

**SOUTH AFRICAN AGENCY FOR SCIENCE AND TECHNOLOGY ADVANCEMENT**

**56<sup>th</sup> LIFE SCIENCES OLYMPIAD**

**GRADES 10-12**

**2020**

**INSTRUCTIONS**

Please read the instructions carefully before answering the questions

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This is a multiple choice paper. Please answer all the questions on the answer sheet provided. Each question is followed by answers marked A, B, C, and D. **Only one answer is correct.** Choose the correct answer and shade the corresponding circle on the answer sheet completely, using an HB pencil.

NB! The answer sheets are marked electronically – do not make any other dots or marks on the answer sheet. Select only one answer for each question or your answer will be discarded. **Ensure that you shade your selection clearly.**

Note that the question numbers 1 to 100 on the answer sheet move from top to bottom in several columns. Ensure that the number of your selection on the answer sheet corresponds with the number of the question in your examination paper. Should you make a mistake, please erase the incorrect answer completely.

The use of **non-programmable** electronic calculators is permitted.

**To avoid disqualification** - You are required to complete **all** the information requested on the answer sheet. Please complete the information in script, as well as shade the corresponding blocks. If the corresponding blocks are not shaded appropriately, i.e. a single selection per question clearly shaded, your results will be returned without a name and you will be disqualified. Do not fold the answer sheets.

You will be given three hours to answer the questions

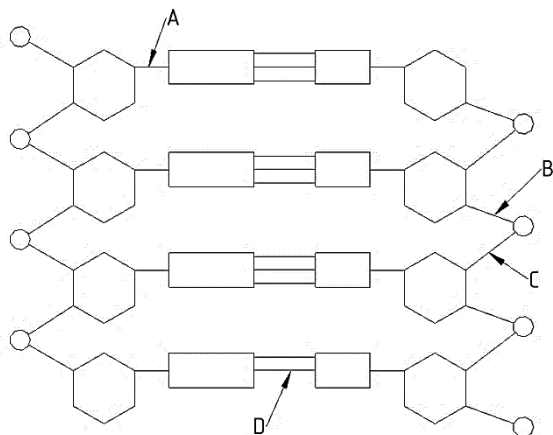
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**56<sup>th</sup> LIFE SCIENCES OLYMPIAD  
GRADES 10-12**

1. During fertilisation in humans, where do the acrosome and the cortical reactions occur most often?

|   | Acrosome reaction | Cortical reaction |
|---|-------------------|-------------------|
| A | Vagina            | Uterus            |
| B | Uterus            | Fallopian tube    |
| C | Fallopian tube    | Uterus            |
| D | Fallopian tube    | Fallopian tube    |

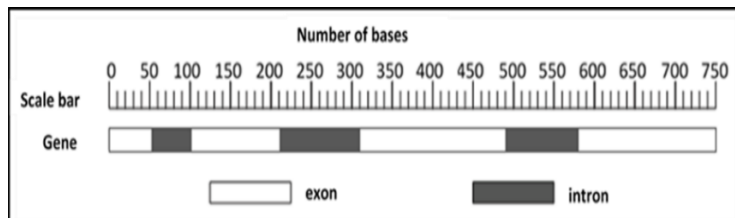
2. In the model of the DNA molecule shown below, which types of bonds are shown by the arrowed labels.



Choose the correct interpretation of the experiment

|   | Covalent bonds | Hydrogen bonds |
|---|----------------|----------------|
| A | B              | C              |
| B | A, B, C        | D              |
| C | B, C           | A, D           |
| D | D              | A, B, C        |

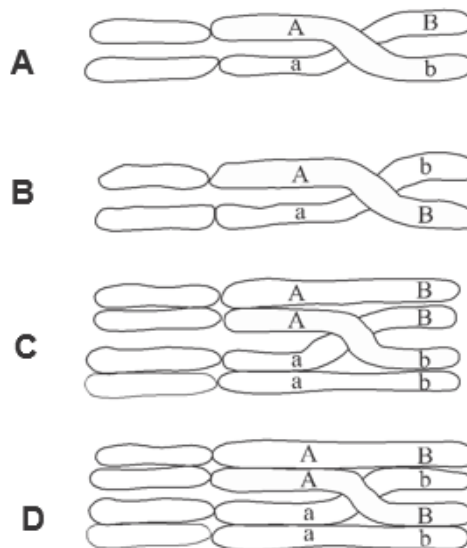
3. The diagram below shows a eukaryotic gene containing introns and exons and a scale bar representing the number of bases in the gene.



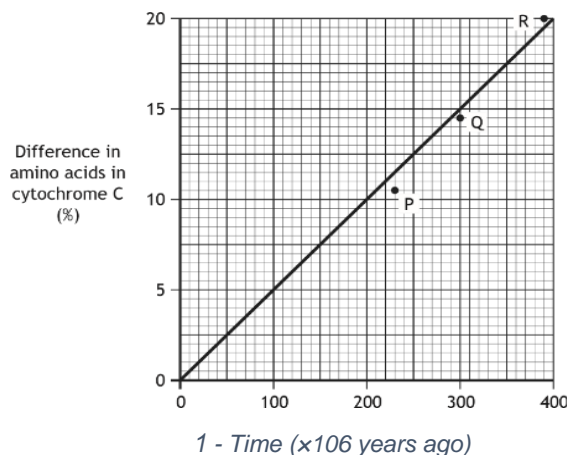
How many bases will there be in the mature mRNA formed from the primary transcript of this gene?

- A 240
- B 510
- C 580
- D 750

4. A cell replicates its DNA and then starts to divide by meiosis. What is the expected arrangement of chromosomes if crossing over has taken place between the two genes shown?



5. The graph below shows a molecular clock that compares the amino acid sequence in the protein cytochrome C in various vertebrate groups.



**Key**  
 P - birds and reptiles  
 Q - reptiles and mammals  
 R - fish and reptiles

From the information in the graph, which vertebrate groups shared a common ancestor most recently?

- A Fish and reptiles
- B Birds and mammals
- C Reptiles and mammals
- D Birds and reptiles

6. Consider the following products:

- (i) ATP
- (ii) Lactate
- (iii) Carbon dioxide

Which of the products can be seen as a byproduct of fermentation in human muscle?

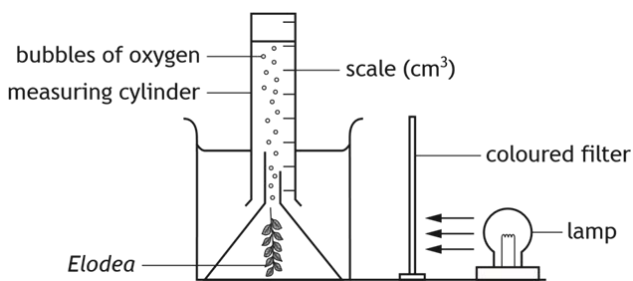
- A (ii) only
- B (i) and (ii) only
- C (ii) and (iii) only
- D (i), (ii) and (iii)

7. An experiment was carried out into the effect of lead nitrate concentration on the activity of catalase. Six flasks were set up each containing 25 cm<sup>3</sup> of hydrogen peroxide and 10 cm<sup>3</sup> of yeast suspension. 10 cm<sup>3</sup> of a different concentration of lead nitrate was then added to each flask.

Identify the independent variable in this experiment.

- A Volume of lead nitrate
- B Volume of oxygen produced
- C Activity of catalase
- D Concentration of lead nitrate

8. The diagram shows apparatus used in an investigation to measure the rate of photosynthesis in *Elodea* (pondweed) at different wavelengths of light. Coloured filters were used to change the wavelength of the light. The volume of oxygen collected after 30 minutes was used to measure the rate of photosynthesis.



Which of the following would increase the reliability of the investigation?

- A The volume of oxygen collected after every 30 minutes
- B Repeating the experiment several times and taking the average results
- C The investigation conducted under a range of different environmental conditions
- D The lamp placed at the same distance from the plant for the different wavelengths

9. Each type of human cell has a different structure and function because ...

- A only some of their genes are expressed.
- B they contain different genes.
- C some genes are lost during differentiation.
- D some genes are gained during differentiation.

10. Altruistic behaviour between closely related animals ...

- A reduces competition between individuals in the population.
- B increases the survival chances of the donor animal.
- C increases the frequency of shared genes in the next generation.
- D reduces unnecessary aggression and conflict in social groups.

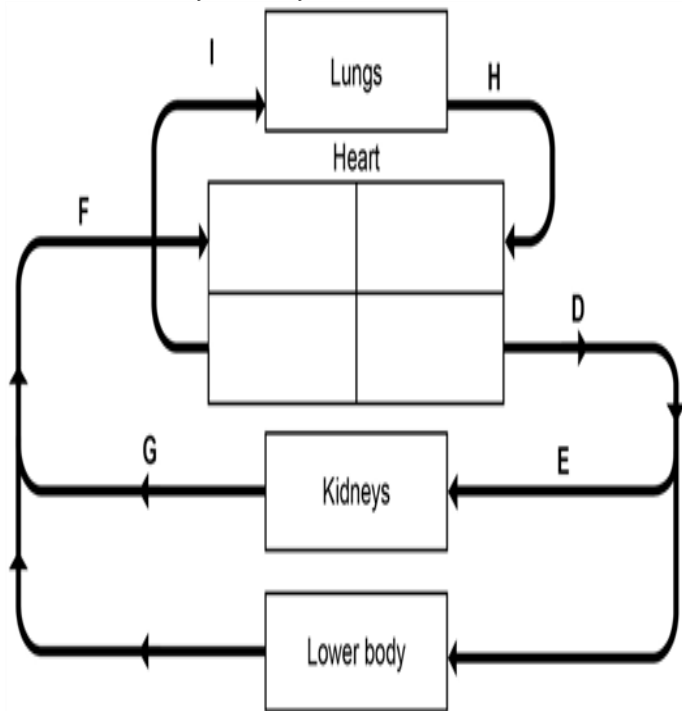
11. Which row in the table below identifies a stage of aerobic respiration, its site, and an event which occurs during that stage?

|   | Stage                   | Site                         | Event                             |
|---|-------------------------|------------------------------|-----------------------------------|
| A | electron transfer chain | inner mitochondrial membrane | carbon dioxide is released        |
| B | electron transfer chain | matrix of mitochondrion      | hydrogen ions combine with oxygen |
| C | citric acid cycle       | inner mitochondrial membrane | hydrogen ions combine with oxygen |
| D | citric acid cycle       | matrix of mitochondrion      | carbon dioxide is released        |

12. Replication of mitochondrial DNA (mtDNA) is different from that of nuclear DNA. The replication of the second strand of mtDNA only starts after two-thirds of the first strand of mtDNA has been copied. A piece of mtDNA is 16 500 base pairs long and is replicated at a rate of 50 nucleotides per second. How long will it take to copy the mtDNA.

