

Time Allowed:

Reading Time: 10 minutes

Examination Time: 120 minutes

INSTRUCTIONS

- *Attempt ALL questions in ALL sections of this paper.*
- Permitted materials: Non-programmable, non-graphical calculator, pens, pencils, erasers and a ruler.
- Answer SECTIONS A and B on the Multiple Choice Answer Sheet provided. Use a pencil.
- Answer SECTION C in the answer booklet provided. Write in pen and use pencil only for graphs.
- Ensure that your diagrams are clear and labelled.
- All numerical answers must have correct units.
- Marks will not be deducted for incorrect answers.
- **Do not write on this question paper. It will not be marked.**

MARKS

SECTION A	43 multiple choice questions	43 marks
SECTION B	22 short answer questions	20 marks
SECTION C	5 written answer questions	42 marks
	Total marks for the paper	105 marks

**SECTION A: MULTIPLE CHOICE
USE THE ANSWER SHEET PROVIDED**

1. Which of the following would be found in an animal cell but not in a bacterial cell?
 - a. DNA.
 - b. Cell wall.
 - c. Ribosomes.
 - d. Plasma membrane.
 - e. **Endoplasmic reticulum.**

2. Which of the following is true of an amino acid and starch? Both:
 - a. contain nitrogen.
 - b. **contain oxygen.**
 - c. are found in proteins.
 - d. are large polymers.
 - e. are the functional components of lipids.

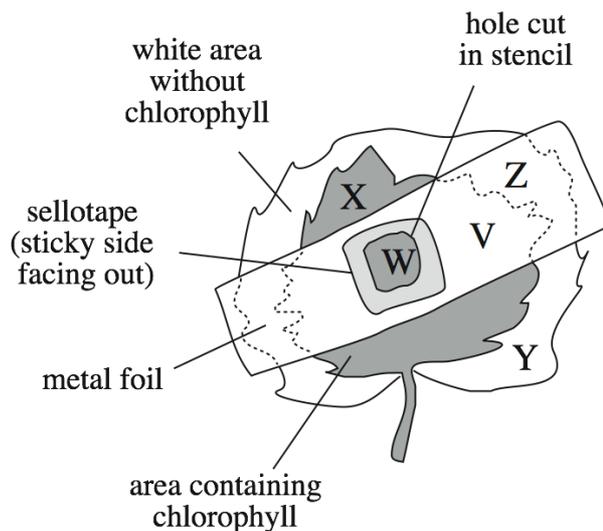
3. Which element occurs in nucleic acids but not in carbohydrates?
 - a. **Phosphorous.**
 - b. Sulfur.
 - c. Carbon.
 - d. Iron.
 - e. Hydrogen.

4. Hydrophilic substances are _____, whereas hydrophobic substances are _____
- water-fearing; water-loving.
 - non-polar; polar.
 - soluble in water; soluble in lipid.
 - charged; neutral.
 - hydrogen bonding; non-hydrogen bonding.
5. Cellulose is a major carbohydrate component of plant cell walls. Most animals are unable to digest cellulose whilst they can digest other carbohydrate polymers such as starch. What is the correct explanation for this?
- There are many hydrogen bonds holding the subunits together.
 - Cellulose is made up of chitin, which is indigestible.
 - The bonds holding cellulose subunits together are stronger than those in any other macromolecule.
 - They don't have the correct enzyme to break the bonds between the cellulose subunits.
6. You are conducting an experiment to test the hypothesis that dairy cows will give more milk during milking if they are listening to classical music. Your 20 experimental cows listen to classical music during milking; you collect all their milk and measure how much there is. Your 20 control cows should experience identical experimental conditions except that they should:
- listen to classical music at a louder volume.
 - listen to classical music all the time, not just during milking.
 - listen to a different type of music, like heavy metal.
 - not listen to any music.
 - not be milked.

