
- D. 6 months
- E. 3 years

(C)

40. Which of the following combination of statements concerning the role(s) platelets play in the clotting process is correct?

- (1) They help to form a plug for protection against blood loss.
- (2) They release chemical signals for fibrin formation.
- (3) They release chemical signals for reducing blood pressure.

A. 1 only,    B. 1 & 2,    C. 2 & 3,    D. 1 & 3,    E. 1, 2 & 3.    (B)

41. Which combination of the following substances correctly lists the substances that are reabsorbed in the proximal tubule of the mammalian kidney?

1.  $\text{Na}^+$     2.  $\text{Cl}^-$     3. Water    4. Glucose    5. Amino acids    6. Urea

- A. 1, 2, 3
- B. 6,
- C. 1, 2, 4, 5,
- D. 1, 2, 3, 4, 5
- E. 4, 5

(D)

42. Vertebrate whole blood consists of plasma and suspended cells or fragments. The following statements relate to the composition of a normal blood sample.

- 1. Red cells get their colour from the waste  $\text{CO}_2$  carried by the haemoglobin.
- 2. Erythrocytes are the most abundant cell type in blood.
- 3. Platelets contains a nucleus and DNA.
- 4. Haemoglobin is composed of two polypeptide chains.
- 5. Gamma-globulin is a key protein in plasma.
- 6. All adult blood cells originate in the bone marrow.

Which of the following combinations contains only true statements?

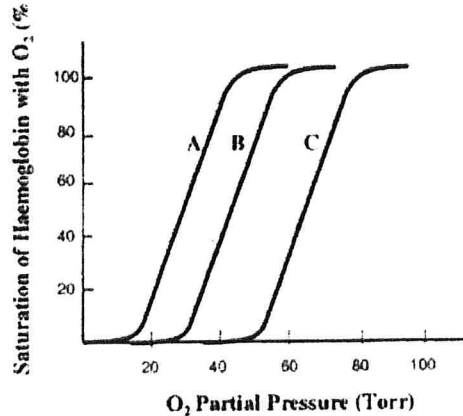
A. 3, 4 & 5    B. 2, 5 & 6    C. 1, 2, 3, 5 & 6    D. 4, 5 & 6    E. 2, 4 & 6    (B)

43. Which immune cells are delivered to the site of infection to phagocytose invading bacteria?

- A. Lymphocytes
- B. Neutrophils
- C. Eosinophils
- D. Basophils
- E. Plasma cells

(B)

44. The amount of oxygen carried in the blood is dependent on the amount of respiratory pigment (such as haemoglobin) and the partial pressure of oxygen. For a fixed concentration of haemoglobin, the greater the partial pressure of oxygen the greater the percent saturation of haemoglobin.



Which of the following combinations represents the oxygen equilibrium curves (dissociation curves) shown above for conditions A, B and C, in order? [\*Exercise blood is blood collected after a period of extreme exercise.]

- A. Normal blood, foetal blood, exercise blood\*
  - B. Foetal blood, exercise blood\*, normal blood
  - C. Foetal blood, normal blood, exercise blood\*
  - D. Exercise blood\*, foetal blood, normal blood
  - E. Exercise blood\*, normal blood, foetal blood
- (C)

45. Which of the following statements are true?

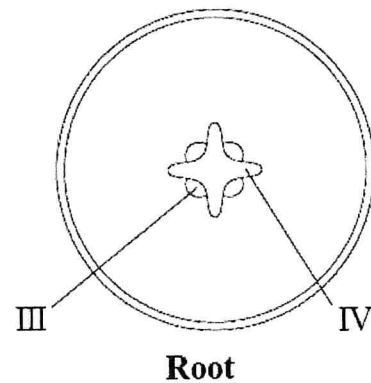
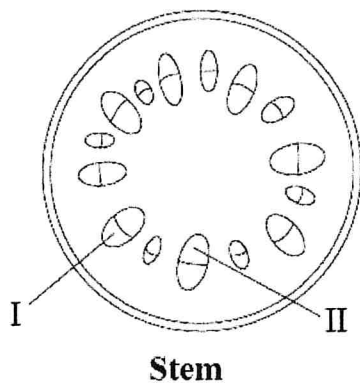
1. If the heart muscle cells stop contracting an electrical shock from a defibrillator could start them again.
2. Cutting the parasympathetic nerves to the heart causes the heart rate to decrease.
3. Thyroxine increases heart rate.
4. There is no muscular connection between the atria and ventricles.