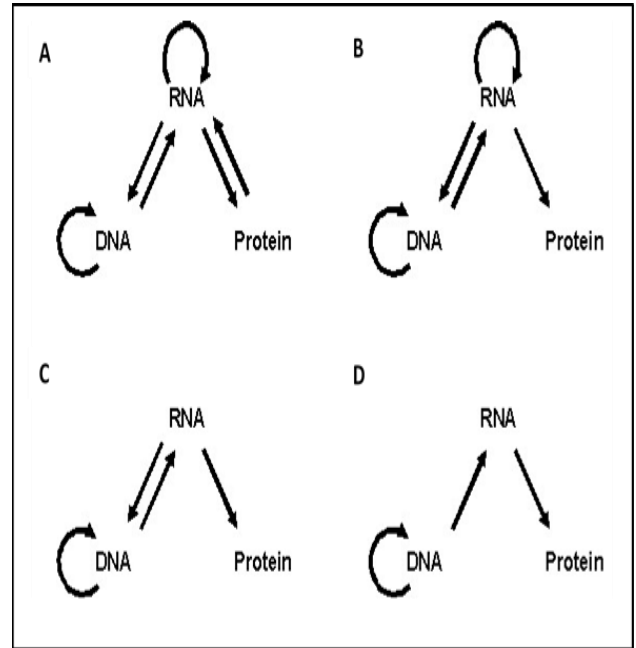
- A 330 seconds
- B 440 seconds
- C 550 seconds
- D 660 seconds

13. The following diagram shows the blood circulation of human body. Identify the different blood vessels.



- A H- Pulmonary Vein, D- Aorta, F- Vena Cava, I- Pulmonary Artery  
 B H- Pulmonary Artery, D- Aorta, F- Vena Cava, I- Pulmonary Vein  
 C I- Lung capillaries, F- Pulmonary vein, H- Capillaries of body, D- Aorta  
 D H- Pulmonary Vein, E- Vena Cava, I- Aorta, F- Pulmonary artery
14. Which feature of DNA was discovered as a result of Rosalind Franklin's work?
- A Double helix shape  
 B Long stranded molecule  
 C Sugar-phosphate backbone  
 D Complementary nucleotides
15. What are the three products extracted from donated blood?
- A Oxygen, water and urea  
 B Red blood cells, salts and oxygen  
 C Plasma, platelets, and red blood cells  
 D Platelets, hormones and amino acids

16. Which one of the following schematics correctly depicts our current understanding of the replication of genetic material in various organisms and the "flow of information" in biological systems?



17. The average daily intake of different food types by two persons, **A** and **B**, is represented in the table below.

| FOOD          | PERSON A | PERSON B |
|---------------|----------|----------|
| Fat           | 110g     | 110g     |
| Carbohydrates | 275g     | 260g     |
| Proteins      | 160g     | 240g     |

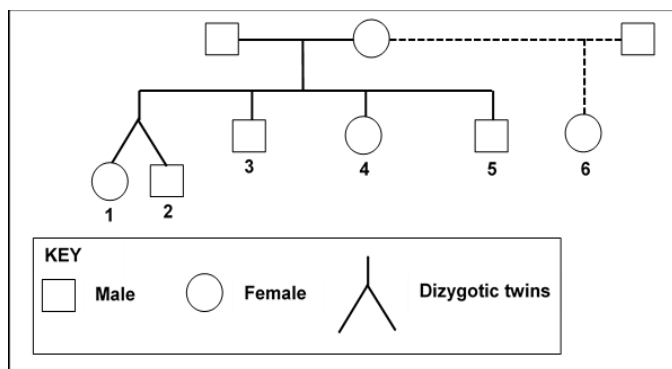
Normal urine from person A is likely to be different from that of person B in having:

- A More glucose  
 B Less urea  
 C More water  
 D Less glucose
18. Alleles  $I^A$  and  $I^B$  present on chromosome 9 are responsible for blood groups **A** and **B**, respectively. Blood group **O** results when these alleles are either absent or not expressed. The alleles  $I^A$  and  $I^B$  are expressed only if the **H** allele is present on chromosome 19, either in homozygous or heterozygous condition, where **h** stands for the recessive allele. Gilbert belongs to the **AB** blood group. His sister, Helen, belongs to the **A** group and their father belongs to the **A** group.

Identify the maternal and paternal genotypes.

|   | MOTHER                              | FATHER                              |
|---|-------------------------------------|-------------------------------------|
| A | H/H, I <sup>A</sup> /I <sup>B</sup> | H/h, i/i                            |
| B | H/h, I <sup>B</sup> /i              | h/h, I <sup>A</sup> /i              |
| C | H/h, I <sup>A</sup> /i              | H/H, I <sup>A</sup> /I <sup>A</sup> |
| D | h/h, I <sup>B</sup> /i              | H/h, i/i                            |

19. Using the given pedigree diagram state the genetic relatedness between individuals 1 and 2 and between individuals 5 and 6, respectively.



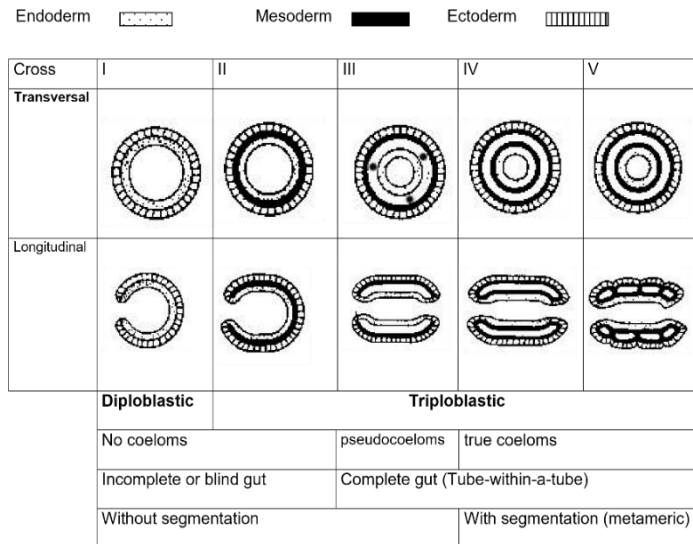
- A 0,5 and 0,25  
 B 0,25 and 0,5  
 C 1,0 and 0,5  
 D 1,0 and 0,25

20. One of the main hormones secreted by the pancreas is insulin. Insulin allows cells in the muscles, liver and fat to take up glucose and use it as a source of energy so they can function properly. Insulin has different effects on fat tissue, muscle and liver.

Which one of the following rows is true regarding the effects of insulin on each tissue?

|   | FAT TISSUE                       | MUSCLE TISSUE                      | LIVER TISSUE                  |
|---|----------------------------------|------------------------------------|-------------------------------|
| A | Increase in glucose entry        | Decrease in glucose entry          | Decrease in lipid synthesis   |
| B | Increase in glucose entry        | Increase in glycogen synthesis     | Decrease in ketogenesis       |
| C | Increase in fatty acid synthesis | Decrease in glycogen synthesis     | Increase in ketogenesis       |
| D | Decrease in fatty acid synthesis | Decrease in amino acid acquisition | Decrease in protein synthesis |

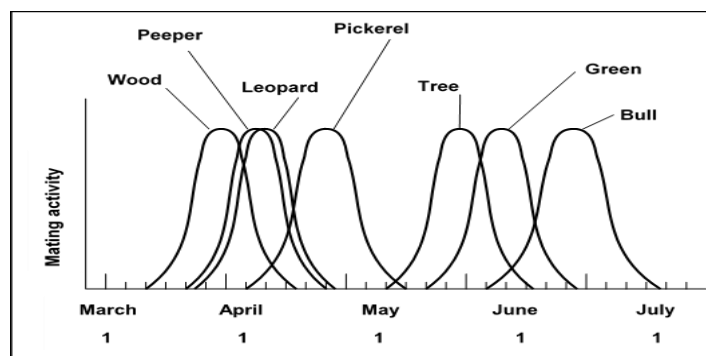
21. The diagrams of invertebrate embryos show the characteristics of the body plan.



Select the correct sequence that corresponds to the phyla represented with I, II, III, IV and V.

|   |          |                 |                 |                 |            |
|---|----------|-----------------|-----------------|-----------------|------------|
| A | Cnidaria | Platyhelminthes | Annelida        | Nematoda        | Arthropoda |
| B | Cnidaria | Platyhelminthes | Nematoda        | Arthropoda      | Annelida   |
| C | Nematoda | Arthropoda      | Platyhelminthes | Cnidaria        | Annelida   |
| D | Annelida | Cnidaria        | Arthropoda      | Platyhelminthes | Nematoda   |

22. The graph below shows breeding seasons of some species of frogs.



Which frog species would most likely interbreed?

- A Peeper and leopard  
 B Wood and pickerel  
 C Bullfrog and green  
 D Tree and pickerel

23. Which row in the table identifies the correct order of stages involved in genetic engineering?

| STAGES IN GENETIC ENGINEERING     |                            |                            |                            |
|-----------------------------------|----------------------------|----------------------------|----------------------------|
| 1st                               | 2nd                        | 3rd                        | 4th                        |
| <b>A</b> Required gene identified | Gene and plasmid extracted | Gene inserted into plasmid | Modified cells grown       |
| <b>B</b> Required gene identified | Gene inserted into plasmid | Gene and plasmid extracted | Modified cells grown       |
| <b>C</b> Required gene identified | Gene inserted into plasmid | Modified cells grown       | Gene and plasmid extracted |
| <b>D</b> Required gene identified | Modified cells grown       | Gene and plasmid extracted | Gene inserted into plasmid |

24. Plants use light energy to make sugars through a process called photosynthesis. The spectrum of photosynthesis shows the ability of green plants to ...

- A use light for photolysis.
- B absorb all wavelengths of light in photosynthesis.
- C absorb different wavelengths of light in photosynthesis.
- D use light of same wavelengths for photosynthesis.