7. Two animal cells were placed in a 0.5% sucrose solution. Initially both cells started to increase in size. However, cell A soon ceased to enlarge whilst Cell B increased in size until it burst. Which statement was true at the start of the experiment?
- Cell A was hypotonic to the solution and cell B was hypertonic.
 - Cell A was hypertonic to cell B.
 - Cell A was hypertonic to the solution and cell B was hypotonic.
 - Cell B was hypertonic to cell A.
8. A plant suspension was prepared by grinding up plant material. The component parts were then separated via centrifugation. At the end of this process, there was a layer of sediment at the bottom of the test tube covered by an aqueous solution. Organelles found in the sediment took up carbon dioxide and produced oxygen when illuminated. The organelles are likely to be:
- ribosomes.
 - mitochondria.
 - nuclei.
 - chloroplasts.
 - endoplasmic reticulum.
9. A species of insect was found to have developed resistance to a commonly used insecticide. Which of the following is the most likely explanation?
- The insecticide caused development of resistance in the insects.
 - The original gene pool included genes that conferred resistance to the insecticide.
 - The insecticide stimulated development of resistance in certain individuals and this was inherited.
 - The insecticide caused a mutation that conferred resistance and this was inherited.

Use the following information to answer questions 10-14

In an experiment to test the hypothesis that leaves need both light and chlorophyll to make starch, a stencil was fixed to both sides of a leaf of a variegated geranium plant as shown.

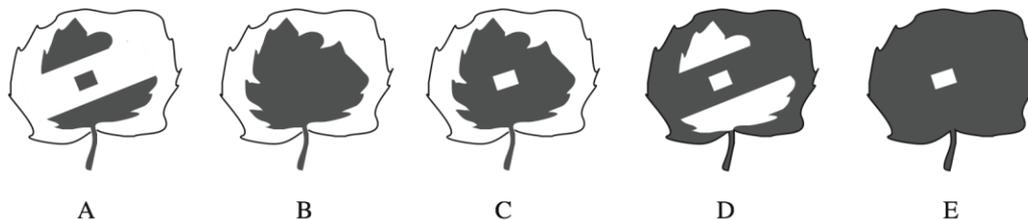


The hole cut in the stencil was covered by a small piece of transparent sellotape. As a result of this treatment, the leaf had been divided into FIVE parts experiencing different conditions, the positions of which are indicated by the letters V – Z in the diagram above.

- V contained chlorophyll but was in darkness.
- W contained chlorophyll and was open to the light but was covered with sellotape.
- X contained chlorophyll and was open to the light but not covered with sellotape.
- Y had no chlorophyll and was open to the light.
- Z had no chlorophyll and was in darkness.

The plant was then left in bright light for 48 hours, after which the stencil was removed and the leaf tested for starch.

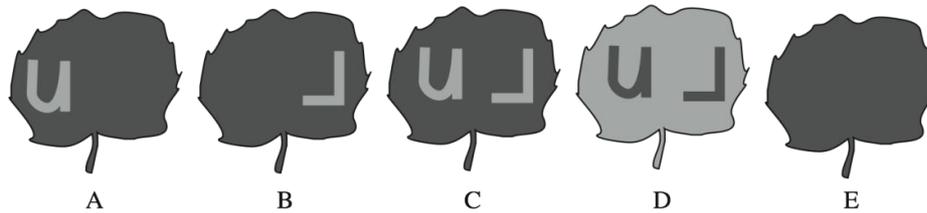
10. Which of the diagrams A - E would indicate the appearance of the leaf after testing for starch?



(Note: Starch positive = grey area) **A**

- 11.** The purpose of the sellotape covering over the hole in the stencil was to
- protect the leaf from excessive light.
 - prevent the part of the leaf under the stencil from drying out.
 - reflect excessive light.
 - ensure an equal air supply to the illuminated and darkened parts of the leaf .
 - prevent too much carbon dioxide from reaching the leaf.
- 12.** After testing for starch, which two parts of the leaf would you have to compare in order to decide whether light is necessary for the leaf to make starch?
- V and W.
 - W and X.
 - V and Y.
 - W and Y.
 - X and Y.
- 13.** After testing for starch, which two parts of the leaf would you have to compare in order to decide whether chlorophyll is necessary for the leaf to make starch?
- V and W.
 - W and X.
 - V and Y.
 - W and Y.
 - X and Y.