A 1 & 2, B 1 & 3, C 2 & 3, D 3 & 4, E. 2, 3 & 4. (D)

46. Which property of water is **most** important to plants living below the surface of water in ponds?

- A. Cohesion
  - B. Oxygen solubility
  - C. High surface tension
  - D. Transparency
  - E. High latent heat of fusion
- (D)

47. These diagrams show the distribution of tissues in the stem and root of a dicotyledonous plant.



Which tissues are xylem?

- A. I and III
- B. I and IV
- C. II and III
- D. II and IV

(D)

48. Where do beans (*Fabaceae*, e.g. soybean *Glycine max*, syn. *Soja hispida*) store reserve material for germination?

- A. In the pericarp
- B. In the cotyledons of the seed
- C. In the triploid nutritive tissue (endosperm) of the seed
- D. In the diploid nutritive tissue (perisperm) of the seed
- E. In the cotyledons and the endosperm.

(B)

49. Which sugar is mostly transported in the phloem?

- A. Glucose
- B. Sucrose
- C. Fructose
- D. Maltose
- E. Starch

(B)

50. All of the following are examples of root modification except which one?

- A Sugarbeet
- B Potato
- C Carrot
- D Sweet potato
- E Yam

(B)

51. All of the following could be used as a possible application of auxins except:

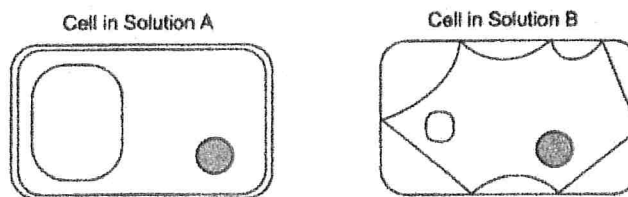
- A. production of seedless fruit
  - B. use as weedkillers in a field of cereal crop
  - C. production of short bushy plants instead of tall ones
  - D. delaying "fruit drop" (abscission of fruit before harvesting)
  - E. use as rooting powder in horticulture
- (C)

52. Which conditions will cause the most rapid transpiration in a terrestrial, mesophytic plant?

A.	no wind	20°C	0% humidity	bright light
B.	strong wind	20°C	100% humidity	bright light
C.	strong wind	10°C	0% humidity	darkness
D.	no wind	10°C	100% humidity	darkness

(A)

53. Two identical plant cells are placed in two different solutions A and B. The diagrams below show the two plant cells after being placed in each solution. From these diagrams, determine which of the following statements is correct:



- A. Solution A has a higher solute concentration (lower water potential) than solution B.
  - B. Solution A has the same solute concentration as solution B.
  - C. Solution A has a lower solute concentration than solution B
  - D. The cell in solution A now has the same solute concentration as the cell in solution B.
  - E. It is not possible to determine the relative solute concentration of solution A and B.
- (C)

54. A water-soluble dye injected into a plant cell may pass to an adjacent cell through

- A. tight junctions.
  - B. microtubules.
  - C. desmosomes.
  - D. plasmodesmata.
  - E. gap junctions.
- (D)

55. Most plants flower according to the number of hours of uninterrupted darkness they receive. Some plants known as 'short day' plants require more than 12 hours of uninterrupted darkness in order to flower. Other plants known as 'long day' plants require less than 12 hours of uninterrupted darkness in order to flower. You grow a 'short day' plant and a 'long day' plant on a cycle of 10 hours light then 7 hours darkness then 1 hour light then 6 hours darkness per day. Which plant/s will flower under these conditions?

- A. The 'short day' plant only.
- B. The 'long day' plant only.
- C. Both plants will flower.
- D. Neither plant will flower.
- E. Both plants will flower during the day but not at night. (B)

56. Mycorrhizae are symbiotic (mutualistic) associations of fungi and plant roots. Which of the following combinations of statements about mycorrhizae is correct?