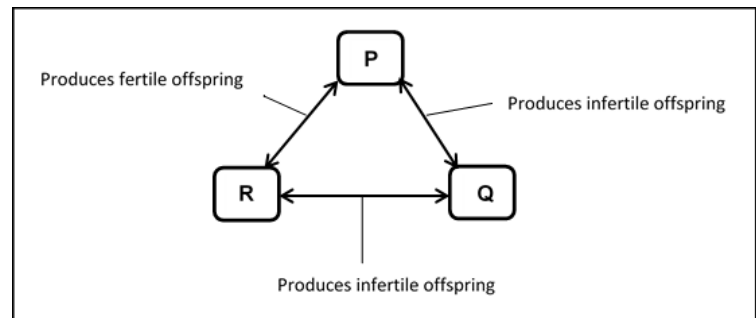
25. Different groups of organisms can be distinguished by means of their cellular structures. The table below shows the cell organelles and functions of different groups of organisms.

| KINGDOM  | META-BOLISM  | CONTROL    | COVER-ING     | FOOD PRODUC--TION      |
|----------|--------------|------------|---------------|------------------------|
| Fungi    | mitochondria | nucleus    | cell wall     | none                   |
| Animalia | mitochondria | nucleus    | cell membrane | none                   |
| Plantae  | mitochondria | nucleus    | cell wall     | chloroplast            |
| Protista | mitochondria | nucleus    | cell membrane | some with chloroplasts |
| Monera   | ribosomes    | DNA strand | cell wall     | none                   |

Which ONE of the following is supported by the data shown in this table?

- A Most kingdoms are made up of prokaryotic cells.
- B All cells have nuclei for control of cell functions.
- C Eukaryotic cells vary in covering and in food production.
- D Each of the kingdoms has different organelles for metabolism.

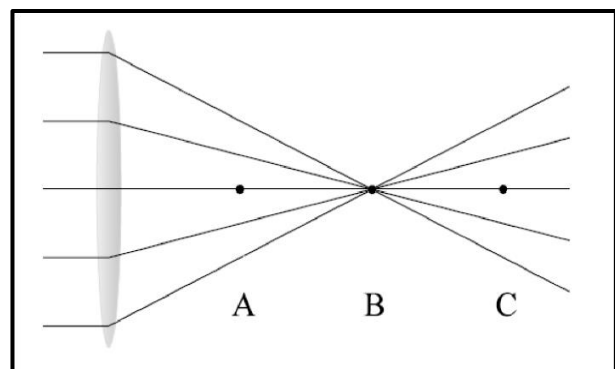
26. The diagram below shows the fertility of the offspring produced when three populations of mice - **P**, **Q** and **R** - interbreed.



Which ONE of the following statements is CORRECT?

- A All three populations are of the same species
- B Populations **P** and **Q** are of the same species, but populations **P** and **R** are different species
- C Populations **R** and **Q** are different species, but populations **P** and **R** are of the same species
- D Populations **P** and **R** are different species, but populations **R** and **Q** are of the same

27. In the diagram below, parallel light rays pass through a convex lens and converge to a focus. What defect is illustrated when the focus falls on **C**?



- A Short sightedness
- B Astigmatism
- C Cataract
- D Long sightedness



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28. Organisms that reproduce sexually exhibit zygotic, gametic, or sporic meiosis.

One way to determine the type of life cycle an organism has is by ...

- A observing embryonic development.
- B comparing the diploid and haploid forms of the organism.
- C determining when in the life cycle fertilisation occurs.
- D determining if gametes are multicellular or unicellular.

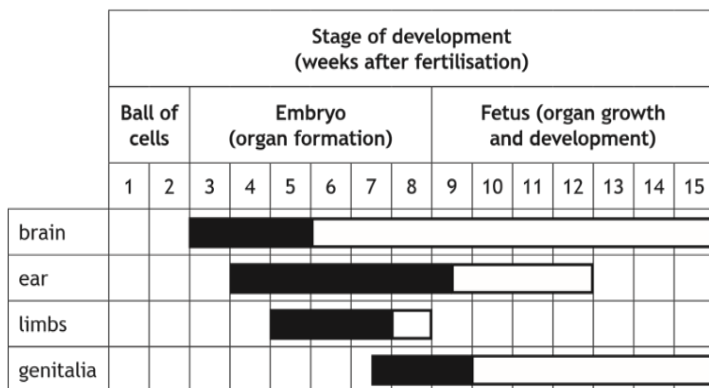
29. Meiosis involves the creation of haploid cells from diploid cells. The haploid chromosome number is when ...

- A ova and sperm go through their respective mature processes.
- B the S phase of the cell cycle is bypassed during meiotic interphase.
- C sister chromatids separate.
- D homologous chromosomes separate.

30. Nicotine is a chemical that may affect antenatal development. The diagram shows the stages of development when major and minor malformations of organs may occur if there is exposure to nicotine.

Key

- major malformation
- minor malformation



For how many weeks during pregnancy is there a possibility of major malformations to organs during development?

- A 6
- B 7
- C 9
- D 13

31. The table contains information about four semen samples.

Which semen sample has the lowest number of active sperm?

|   | SEMEN SAMPLE |    |    |    |
|---|--------------|----|----|----|
|   | A            | B  | C  | D  |
| Number of sperm in sample (millions/cm <sup>3</sup> ) | 40           | 30 | 20 | 60 |
| Active sperm (%)                                      | 50           | 60 | 75 | 40 |
| Abnormal sperm (%)                                    | 30           | 65 | 10 | 70 |

32. Eusocial honeybees have a specific system of sex determination. Females are diploid (2n) and develop from fertilised eggs; males are haploid (n) and develop from unfertilised eggs. Assuming that the queen copulated a single male, which of the following is/are most likely TRUE for this social group?

- (i) The males have mothers but not fathers.
- (ii) A female should foster her brothers to increase her inclusive fitness rather than trying to increase her direct reproduction.
- (iii) It is advantageous to females' (workers) fitness if the queen produces sons and daughters in equal proportions.
- (iv) A female should remove the eggs of other females (workers) from the nest to increase her fitness.

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

33. The table below shows the change in the abundance pattern of three trophic levels in a lake when it was polluted by city sewage. Ground-feeding carps increase in frequency because they benefit directly from additional mineral nutrients.

| Trophic level | After eutrophication |
|---------------|----------------------|
| Carp          | Increase             |
| Zooplankton   | Decrease             |
| Algae         | Increase             |

The following are possible methods of improving water quality:

- I Top-down control: attempt to introduce predatory fish on carp.
- II Bottom-up control: attempt to inhibit recycling of nutrients accumulated in the substrate of the lake.
- III Bottom-up control: attempt to reduce primary producers as well as consumers by introducing carp.

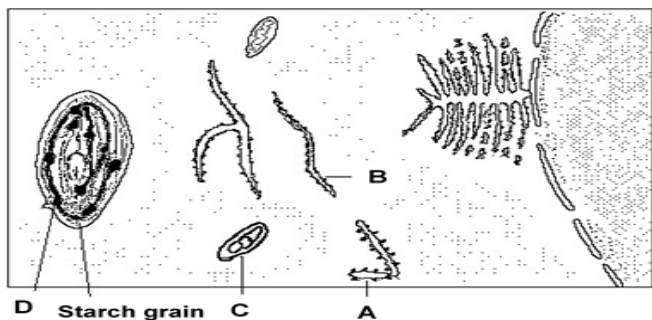
Which combination of the ecological control methods could best improve the water quality of the lake?

- A Only I
- B I and II
- C Only II
- D I, II and III

34. In the photic zone of freshwater and marine environments, where light penetrates, cyanobacteria are found in the upper part of the zone, and purple and green bacteria are in the lower part of the zone. Which of the following statements best explains the vertical distribution of the photosynthetic bacteria?

- A Green and purple bacteria are anaerobic, while cyanobacteria are aerobic.
- B Green and purple bacteria are better able to use light wavelengths that cyanobacteria do not use as efficiently.
- C Habitat isolation develops due to competition for nutrients and oxygen.
- D Cyanobacteria are better able to use oxygen as an electron donor for photosynthesis.

35. Consider the following diagram, which represents part of a cell. If the cell comes from an organism that has been growing in an environment in which its sole source of nitrogen is labelled radioactively, we would expect to find radioactivity in structure/s:

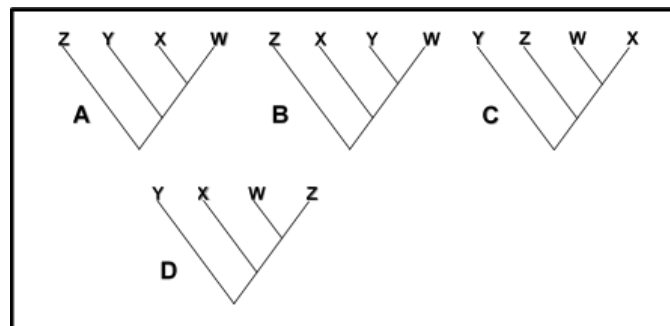


- A A only
- B A and B only
- C A, B and C only
- D A, B, C and D

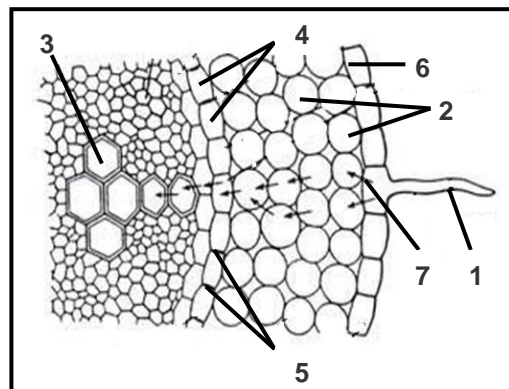
36. A cladogram is a branching diagram in which groups of closely related species (i.e. those sharing many characteristics) are shown to have branched away from the common line of descent via the same ancestor. The table gives a number of characteristics which are found in a group of four species, **W**, **X**, **Y** and **Z**. Shading indicates that the characteristic is present.

| Characteristic         | Species |   |   |   |
|------------------------|---------|---|---|---|
|                        | W       | X | Y | Z |
| Fingers and toes       |         |   |   |   |
| Endothermy             |         |   |   |   |
| 3 ear ossicles         |         |   |   |   |
| Amnion                 |         |   |   |   |
| Placenta               |         |   |   |   |
| Internal fertilisation |         |   |   |   |
| Mammary glands         |         |   |   |   |
| Oviparity (lays eggs)  |         |   |   |   |
| Webbed feet            |         |   |   |   |
| Hair                   |         |   |   |   |
| Feathers               |         |   |   |   |

Which one of the cladograms below is the most likely hypothesis explaining the distribution of characteristics?



37. The drawing shows a cross section of a plant root. The lines (1 - 6) indicate parts and the arrow (7) indicates a pathway in the root





Which of the following correctly identifies each part in the drawing?