14. An 'L'-shaped area was painted on the lower side of a de-starched leaf using clear nail varnish. A few centimetres away from the 'L', a 'U' shape was painted on the upper surface of the same leaf. The leaf was then exposed to bright light for 4 hours and tested for starch. Which of the following diagrams would show the appearance of the leaf? (The leaf is shown from above). **B**



15. If a molecule of carbon dioxide released into the blood in your left foot travels out of your nose, it must pass through all of the following structures except the:

- right atrium.
- pulmonary vein.**
- alveolus.
- bronchus.
- pulmonary artery.

16. Which of the following can children **only** inherit from their mother? A mutation:

- on the X chromosome.
- on the Y chromosome.
- in the mitochondrial genome.**
- in the chloroplast genome.
- in the ribosomal RNA.

17. We often draw upon the idea of similarities between species to support an argument for evolution. Which of the following pairs are analogous structures?
- The front leg of a horse and a human arm.
 - The front leg of a frog and a bat wing.
 - The wing of a bird and a bat wing.
 - The front flipper of a porpoise and a human arm.
 - The wing of a bird and a butterfly wing.

Use the following information to answer questions 18-19

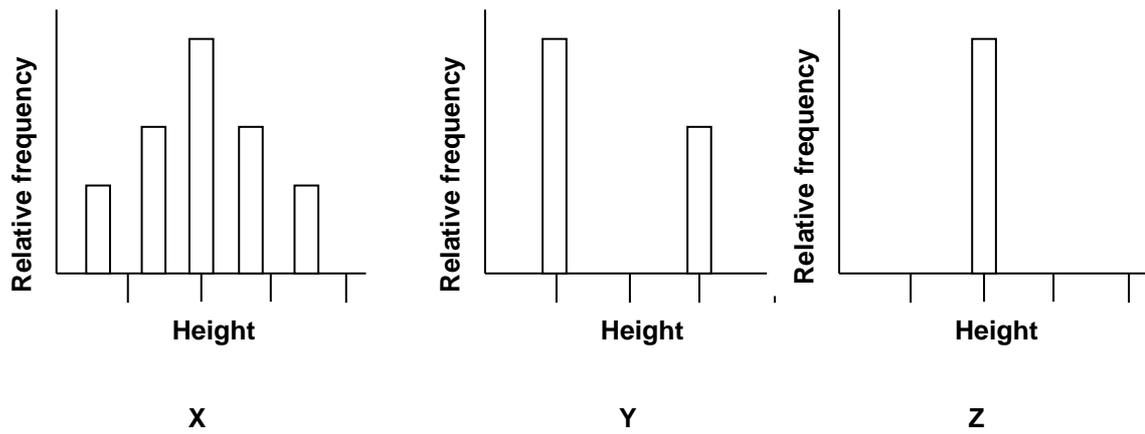
The table below shows the production in two ecosystems in the temperate zone: a rainforest and a field with an annual crop. All results are stated in MJ/m² / year (1 MJ = 10⁶J).

	[I] Rainforest	[II] Field with an annual crop
Gross Primary Production (GPP)	188	102
Respiration (autotrophs)	134	38
Respiration (heterotrophs)	53	3

18. Of these two ecosystems, which has a higher ratio of respiration by heterotrophic organisms to net primary production (NPP)?
- I.
 - II.
 - They are the same.
19. What is the reason?
- The rainforest has larger GPP and more consumers than the crop field.
 - The rainforest has larger NPP and more consumers than the crop field.
 - The rainforest has smaller GPP and more consumers than the crop field.
 - The rainforest has smaller NPP and more consumers than the crop field.
 - The rainforest has smaller NPP and less consumers than the crop field.