- 1. They are often harmful to plant roots while beneficial to fungi.
- 2. They are often beneficial to plants but harmful to fungi
- 3. They are helpful for plants to absorb water and minerals.
- 4. They could help the older root region above the root hair area to supply minerals to plants.

A. 1 & 2,    B. 3 & 4,    C. 1 & 3,    D. 2 & 4,    E. 2, 3 & 4. (B)

57. One of the means to prevent self-fertilization in plants is self-incompatibility. Which of the following combinations of statements is TRUE about self-incompatibility?

- 1. The plants that show self-incompatibility have a unique stigma structure.
- 2. The flowers of the plants that show self-incompatibility only produce pollen when stigmas fail to develop.
- 3. Self-incompatibility is analogous to the animal immune response in that both have the ability to distinguish the cells of "self" from those of "non-self".
- 4. Pollen from one plant will only develop a pollen tube on its own stigma if a pollen from another plant is present on the stigma.
- 5. Pollen from one plant will develop a pollen tube on its own stigma, but will not be able to fertilize the egg.

A. 1, 2, 3    B. 2, 3, 4    C. 1, 3, 5    D. 1 & 3 only    E. 3 & 5 only (E)

58. Lowering the level of a hedge with a hedge trimmer stimulates the hedge to become bushy because:
- A. It stimulates the production of ethylene gas.
  - B. Removing the apical meristems makes more auxin, which stimulates lateral branch buds to grow.
  - C. Removing the apical meristems makes less ethylene, which stimulates lateral branches to grow
  - D. Removing the apical meristems results in less auxin, which then allows lateral branches to grow.
  - E. Removing the lateral buds results in apical dominance under the influence of cytokinins (D)
59. Which of the following is a feature of both fungi and bacteria?
- A. The absence of a cell wall.
  - B. Ability of some species to undertake photosynthesis.
  - C. Ability to exist in both unicellular and multicellular forms.
  - D. The absence of internal membrane bound organelles such as mitochondria.
  - E. Ability of some species to form symbiotic relationships with plants. (E)
60. When a tree is ringed (a ring of bark removed from the trunk), the bark tissues above the ring can be observed to become swollen. During what time of the year would the swelling be greatest?
- A. It is the same all year round
  - B. Winter
  - C. Spring
  - D. Summer
  - E. Autumn (D)
61. Earthworms come to the surface of the soil at night, but if touched they will retreat into their burrows. This is an example of:
- A. a conditioned reflex
  - B. learned behaviour
  - C. a simple innate reflex
  - D. kinesis
  - E. territorial behaviour (C)
62. Habituation is a beneficial form of behaviour because it enables an animal to
- A. avoid a potentially dangerous situation
  - B. defend itself against an enemy
  - C. effect its escape response quickly
  - D. conserve energy for essential activities
  - E. recognise other individuals of the same species (D)

63. Female spotted sandpipers aggressively court males and, after mating, leave the clutch of eggs for the male to incubate. This sequence may be repeated several times with different males until no available males remain, forcing the female to incubate her last clutch.

Which of the following terms could be used to describe this behaviour?

1. Polygamy
2. Promiscuity
3. Polyandry
4. Polygyny
5. Parental investment

A. all of them; B. 1, 2 & 3; C. 1, 3 & 5; D. 1, 2 & 5; E. 2, 3 & 5. (E)

64. Social behaviour in a hive of honey bees is tightly controlled. Which of the statements explains this phenomenon?

- A. The hive is regulated by classical conditioning,
- B. The hive is regulated by pheromones secreted by the queen,
- C. The hive is regulated by an established hierarchy of bees,
- D. The hive is regulated by communication through dance,
- E. The hive is regulated by external environmental conditions. (B)

65. Which of the following columns correctly summarises Pavlovian (classical) conditioning?

KEY: UCS = Unconditioned stimulus  
 UCR = Unconditioned response  
 CS = Conditioned stimulus  
 CR = Conditioned response

	<b>A</b>	<b>B</b>	<b>C</b>	<b>D</b>
Before training	UCS→UCR	UCS→UCR	CS → CR + UCS→UCR	CS→UCR
During training	UCS+CS→UCR	CS→UCR+CR	UCS+CS→UCR+CR	CS→CR
After training	CS→CR	CS→CR	UCS→CR	UCS→CR

(A)

66. In humans, brown eyes are dominant to blue, and the gene for eye colour is carried on an autosome. A brown-eyed woman marries a blue-eyed man and their first child has blue eyes. Which of the following statements is true?