- A 1 – trichome, 2 – cortex, 3 – phloem, 4 – pericycle, 5 – endodermis, 6 – epidermis, 7 – pathway of water and sugars
- B 1 - root hair, 2 – cortex, 3 – xylem, 4 – endodermis, 5 – Casparian strip, 6 - epidermis, 7 – pathway of water and minerals
- C 1 - root hair, 2 – cortex, 3 – xylem, 4 – Casparian strip, 5 -pericycle, 6 – epidermis, 7 – pathway of water and minerals
- D 1 – root hair, 2 – periderm, 3 – phloem, 4 – endodermis, 5 – Casparian strip, 6 – epidermis, 7 – pathway of phytohormones

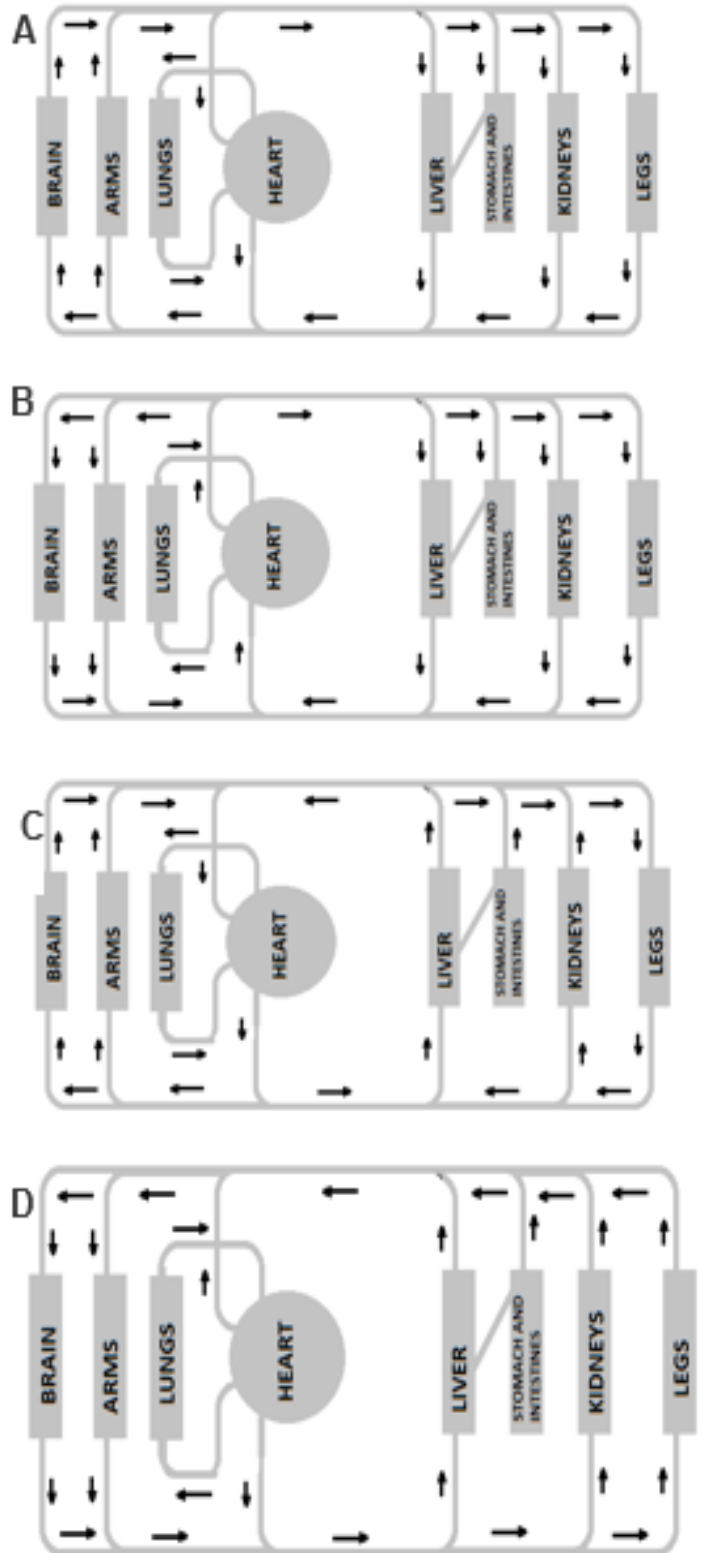
38. The numbers in the first column of the table below represent human, elephant, bat, mouse and carp, but not in the correct order.

| Number | Body temperature (°C) | Heart rate (beats/min) | Maximal speed of locomotion (m/s) |
|--------|-----------------------|------------------------|-----------------------------------|
| 1      | 1 – 30                | 30 – 40                | 1,5                               |
| 2      | 38                    | 450 – 550              | 3,5                               |
| 3      | 31                    | 500 – 660              | 14                                |
| 4      | 36,2                  | 22 – 28                | 11                                |
| 5      | 36,6                  | 60 – 90                | 10                                |

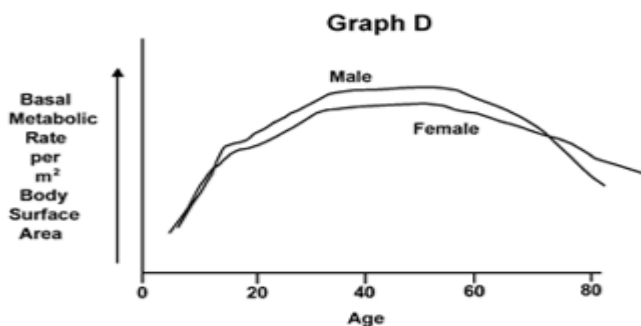
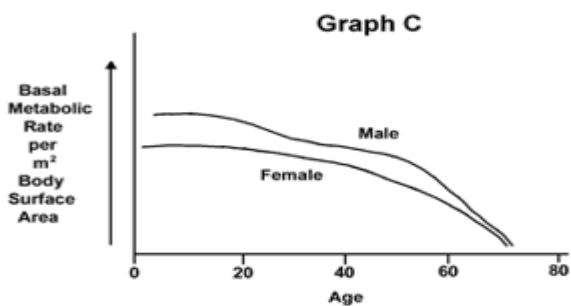
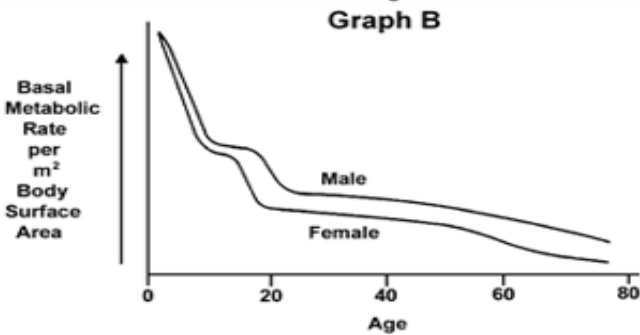
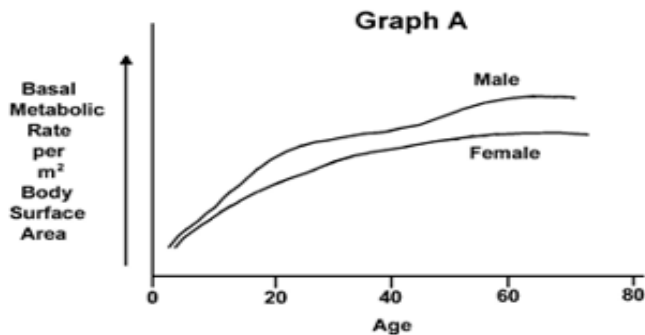
Which number CORRECTLY indicates each organism?

|   | 1     | 2        | 3        | 4        | 5     |
|---|-------|----------|----------|----------|-------|
| A | Bat   | Elephant | Carp     | Human    | Mouse |
| B | Mouse | Bat      | Elephant | Human    | Carp  |
| C | Carp  | Mouse    | Bat      | Elephant | Human |
| D | Carp  | Mouse    | Elephant | Bat      | Human |

39. Which figure shows the correct blood flow direction in a normal human being?



40. Which of the figures shows the correct relationship between basal metabolic rate per m<sup>2</sup> body surface area and age (in years) of human male and females?

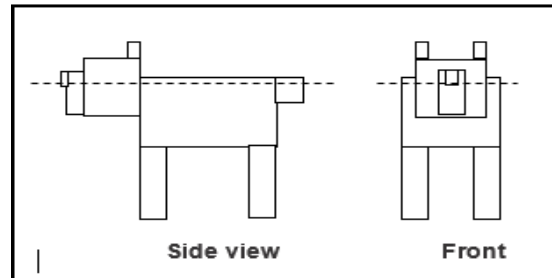


41. A 70 kg adult female has approximately 42L of water in her body. Of this volume, 55% of the water is found within the cells and 45% of water is found outside the cells. For the water found outside the cells, 83.3% is found outside the blood vessels.

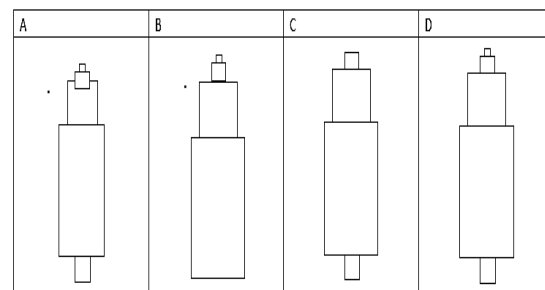
What is the estimated amount of water found at the outside of the blood vessels?

- A 23,1 L  
B 18,9 L  
C 15,7 L  
D 3,2 L

42. The diagrams show a front view and a side view.



Which of the following shows a cross section through the dashed line?



43. Spines and thorns on plants look similar, and both provide protection from herbivores. However, not all plants with spines or thorns have descended from a recent common ancestor. Spines are modified leaves, and thorns are modified stems.

Which of the following statements best describes how this information provides evidence for evolution by natural selection?

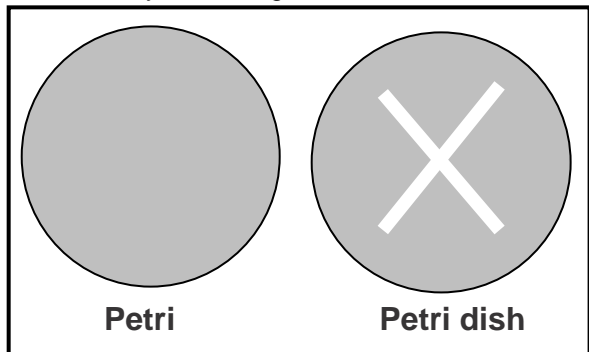
- A It shows that different organisms sometimes look alike.  
B It shows that herbivores are the strongest selection force on organisms.  
C It shows that a variety of structures can be effective in protecting an organism from herbivores.  
D It shows that environmental pressures can cause unrelated species to change in similar ways.