20. The energy input into food webs typically depends upon which of the following factors?
- The extent of grazing of the primary consumers.
 - The mineral cycling efficiency of the whole ecosystem.
 - The efficiency of producers converting solar radiation energy into chemical energy.
 - The action of nitrogen-fixing bacteria.
 - The amount of energy lost as heat at each trophic level.
21. A particular flower farm has four rows of flowers. Each row has five pots. The farm produces yellow, red, green and blue flowers. There must be blue flowers in each row to attract bees, and yellow flowers must be in groups of two or more, and there are more pots of red flowers in the middle two rows than in the outer two rows. The farm produces an equal amount of each flower colour. Which cannot be a combination of the middle two rows?
- YYRBB and GGRRB.
 - YYRRB and YYRR.
 - BYYYY and RRRRB.
 - GRRBG and GRRBG.

22. The phenotypes of three experimental populations of plants are shown in the following graphs.

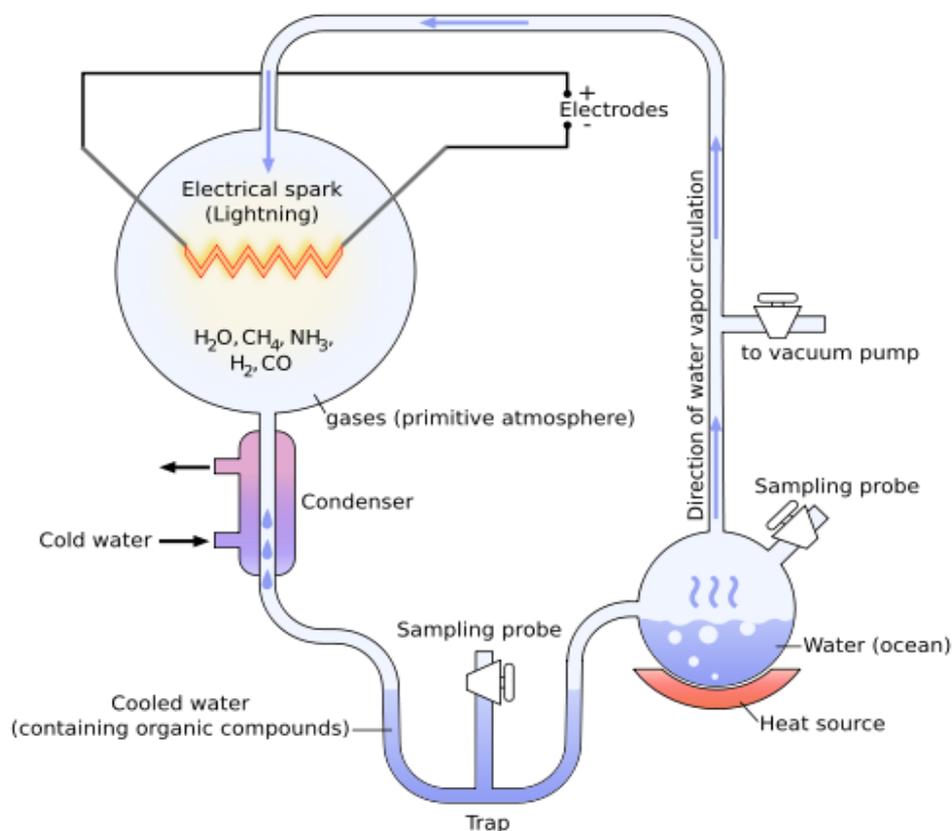


The three populations X, Y and Z represent, respectively, the:

- F_1 , F_2 and F_3 generations.
- P, F_1 and F_2 generations.
- F_2 , P and F_1 generations.**
- F_3 , F_1 and F_2 generations.

Use the following information to answer questions 23-25.

The diagram below shows the Miller-Urey experimental set up to test the Oparin-Haldane hypothesis about the origin of life on earth.