- A. The woman must be homozygous for eye colour
- B. The man must be heterozygous for eye colour
- C. It is certain that the next child will also have blue eyes
- D. There is a 50% chance the next child will have blue eyes
- E. There is no chance the next child will have blue eyes (D)



67. All of the following statements are correct except which one?

- A. Inbreeding increases the chance of individuals that are double recessive for an unfavourable allele.
- B. Inbreeding results in loss of genetic diversity amongst individuals of a domestic variety.
- C. Inbreeding depression often results from hybridization between unrelated species.
- D. Inbreeding promotes the retention of favourable characteristics.
- E. Inbreeding decreases the size of the gene pool for any population.

(C)

68. In the Japanese Morning Glory plant (*Pharbitis nil*), flowers can be red, blue or purple. The genotypes which give each of the three flower colours are shown below:

<b>Red</b>	aabb
<b>Blue</b>	A-B-
<b>Purple</b>	A-bb or aaB-

Which cross would give an offspring ratio of 2 red : 6 blue : 8 purple?

- A. AaBb x AABb
- B. AaBb x aabb
- C. AaBB x AABb
- D. AaBb x Aabb
- E. AaBb x AaBb

(D)

69. The following statements are parts of the theory of evolution by natural selection.

- I. Only the best adapted individuals survive and pass on their genes.
- II. More offspring are produced than the environment can support.
- III. As one generation follows another, the characteristics of the species gradually change.
- IV. There is a struggle for survival in which some individuals are more successful than others.

What is the correct sequence of statements?

- A. I → II → III → IV
- B. IV → I → II → III
- C. III → I → IV → II
- D. IV → III → II → I
- E. II → IV → I → III

(E)

70. The pattern of inheritance of sex-linked genes is the same in *Drosophila* as in humans. Eye colour in *Drosophila* is controlled by a sex-linked gene. The allele for red eye is dominant over the allele for white eye. A red-eyed male mates with a white-eyed female.

Which eye colours are found in the offspring?

	Male offspring	Female offspring
A.	all red	all red
B.	all red	all white
C.	all white	all red
D.	all white	all white
E.	50 % red and 50% white	50 % red and 50 % white

(C)

71. Normal wild-type mice have dark coat colours. A mutation called *yellow* causes lighter coat colour. If a yellow mouse is mated to a homozygous wild-type mouse, the result is a 1:1 ratio of yellow to wild-type mice. If any two yellow mice are mated, a ratio of 2 yellow : 1 wild-type is observed.

What is this an example of?

- A. Codominance
- B. Incomplete dominance
- C. A lethal allele
- D. Pleiotropy
- E. Crossing-over

(C)

72. Haemophilia is an X-linked recessive disorder. Queen Victoria was a carrier of haemophilia. One of her daughters was Alice of Hesse, who had a son named Frederick of Hesse. What was the probability that Frederick would be a haemophiliac? (All marriage partners were normal.)

- A. 0
- B. 1/8
- C. 1/4
- D. 1/2
- E. 1

(C)

73. Which of the following is a true statement about Darwinian evolution?

- A. Bacteria are no longer evolving.
- B. Dolphins are more highly evolved than fish.
- C. An organism evolves throughout its lifespan.
- D. Species that reproduce asexually do not evolve.
- E. Predators are not the only selection pressure faced by most populations.

(E)

74. With regard to the ABO blood group typing system, two parents have children with the following blood types:

Child 1 – Group A.      Child 2 – Group O.

Child 3 – Group AB.      Child 4 – Group B.

If the father has blood group A, what blood group must the mother have?