44. Plasmolysis occurs when living plant cells, such as those of the onion bulb scale epidermis, are placed in a strong sugar solution. After plasmolysis, which one of the following occupies the region between the plasma membrane and the cell wall?

- A sugar solution  
B pure vacuolar sap  
C diluted vacuolar sap  
D water

45. A student filled two Petri dishes with a clear cornstarch gel, then marked the letter "X" invisibly onto the gel in Petri dish 1 with a damp cotton swab.

He then placed saliva from his mouth onto a second cotton swab and used that swab to mark the letter "X" invisibly onto the gel in Petri dish 2.



Fifteen minutes later, the student rinsed both Petri dishes with a dilute solution of iodine to indicate the presence of starch. The entire surface of Petri dish 1 turned blue-black, indicating starch. Most of the surface of Petri dish 2 was blue-black, except that the letter "X" was clear, as shown above.

The most probable explanation of the clear "X" is that?

- A The starch in the gel was absorbed by the damp cotton swab.
- B The iodine reacted with a chemical the saliva and broke down.
- C A chemical in the saliva broke down the starch in the gel.
- D The saliva prevented the iodine from contacting the starch in the gel.

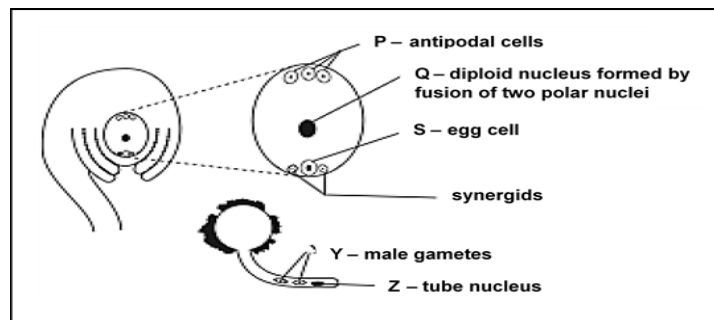
46. The pea weevil is a type of insect. The table below shows the average time it takes for pea weevil eggs to hatch at different temperatures.

| Temperature (°C) | Average Hatching Time (days) |
|------------------|------------------------------|
| 11               | 38                           |
| 14               | 20                           |
| 16               | 16                           |
| 18               | 10                           |
| 22               | 10                           |
| 24               | 7                            |
| 25               | 5                            |
| 27               | 5                            |
| 28               | 7                            |

Based on the data, which of the following climatic conditions would promote the highest population growth rate in pea weevils?

- A Cold springs with temperatures from 11°C to 16°C
- B Moderate summers with temperatures from 25°C to 27°C
- C Heat waves in which the temperature is sustained well above 28°C
- D Overnight frosts after which the temperature warms from 0°C to 11°C

47. The diagrams show vertical sections of an ovule and of a pollen grain from the same species of flowering plant.



Which one of the following combinations, A – D, represents the structure which, after fertilisation, becomes the endosperm?

- A Z + Q
- B Z + S
- C Y + S
- D Y + Q

48. Which one of the following would *NOT* increase the rate of water uptake from soil to root?

- A An increase in the concentration of soluble metabolites in root cells.
- B A decrease in the concentration of mineral ions in the soil.
- C An increase in root surface area.
- D A decrease in pressure potential of the root xylem sap.

49. Vampire bats feed solely on blood and can only survive about two days without a meal. When a bat fails to find food it will "beg" from other members of the colony. The other bat will then vomit a small amount of blood, even if the "begging" bat is unrelated. His shared altruism is ...

- A largely limited to species living in stable social groups.
- B adaptive only if the aided individual returns the favour at a later date.
- C seen when there are likely to be negative consequences associated with not returning favours.
- D A, B and C.

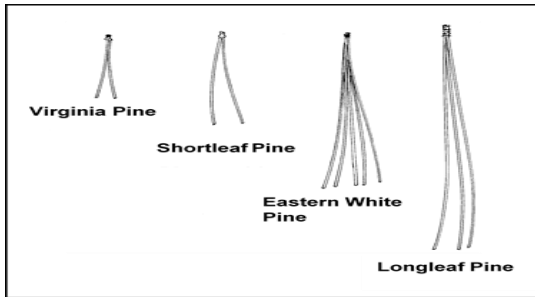
50. In the human body, the circulatory system transports and delivers substances. Within the cell, which organelle performs a similar function?

- A Nucleus
- B Golgi apparatus
- C Mitochondrion
- D Endoplasmic reticulum

51. Which one of these organisms has the LEAST specialised body organisation?

- A Jellyfish
- B Sea urchin
- C Starfish
- D Sponge

52. A student collected pine needles from four different species of trees. She then made diagrams showing the number and actual length of needles in a bundle and the common and scientific name of each species.



These four different pine trees are NOT classified in the same ...

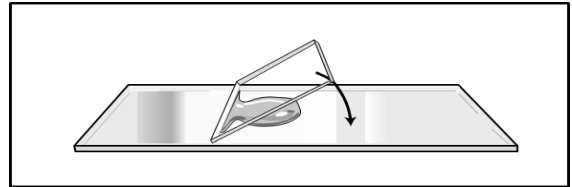
- A order
- B species
- C genus
- D phylum

53. In 1910 Thomas Morgan discovered traits linked to sex chromosomes in the fruit fly. The Punnett square shows the cross between red-eyed females and white-eyed males. Fruit flies usually have red eyes. If a female and male offspring from the cross shown below are allowed to mate, what would the offspring probably look like?

|                 |       |                 |         |
|-----------------|-------|-----------------|---------|
|                 |       | White-eyed male |         |
|                 |       | $X^r$           | Y       |
| Red-eyed female | $X^R$ | $X^R X^r$       | $X^R Y$ |
|                 | $X^R$ | $X^R X^r$       | $X^R Y$ |

- A 2 red-eyed females; 2 white-eyed males
- B 2 red-eyed females; 1 red-eyed male; 1 white-eyed male
- C 1 red-eyed female; 1 white-eyed female; 2 red-eyed males
- D 2 white-eyed females; 1 white-eyed male; 1 red-eyed male

54. The picture below shows a coverslip correctly being lowered onto a slide.



This method is used because it ...

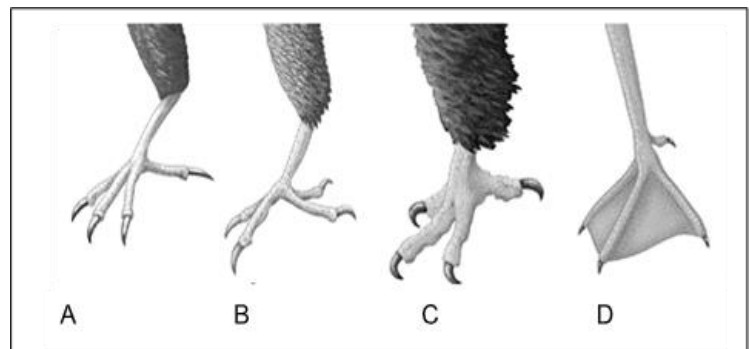
- A reduces the possibility of air bubbles on the slide.
- B prevents the escape of micro-organisms found in the water.
- C allows micro-organisms to move freely in the water.
- D prevents the coverslip from moving.

55. Which of the following is an example of a genetically engineered organism?

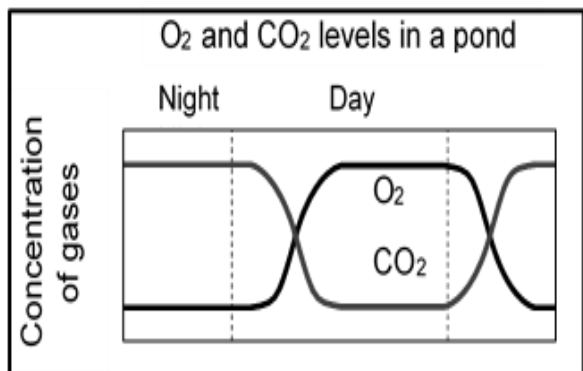
- A A plant that received external DNA to produce natural insecticides.
- B A new plant variety created by cross-pollination.
- C Seedless fruits resulting from grafting of one plant onto another.
- D A plant that naturally possessed medicinal properties.

56. These feet belong to different birds. Three of the birds spend most of their time on the ground, while one bird rarely walks on the ground.

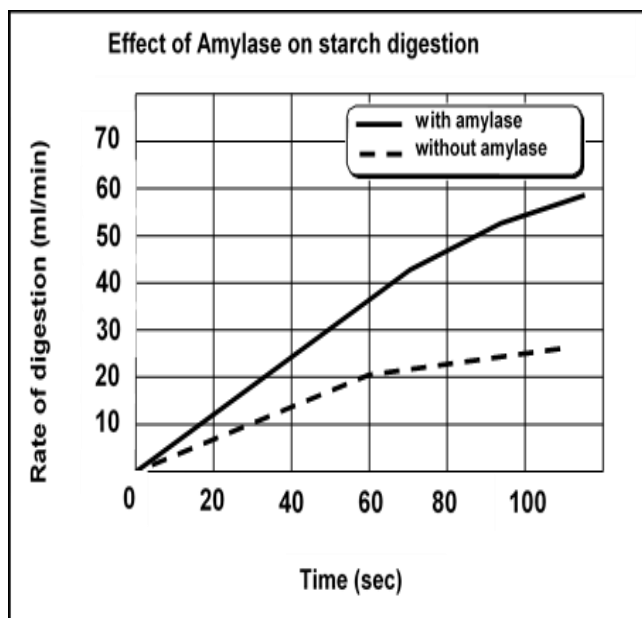
Which foot belongs to the bird that is best adapted for grasping branches?



57. The graph shows how dissolved O<sub>2</sub> and CO<sub>2</sub> levels changed in a pond over a 24-hour period. What caused the decrease in O<sub>2</sub> concentration during the night?