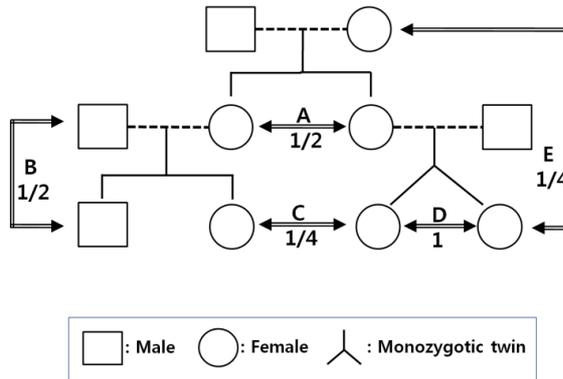
From http://upload.wikimedia.org/wikipedia/commons/thumb/5/54/Miller-Urey_experiment-en.svg/500px-Miller-Urey_experiment-en.svg.png

23. What was the source of energy in this experiment?

- a. Ultraviolet light.
- b. Lightning.
- c. **Electrical spark.**
- d. Radioactivity.

24. Which of the gases in the 'primitive atmosphere' gave rise to amino acids in the cooled water a week after the experiment had started?
- a. Carbon monoxide and methane.
 - b. Carbon monoxide and water.
 - c. Methane and ammonia.
 - d. Hydrogen and ammonia.
25. One of the elements **NOT** present in the original Miller-Urey experiment but thought to be abundant in the early earth's formation is:
- a. Hydrogen.
 - b. Carbon monoxide.
 - c. Nitrogen.
 - d. Sulfur.

26. Coefficient of relatedness' (or 'genetic relatedness') refers to the probability of two related individuals inheriting a particular allele of a single gene from their common ancestor.

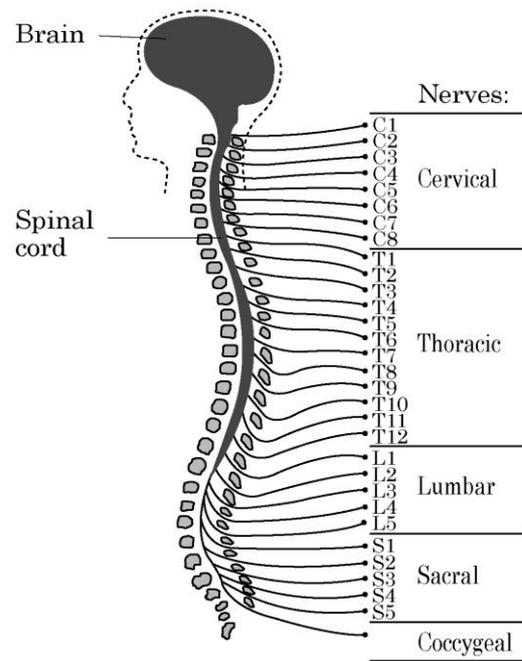


In this family tree of diploid individuals, which of the following 'coefficient of relatedness' is **not** true? Coefficient of relatedness of:

- a. A being $1/2$.
- b. B being $1/2$.
- c. **C being $1/4$.**
- d. D being 1.
- e. E being $1/4$.

Use the following information to answer questions 27-28.

The diagram below depicts the exit of nerves from different areas of the spinal cord.



It is known that:

- sensory information from the skin on the left side of the body ascends through the left side of the spinal cord.
- pain information from the skin on the left side of the body ascends through the right side of the spinal cord.
- motor neurons on the left side of the spinal cord control contraction on the left side of the body.
- the upper limbs are innervated by nerves exiting the spinal cord in the cervical region.