- A. Group A.
- B. Group B.
- C. Group O.
- D. Group AB.
- E. It is not possible for the woman to have given birth to the children if the father has blood group A. (B)

75. When a normal diploid cell undergoes complete meiosis it will produce:

- A. four haploid cells.
- B. four diploid cells.
- C. two haploid cells.
- D. two diploid cells.
- E. none of the above. (A)

76. A homozygous plant with green prickly leaves is crossed to a homozygous plant with yellow smooth leaves. Green leaf colour is related to a dominant allele G and yellow leaf colour is related to the recessive allele g. Smooth textured leaves are related to the dominant allele T and prickly leaves to the recessive allele t. Given this information select the correct statements from the following list.

1. The ratio of green to yellow leafed progeny will be 3 : 1
2. All the progeny will have smooth leaves
3. The alleles G and g must be located on different chromosomes
4. The green prickly leafed plant would produce two different kinds of gametes
5. All the progeny would be heterozygous.

A. 1 & 2, B. 2 & 3, C. 2,3 & 4, D. 3 & 5, E. 2 & 5. (E)

77. In rabbits, the dominant allele (B) is related to black body colour and the recessive allele (b) is related to white body colour. A cross between two rabbits produced 9 black and three white offspring. Which of the following statements about this cross are most likely to be correct?

1. This is a monohybrid cross showing sex linkage.
2. This is a monohybrid autosomal cross between two heterozygotes.
3. The male used in the cross was homozygous recessive.
4. The genotypes of the offspring could include Bb, BB, and bb individuals.
5. The female used in this cross was homozygous dominant.

A. 1 & 3; B. 2 & 5; C. 3 & 4; D. 1 & 4; E. 2 & 4. (E)

78. Which of the following do mitosis and the second division of meiosis have in common?

1. Genetically identical material passes to each pole
2. A 'resting phase' (interphase) always occurs before the division commences
3. Both chromosomes of an homologous pair lie at the equator during metaphase
4. Chromatids separate during anaphase

A. 1 & 3; B. 2 & 4; C. 3 & 4; D. 3 only; E. 4 only. (E)

79. Which of the following is/are characteristic(s) of polyploid plants which may explain the fact that polyloidy has not been a major factor in evolutionary change?

1. Decreased resistance to disease
2. Reduced hardiness
3. Lowered fertility

A. 1 only, B. 2 only, C. 3 only, D. 1 & 3, E. 2 & 3. (C)

80. A man with an X-linked dominant disorder marries a woman without the disorder. What proportion of their daughters will be affected by the disorder?

- A. 0%
  - B. 25%
  - C. 50%
  - D. 75%
  - E. 100%
- (E)

81. Plant breeders induce chromosome doubling in hybrids by the use of agents such as:

- A. acetaldehyde
  - B. colchicine
  - C. DNA-ase
  - D. RNA-ase
  - E. Thymine
- (B)

82. In cattle, the male is heterogametic. When a normal male is crossed with a female heterozygous for a sex-linked lethal gene, the sex ratio of their living offspring will be

- |    | female: male |
|----|--------------|
| A. | 3 : 1        |
| B. | 2 : 1        |
| C. | 1 : 1        |
| D. | 1 : 2        |
| E. | 2 : 2        |
- (B)

83. Sex-linked recessive alleles are usually carried on:

- A. The homologous part of the X chromosome.
- B. An extra Y chromosome.
- C. The non-homologous part of the X chromosome.
- D. The homologous part of the Y chromosome.
- E. An extra X chromosome.

(C)

84. Sickle-cell disease is a classic example of an inherited disease.

The following statements are all true about this disease except:

- A. sickle-cell haemoglobin differs from the normal protein by only a single amino acid
- B. the cause of the sickle-cell disease is the genetic disorder of an autosomal recessive gene
- C. in a heterozygous individual there are two kinds of haemoglobin molecule
- D. a heterozygous individual has normal and sickle-shaped red cells in about the same proportion
- E. the heterozygous condition causes the individual to be more resistant to malaria

(D)

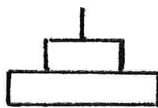
85. Duchenne muscular dystrophy (DMD) in humans is caused by a recessive allele located only on the X chromosome.

What will be the occurrence of DMD in females?