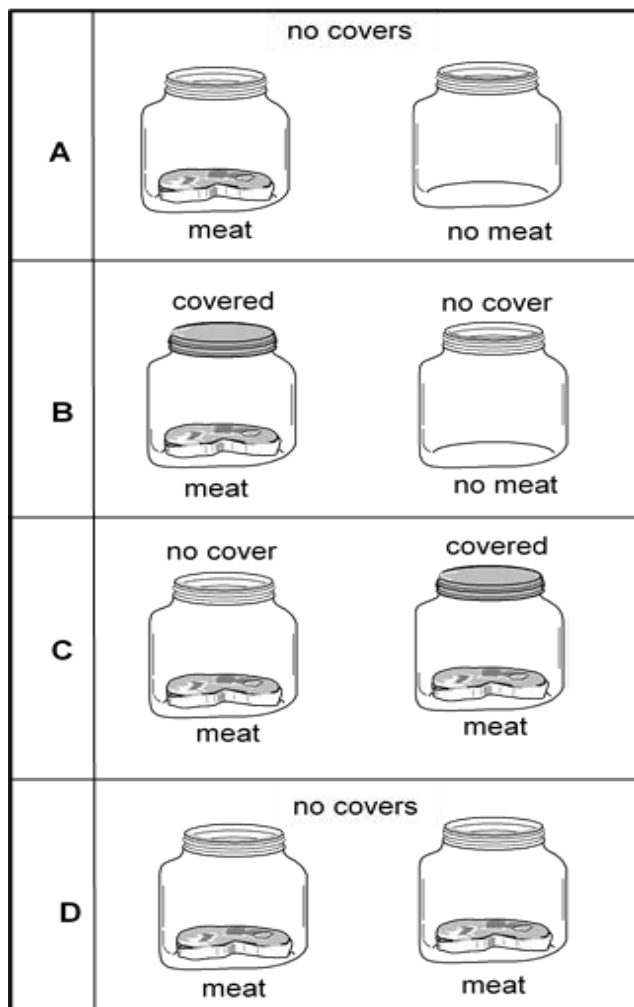


- A Increased evaporation  
B Decreased photosynthesis  
C Increased respiration  
D Decreased temperatures
58. According to the graph, addition of the enzyme amylase causes the reaction to ...

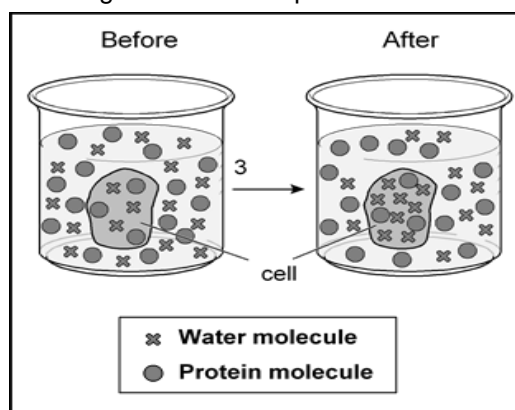


- A slow down  
B speed up.  
C give off heat.  
D take in heat.
59. People long ago believed that maggots came from meat. In the late 1600's, Francesco Redi made the hypothesis that maggots came from flies rather than from meat.

- Which of these experimental designs could be used to test Redi's hypothesis?



60. The diagram shows the process of osmosis.



Only the water molecules could enter the cell because water molecules ...

- A have more energy than the protein molecules.  
B are smaller than the protein molecules.  
C are more numerous than the protein.  
D contain more hydrogen atoms than the protein molecules.

**56<sup>th</sup> LIFE SCIENCES OLYMPIAD  
GRADES 10-12**

61. The 14 different species of finches in the Galapagos Islands originated from a single ancestral species. What is it about these islands that is responsible for the diversity of finch species?

- A The islands are made of volcanic peaks.
- B Each island has different food sources.
- C Each island has a different climate.
- D The islands are clustered near each other.

62. Cleaner fish feed off the algae, fungi and other micro-organisms that are found on larger fish. Other species of fish, which look like the cleaners, are able to approach the larger fish and remove large bites of flesh.

The following are suggested outcomes of the interactions:

- I micro-organisms on large fish would decrease.
- ii cleaner populations would decrease.
- iii behavior of large fish would change.
- iv cleaners and mimics would interbreed.

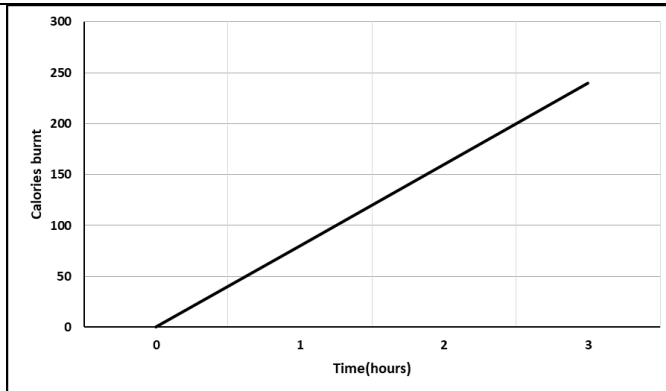
If the look-alike populations outnumber the cleaner fish, which combination of the outcomes is most likely to occur?

- A i and ii only
- B I and iii only
- C ii and iii only
- D i, and iv only

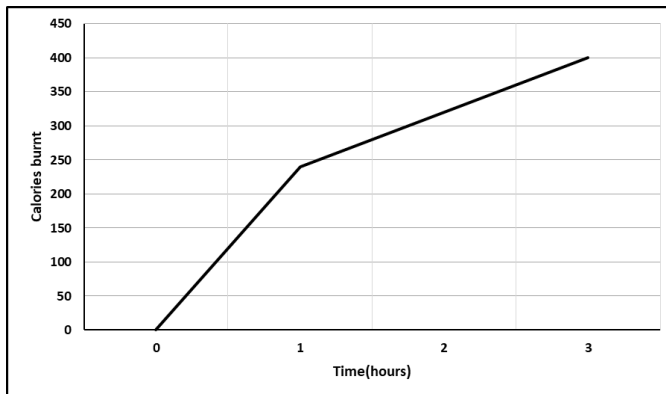
63. Study the table showing the calories used per certain activities.

| ACTIVITY   | CALORIES USED per hour |
|------------|------------------------|
| Walking    | 80                     |
| Gymnastics | 170                    |
| Jogging    | 240                    |
| Tennis     | 280                    |
| Bicycling  | 320                    |
| Swimming   | 440                    |

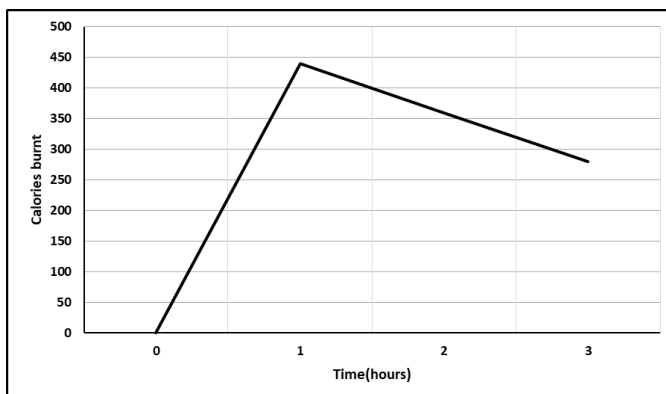
According to the information in the table, which graph below illustrates the calories used for 1 hour of jogging followed by 2 hours of walking?



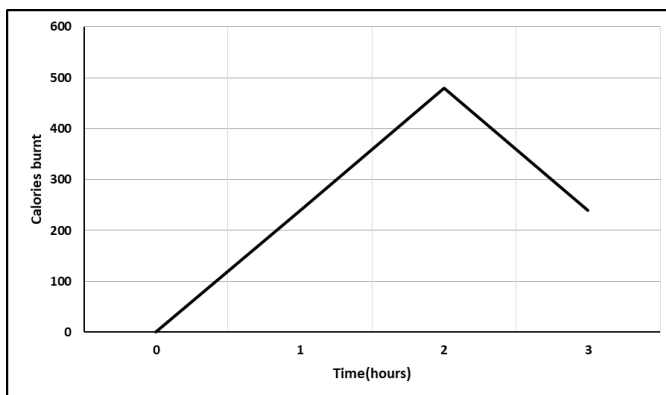
Graph 1 - A



Graph 2 - B



Graph 3 - C



Graph 4 - D

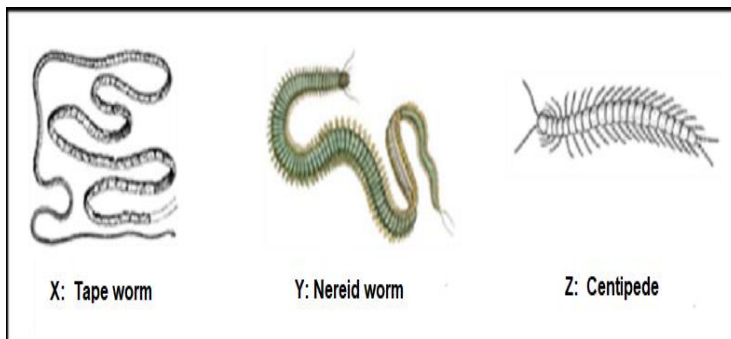


64. Jason, a scientist, is testing a new drug, which is supposed to relieve migraines. He administers the drug to 4000 volunteers with migraines. Each volunteer is asked to describe the effect of the drug on the migraine after taking the drug. Forty eight percent of the people report that the drug has reduced their frequency of migraines and pain associated with migraines.

What can Jason do to make the results of this experiment more reliable?

- A He can increase the sample size
- B He can set up a control group
- C He must get approval from the Health Council
- D He must test two independent variables at the same time

65. The diagrams represent three categories of animals with segmented bodies.



Which organism(s) belong to the phylum of segmented worms?

- A Y only
- B X and Y
- C Y and Z
- D X and Z

66. A digestive system comprising solely mouth, oesophagus, intestine and anus is found in ...

- A an insect.
- B a snail.
- C a nematode.
- D an earthworm.

67. Assuming that the number of chromosomes in the endosperm of a gymnosperm is 80, the number of chromosomes before and immediately after fertilisation in each of the following structures will be:

|   | Structures          | Before fertilization | After fertilization |
|---|---------------------|----------------------|---------------------|
| A | Integument          | 80                   | 160                 |
|   | Cells of archegonia | 80                   | 80                  |
|   | Nucellus            | 160                  | 160                 |
| B | Integument          | 80                   | 80                  |
|   | Cells of archegonia | 40                   | 40                  |
|   | Nucellus            | 80                   | 80                  |
| C | Integument          | 80                   | 80                  |
|   | Cells of archegonia | 40                   | 40                  |
|   | Nucellus            | 40                   | 120                 |
| D | Integument          | 160                  | 160                 |
|   | Cells of archegonia | 80                   | 80                  |
|   | Nucellus            | 160                  | 160                 |

68. The scientific discipline concerned with grouping and naming organisms is called ...

- A taxonomy.
- B cladistics.
- C binomial nomenclature.
- D systematics.