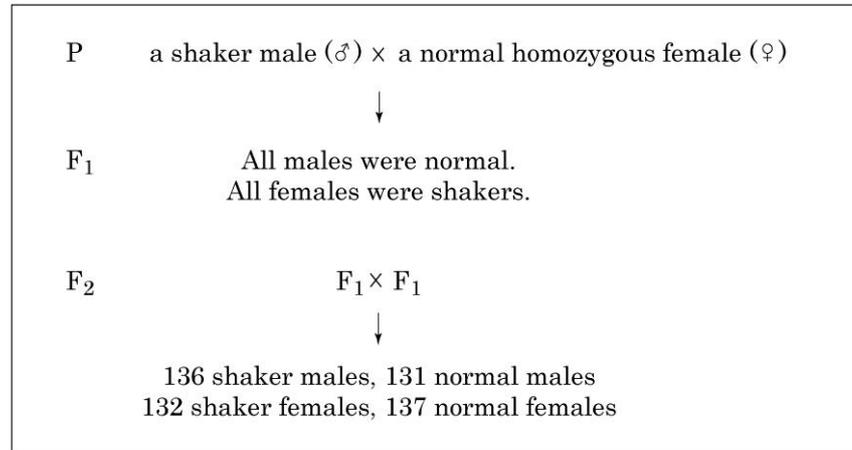
27. From this information, which of the following statements is plausible regarding the motor and/or sensory function of a patient who has injured the left side of the spinal cord at T4?

- a. Abnormal touch sensation in the right foot.
- b. Impaired movement of the right leg.
- c. Normal pain perception in the left leg.
- d. No cutaneous sensation in the left hand
- e. Impaired pain perception in the right arm.

28. A patient that feels no pain when a pin is inserted into their left big toe has damage to:

- a. nerves exiting the spinal cord at C6.
- b. nerves entering the spinal cord C6.
- c. the left side of the spinal cord at T1.
- d. the right side of the spinal cord at T5.
- e. the left side of the spinal cord at S4.

29. Some fruit flies (*Drosophila melanogaster*) have a mutation that makes them shake. These fruit flies are called 'shakers'. An experimental cross to determine the pattern of inheritance of this mutation is shown below:

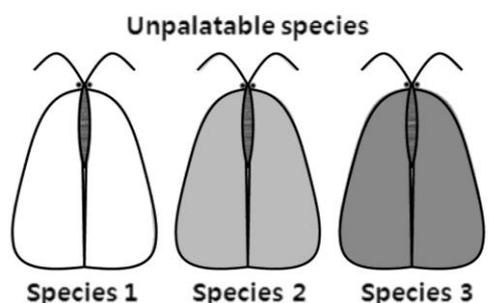


What kind of inheritance best explains the inheritance pattern for the shaker gene?

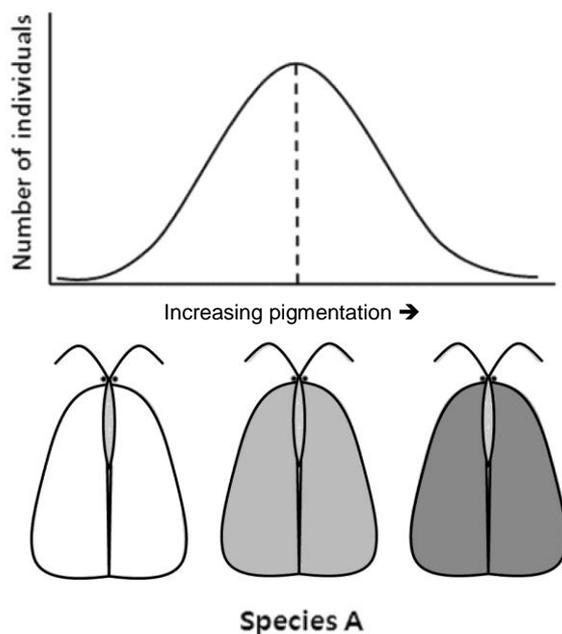
- Somatic dominant.
- Somatic recessive.
- X-linked recessive.
- X-linked dominant.
- Y-linked dominant.

Use the following information to answer question 30 on the following page.

Within a particular ecosystem there are 4 moth species known as Species A, 1, 2 and 3. Moth species A is palatable to predators such as birds. Moth species 1, 2 and 3 (pictured below), are unpalatable to the same predators and after capturing and tasting species 1, 2 and 3, birds learn to avoid eating them.