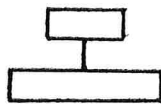
- A. No females will have DMD.
- B. Females will only have DMD if both of their parents had the condition.
- C. Equal proportions of females and males will have DMD
- D. Half as many females as males will have DMD.
- E. 50% of females will have DMD if their father suffers from it and their mother is a carrier.

(E)

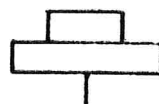
86. Four pyramids of numbers are shown below.



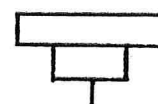
A



B



C

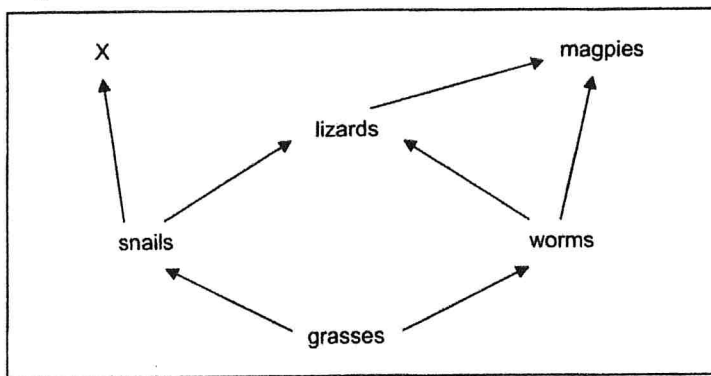


D

Which is representative for plant-aphid-ladybird?

(C)

N.B. Questions 87 & 88 both refer to the food web below.



87. The death of a large number of worms would be predicted to cause

- A. an increase in the number of lizards.
- B. an increase in the number of snails.
- C. a decrease in the number of magpies.
- D. a decrease in the amount of grass.
- E. no change to population numbers.

(C)

88. What type of organism could fill position X?

- A. A plant.
- B. A primary consumer.
- C. A carnivorous mammal.
- D. A herbivorous insect.
- E. An autotroph.

(C)

89. Plants adapted to arid conditions could show any or all of the following adaptations except which one?

- A. Thick waxy cuticles on the surfaces of leaves
- B. Stem modified to store water
- C. C<sub>4</sub> photosynthesis
- D. Stomata located in pits on the underside of leaves
- E. C<sub>3</sub> photosynthesis

(E)

90. *Lathraea clandestina* is an unusual plant because it contains no chlorophyll. It grows on the roots of living trees including *Populus* (poplar) and *Salix* (willow) and obtains all its organic matter from them. What is the trophic level of *Lathraea clandestina*?

- A. Producer
- B. Primary consumer
- C. Secondary consumer
- D. Detritivore
- E. Saprotroph

(B)

91. How might climate determine why an organism might survive in one place but not in another?

1. By controlling the length of breeding cycles
2. Food plant availability
3. Foraging times
4. Overwintering

A. 1 & 2,      B. 2 & 3      C. 1, 2 & 3      D. 2, 3 & 4      E. all of them      (E)

92. Which combination of the following statements, referring to the process of ecological succession, is correct?

1. Nutrient availability generally increases
2. Species diversity decreases as the process proceeds
3. A new group of plant species achieves dominance over time and ousts the previous species
4. The height and biomass of the vegetation usually increases as the process proceeds
5. Each group of species modifies the habitat making it more favourable for other species

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

(D)

93. A marine biologist, wanting to calculate the number of fish (N) that lived on a reef, captured a sample of individuals (numbering S1), tagged and released them. One month later, he collected another sample (numbering S2) and found several marked individuals amongst them (numbering S3). Which formula can be used to calculate N?