69. Which of the following correctly represents the events involved in the secretion and action of ADH?

|          | Water level in blood relative to normal | Amount of ADH produced relative to normal | Amount of water reabsorbed by kidneys |
|----------|---|---|---------------------------------------|
| <b>A</b> | <b>Increase</b>                         | <b>Increase</b>                           | <b>Decrease</b>                       |
| <b>B</b> | <b>Increase</b>                         | <b>Decrease</b>                           | <b>Increase</b>                       |
| <b>C</b> | <b>Decrease</b>                         | <b>Increase</b>                           | <b>Increase</b>                       |
| <b>D</b> | <b>Decrease</b>                         | <b>Decrease</b>                           | <b>Decrease</b>                       |

70. Yeast artificial chromosomes (YACs) are genetically engineered chromosomes derived from the DNA of yeast, *Saccharomyces cerevisiae*. YACs are used as cloning vectors to transfer large fragments of DNA.

Consider the following:

- I Telomeric sequences
- II Centromeric sequences
- III Autonomously replicating sequences

Which of the following is/are essential to generate a yeast artificial chromosome (YAC) vector?

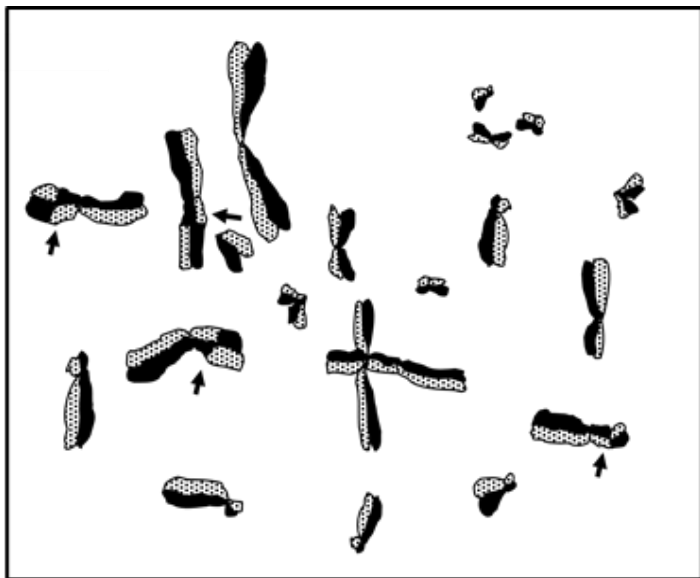
- A III only
- B I and III only
- C II and III only
- D I, II and III

71. Dividing chromosomes can be labelled with a thymine analogue, bromo-deoxy-uridine. After differential staining, the chromosomes can be seen as darkly stained (old) strands and lightly stained (new) strands. The following chromosomes were observed and photographed while studying division of human blood cells.

Consider the following:

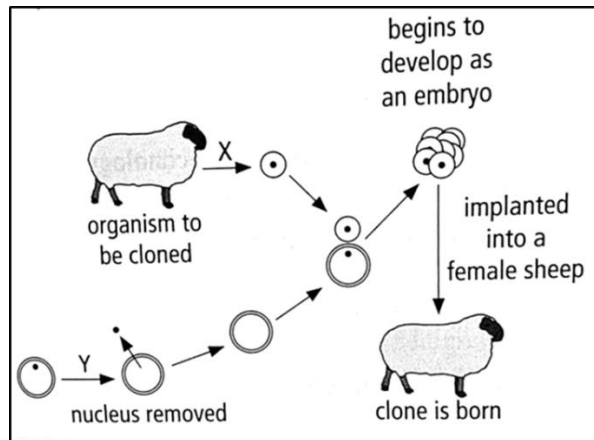
- I The chromosomes belong to metaphase stage.
- II The cell division was taking place in mature red blood cells.
- III Parts of the chromatids were exchanged by crossing over.
- IV The different colours of the two sister chromatids confirm that DNA replication is semi-conservative.

From the picture, which combination of the above statements can be deduced?



- A I, III and IV
- B II and IV
- C I and IV only
- D I, II and III

72. Study the representation of the process of cloning below:



Which processes involved in cloning an animal are indicated by the letters X and Y?

|   | X                                       | Y   |
|---|---|---|
| A | Differentiated cell removed from animal | Nucleus removed from unfertilised ovum          |
| B | Sex cell removed from animal            | Nucleus removed from differentiated animal cell |
| C | Sex cell removed from animal cell       | Nucleus removed from unfertilised ovum          |
| D | Differentiated cell removed from animal | Nucleus removed from differentiated animal cell |

73. There are many fungus species that live inside plant tissues. What determines whether the relationship between a fungus and a plant is commensalism, mutualism, or parasitism?

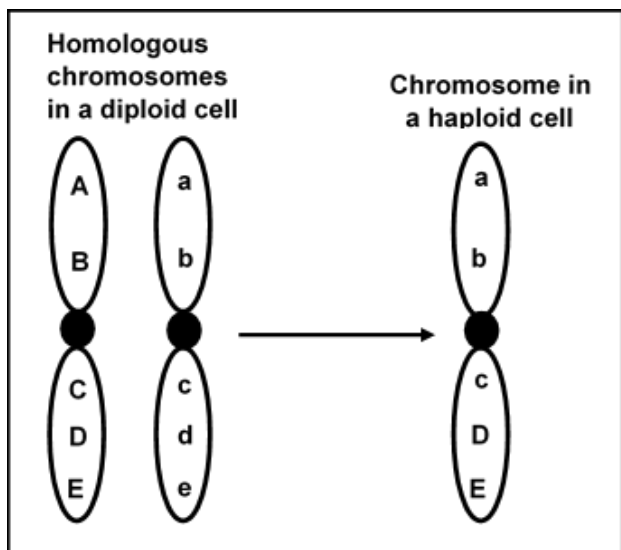
- A Where the fungus is located in the plant.
- B How long the fungus survives in the plant.
- C Whether the fungus reproduces in the plant with spores, seeds, or runners.
- D Whether the effect of the fungus on the plant is neutral, positive, or negative.

74. A student places four small aquatic snails in a test tube containing bromothymol blue solution. The solution will change colour from blue to yellow if the carbon dioxide level increases. The student seals the test tube and notes that the solution is blue. After a few hours, the student observes that the solution is yellow.

What physiological process did the snails perform that caused the colour of the solution to change?

- A cellular respiration
- B chemical digestion
- C fermentation
- D photosynthesis

75. The diagram below represents a pair of homologous chromosomes in a diploid cell, and the resulting chromosome in a haploid cell. The letters represent alleles of genes.



Why does the chromosome in the haploid cell have alleles from both of the chromosomes in the diploid cell?

- A Crossing over occurred during meiosis.  
 B A mutation occurred during a viral infection.  
 C Independent assortment occurred during fertilisation.  
 D Incomplete dominance occurred during gene expression.
76. Scientists studying human diseases often use animal models. For example, fruit flies have been used to study Alzheimer's disease. Scientists insert certain human genes found in patients with Alzheimer's disease into fruit flies and observe how these genes affect the fruit flies.
- Where must the human gene be inserted for a fruit fly to produce offspring with this gene?
- A In the sex cells of the fly.  
 B On several proteins in a fly cell.  
 C In the nervous system of the fly.  
 D On several chromosomes in a fly cell.
77. Valvular stenosis is a condition in which the heart valves are stiff and do not open completely. In people with this condition, blood flow to the body is decreased.

How will valvular stenosis **most likely** affect body cells?

- A Body cells will produce less water than usual.  
 B Body cells will receive less oxygen than usual.  
 C Body cells will store more nutrients than usual.  
 D Body cells will produce more waste products than usual.

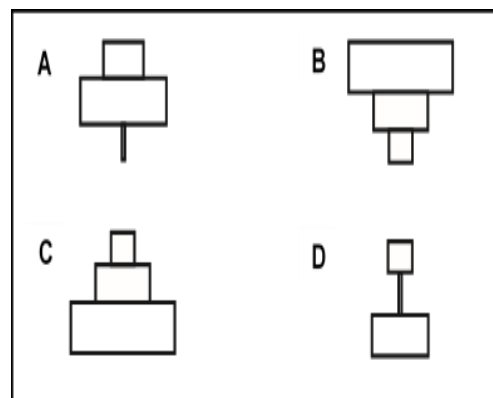
78. When proteins are broken down, phenylalanine is sometimes produced. Phenylalanine contains the elements carbon, nitrogen, hydrogen, and oxygen. Phenylalanine is present in which type of compound?

- A amino acid  
 B fatty acid  
 C monosaccharide  
 D phospholipid

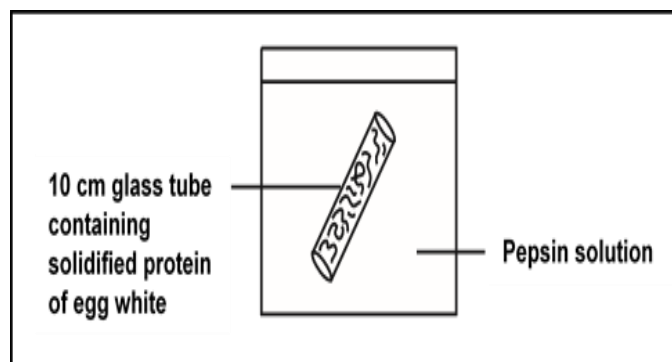
79. Study the following food chain:

*Grass* → *Rabbit* → *Flea*.

Which ONE of the diagrams below will represent the correct pyramid of numbers for the above food chain?



80. The diagram below was used to investigate the effect of different pH levels (2, 5, 7 and 10) on pepsin activity.



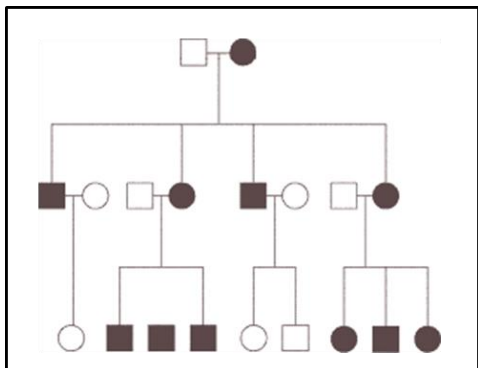
The table below shows the lengths of the protein after one hour at each pH level.

| pH | LENGTH (cm) |
|----|-------------|
| 2  | 6           |
| 5  | 8           |
| 7  | 9           |
| 10 | 10          |

What is the optimum pH for pepsin?