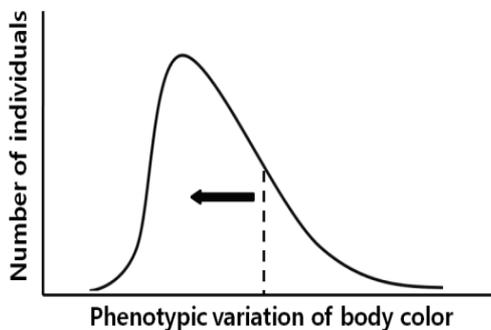
Within species A there is variation in body pigmentation such that lighter individuals resemble species 1, individuals with intermediate pigmentation resemble species 2 and individuals with darker pigmentation resemble species 3. The diagram below depicts the frequency of body pigmentation phenotypes within Species A in this ecosystem.



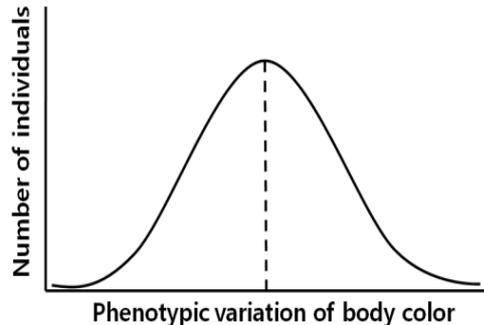
30. If Species 3 was to become the most abundant moth species within this ecosystem which of the following graphs would most accurately represent the resulting frequencies of pigmentation phenotypes in species A? (The dotted line shows the location of the original mean pigmentation).

D

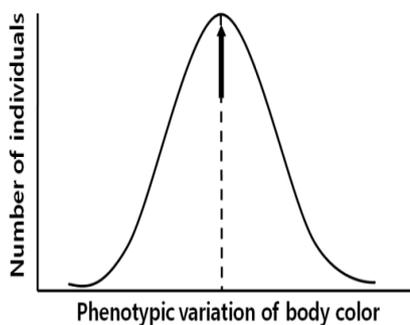
A



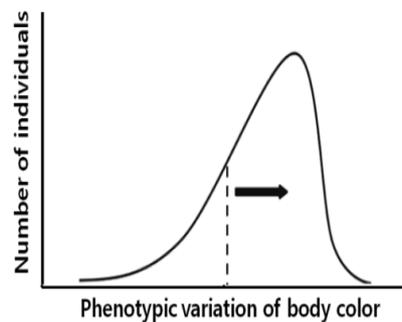
B



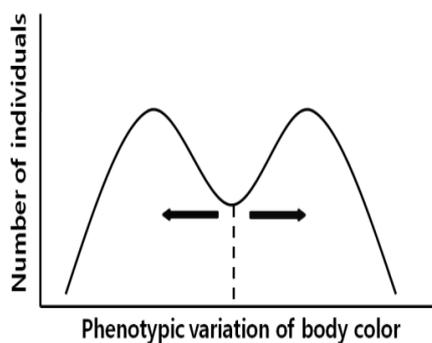
C



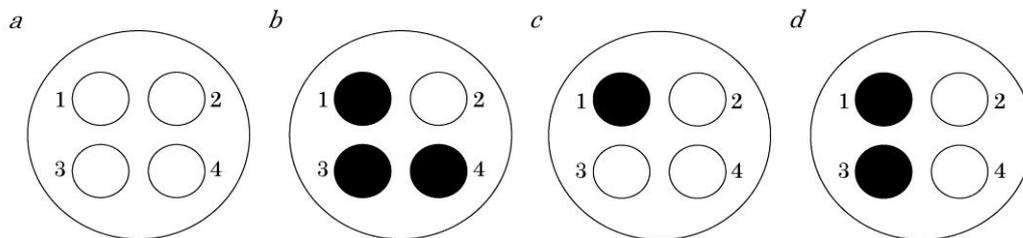
D



E



31. Four mutant strains of bacteria (1-4) all require substance S to grow (each strain is blocked at one step in the S-biosynthesis pathway). Four plates were prepared with minimal medium and a trace of substance S, to allow a small amount of growth of mutant cells. On plate *a*, mutant cells of strain 1 were spread over the entire surface of the agar to form a thin lawn of bacteria. On plate *b*, the lawn was composed of mutant cells of strain 2, and so on. On each plate, cells of each of the four mutant types were inoculated over the lawn, as indicated in the figure by the circles. Dark circles indicate excellent growth. A strain blocked at a later step in the S substance metabolic pathway accumulates intermediates that can ‘feed’ a strain blocked at an earlier step.