- A.  $N = (S2 \times S3) / S1$
- B.  $N = (S1 \times S2 \times S3)$
- C.  $N = (S1 \times S3) / S2$
- D.  $N = (S1 \times S2) / S3$
- E.  $N = (S2 + S1) / S3$

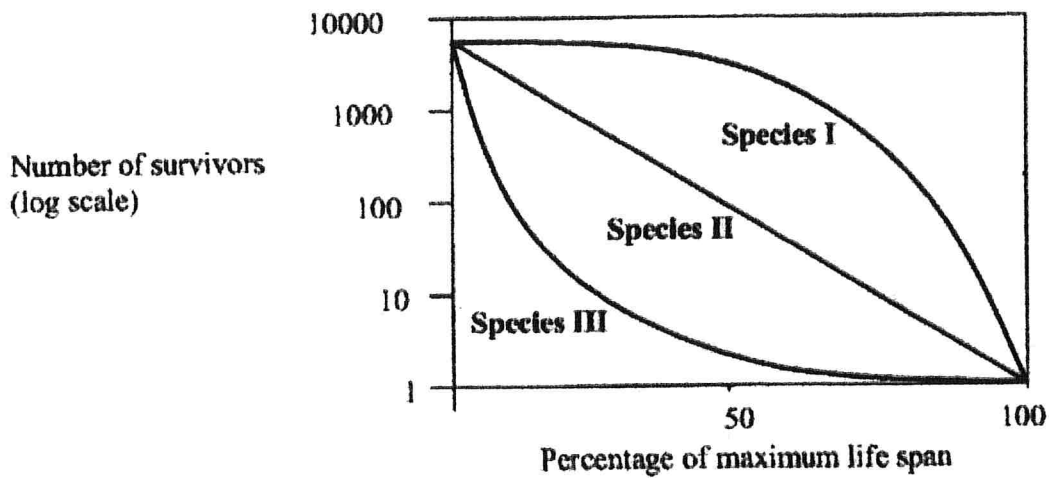
(D)

94. The process by which plants colonize (I) a newly formed island from a volcanic eruption, and (II) bushland after a fire, is respectively termed

- | I                           | II                      |
|-----------------------------|-------------------------|
| A. primary succession       | secondary succession    |
| B. pioneering succession    | inherited succession    |
| C. explorative succession   | competitive succession  |
| D. pioneering succession    | competitive succession  |
| E. developmental succession | evolutionary succession |

(A)

95. Three species of reef organisms exhibit the following survivorship curves:



The following statements are all correct except:

- A. juveniles of species III have a higher mortality than those of species I
  - B. death rates in species II are more uniform than those in species I
  - C. it is likely that fecundity in species II is lower than that of species III
  - D. adults of species II have a longer life expectancy than those of species III
  - E. high adult mortality in species I is likely to be offset by higher fecundity
- (E)

96. Which feature is possessed by angiosperms but not by conifers?

- A. Leaves
- B. Seeds
- C. Xylem
- D. Flowers
- E. Stomata

(D)

97. Moulting is a process observed in insects. Which of the following combinations of statements is true?

1. The exoskeleton of insects is largely made of protein and chitin.
2. The structure of chitin is similar to that of bacterial cell wall peptidoglycan.
3. Moulting can be observed in all arthropods.
4. The only place that is not covered by exoskeleton is the joints between the body and walking legs.

A. 1 & 2,    B. 3 & 4,    C. 2, 3 & 4,    D. 2 & 4,    E. 1 & 3.    (E)



98. The key below can be used to classify organisms into the five kingdoms.

- |   |             |
|---|-------------|
| 1. The organism's DNA is naked and is located in the cytoplasm  | kingdom I   |
| The organism's DNA is associated with protein and is inside a nuclear membrane  | 2           |
| 2. The cells of the organisms have cell walls made of cellulose and the organism has an embryo stage in its development | kingdom II  |
| Not as above  | 3           |
| 3. The organism's cells have no cell wall and there is a blastocyst stage in its development                            | kingdom III |
| Not as above  | 4           |
| 4. The organisms has cell walls made of chitin  | kingdom IV  |
| Not as above  | kingdom V   |

Which kingdom is the Protocista?

- A. I
- B. II
- C. III
- D. IV
- E. V.

(E)

99. Ferns show all the following features except:

- A. dominant gametophyte
- B. stem, root & leaves
- C. vascular tissue
- D. large leaves called fronds
- E. homosporous

(A)

100. In which one of the groups listed below may more than one heart be found?

- A. Echinoderms
- B. Bivalves
- C. Cephalopods
- D. Gastropods
- E. Non-vertebrate chordates

(C)