- A 2
- B 5
- C 7
- D 10

81. The pedigree in the figure below shows the transmission of a trait in a particular family.



Based on this pattern of transmission, the trait is most likely ...

- A sex-linked recessive.
- B sex-linked dominant.
- C mitochondrial.
- D autosomal dominant.

82. If non-disjunction occurs in meiosis II during gametogenesis, what will the result be at the completion of meiosis?

- A Two gametes will be  $n + 1$ , and two will be  $n - 1$
- B One gamete will be  $n + 1$ , one will be  $n - 1$ , and two will be  $n$ .
- C There will be three extra gametes.
- D Two of the four gametes will be haploid, and two will be diploid.

USE THE FOLLOWING INFORMATION TO ANSWER QUESTIONS 83 AND 84

An achondroplastic male dwarf with normal vision marries a color-blind woman of normal height. The man's father was 1,8m, and both the woman's parents were of average height. Achondroplastic dwarfism is autosomal dominant, and red-green color blindness is X-linked recessive.

83. How many of their daughters might be expected to be color-blind dwarfs?

- A All
- B None
- C Half
- D One out of four

84. How many of their sons would be color-blind dwarfs?

- A All
- B None
- C Half
- D One out of four

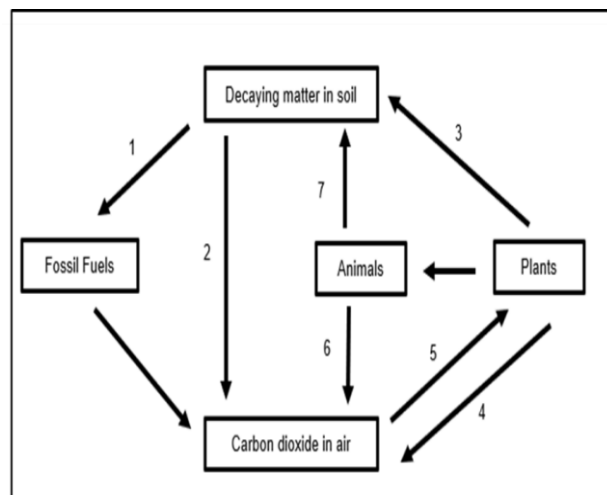
85. Traditional medicines have been used to treat malaria for thousands of years and are the source of the two main groups (artemisinin and quinine derivatives) of modern antimalarial drugs.

Quinine was derived from ...

- A Hoodia plant.
- B Cinchona bark.
- C African potato.
- D Marula berries

USE THE FOLLOWING DIAGRAM TO ANSWER QUESTIONS 86 AND 87.

A part of the carbon cycle is represented by the diagram below.



86. Which numbers represent the conversion of carbon from an organic form to an inorganic form?

- A 2 and 6
- B 3 and 7
- C 4 and 5
- D 6 and 7

87. Which number represents photosynthesis?

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

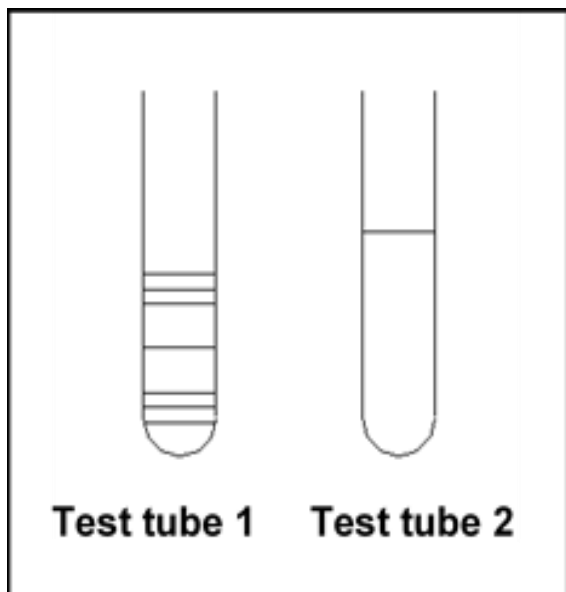
88. Consider the following stages in respiration:

- i. Lung volume increases
- ii. Relaxation of diaphragm
- iii. Air flows into lungs
- iv. Contraction of diaphragm

Which combination provides the CORRECT sequence during inspiration?

- A iv → i → iii
- B iii → i → iv
- C ii → i → iii
- D ii → iii → i

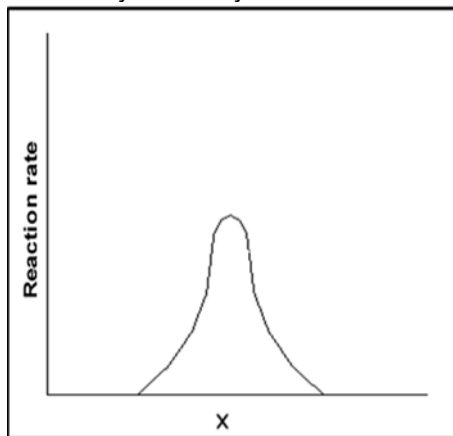
89. A student recorded his observation of a reaction using an enzyme at 37°C in his lab book. Into test tube 1, he put 10 ml of a boiled egg-white solution. This appeared to be cloudy. He then added 2 ml of an enzyme solution and stirred the mixture. Ten minutes later, the solution turned clear as shown in test tube 2.



The suspension might become clear more quickly if ...

- A the mixture had not been stirred.
- B the pH of the mixture had been changed.
- C iodine had been added to the test tube.
- D the temperature had been raised to 75°C.

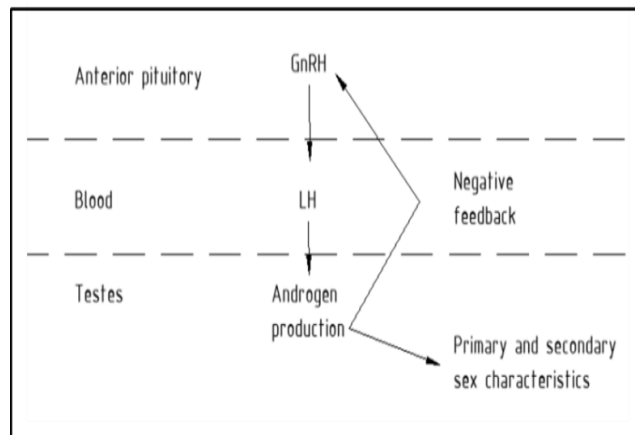
90. The graph shows the effect of x on the rate of reaction of an enzyme-catalysed reaction.



x is represented by which combination?

- A Temperature or pH
- B Enzyme concentration or pH
- C pH or substrate concentration
- D Temperature or enzyme concentration

91. The diagram shows the regulation of the production of the male reproductive hormones.



Consider the following effects:

- I The production of natural androgens would be less than usual.
- ii The level of GnRH released from the anterior pituitary would decrease.
- iii Level of LH in the blood will accumulate.
- iv The stimulation of primary sex characteristics would increase.

If a male body builder takes steroid androgens, which of these effects would be seen?

- A i and ii
- B i and iii
- C i and iv
- D i, ii and iv

92. Which ONE of these processes is carried out in the same way in both plants and animals?

- A Cellular respiration
- B Asexual reproduction
- C Circulation of body fluids
- D Excretion of metabolic waste

93. What property of water (H<sub>2</sub>O) is most important for plants living just under the surface of the water?

- A Surface tension
- B Transparency
- C Adhesion
- D Temperature

94. During which process/phase is it possible to observe the nucleolus?

- A In senescent plant cells.
- B During the elongation of the plant cells.
- C During meiosis.
- D In senescent animal cells.

95. During the Olympics tournament many athletes are measured and tested before and after their events.

Which types of variation are shown by blood group and breathing rate?

|   | BLOOD GROUP   | BREATHING RATE |
|---|---------------|----------------|
| A | Continuous    | Discontinuous  |
| B | Discontinuous | Discontinuous  |
| C | Continuous    | Continuous     |
| D | Discontinuous | Continuous     |

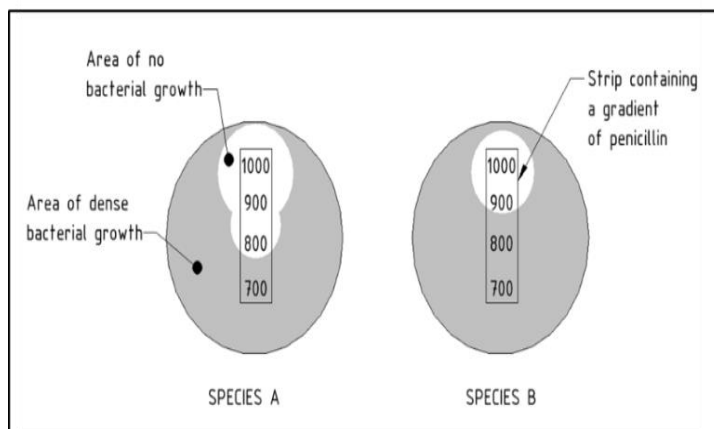
96. Carnivorous plants trap insects and use them to survive. What do they obtain from the insects and what do they use this substance for?

- A They obtain sugars, because they can't produce enough in photosynthesis.
- B They obtain water, because they live in dry environments.
- C They obtain nitrogen to make sugar.
- D They obtain nitrogen to make protein.

97. Which of the following pairs is INCORRECT?

- A Root hair - dermal tissue
- B Companion cell - excretory tissue
- C Guard cell - dermal tissue
- D Palisade parenchyma - ground tissue

98. The diagrams represent Petri dishes with two species of bacteria grown in them. The strip in the middle contains the antibiotic penicillin applied to the strip in a gradient of concentrations.



Which statement is correct?

- A Species A is less resistant to penicillin.
- B The minimum concentration of penicillin required to inhibit the growth of Species B is approximately 800 units
- C Species A replicates faster than Species B
- D The minimum concentration of penicillin required to inhibit the growth of Species A is approximately 700 units.

99. Which of the following is the correct order in which stored food substances in humans are utilised by the body during starvation?

- A Carbohydrates, proteins, fats
- B Fats, proteins, carbohydrates
- C Carbohydrates, fats, proteins
- D Fats, carbohydrates, proteins

100. What causes apical dominance?

- A Abscisic acid in lateral bud
- B Gibberellin in leaf tip
- C Cytokinin in leaf tip
- D Auxin in shoot tip

ooOoo