What is the order of genes (1-4) in the metabolic pathway for synthesis of substance S?

- a. $2 \rightarrow 4 \rightarrow 3 \rightarrow 1$.
- b. $2 \rightarrow 1 \rightarrow 3 \rightarrow 4$.
- c. $1 \rightarrow 3 \rightarrow 4 \rightarrow 2$.
- d. $1 \rightarrow 2 \rightarrow 4 \rightarrow 3$.
- e. $1 \rightarrow 2 \rightarrow 4 \rightarrow 3$.

Use the following information to answer questions 32-33

In general, arsenic is considered to be very poisonous to living things. In the past, it was used in paints, skin creams, and medicinal treatments for some infections before the advent of penicillin. Arsenic has been associated with many premature deaths including that of Cezanne, an artist who worked with Emerald Green, an arsenic-rich pigment.

In biological systems, arsenic inhibits essential enzymes in the body. A recent paper by Wolfe-Simon in the journal *Science* (December 2010) presented evidence that bacteria from the arsenic-rich Lake Mono could grow *in vitro* in a medium with no phosphorous. It appeared that some bacteria were able to 'replace' phosphorous with arsenic. The scientific world reacted to the publication as it was a controversial finding.

32. In which macromolecules would you expect to see arsenic in these 'arsenic bacteria'?

- a. Carbohydrates.
- b. Lipids.
- c. Proteins.
- d. **DNA.**

33. The scientific world was so surprised to learn about the 'arsenic bacteria' apparently living in Lake Mono because it suggested that:

- a. an environment considered hostile to life due to the presence of poisonous arsenic could support living organisms.
- b. **bacteria incorporated the arsenic into a variety of macromolecules in their cells.**
- c. these bacteria may provide evidence of different life forms originated from outer space.
- d. other life forms that do not depend on phosphorous have evolved on earth.

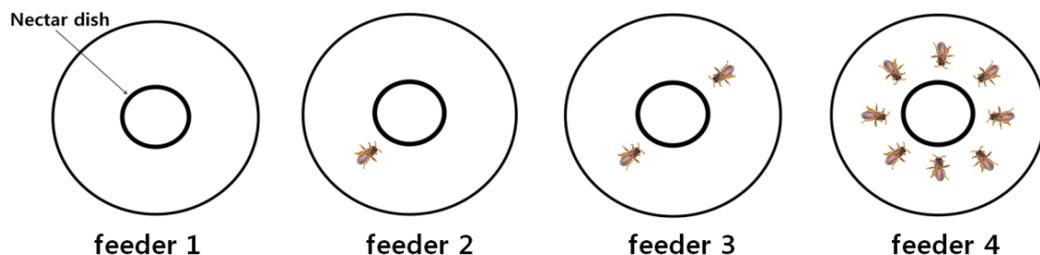
34. In pea plants, the allele for green colour of seeds (G) is dominant over that for yellow colour (g) while the allele for round seeds (R) is dominant over that for wrinkled seed (r). The results of an experimental cross with such garden pea plants are tabulated below:

Seed phenotype	Number
Green and round	32
Green and wrinkled	28
Yellow and round	12
Yellow and wrinkled	9

The parental genotypes are most likely to be:

- $GgRr$ and $Ggrr$.

35. An experiment was designed to test the following hypothesis: “The number of yellow jacket wasps at a feeding site visually affects the feeding-site choices of workers collecting nectar.” Four feeders with zero, one, two or eight individual decoys are prepared, as shown in the figure below. One nectar dish is placed in the middle of each feeder. The feeding-site choice made by each worker is then observed and recorded.



Which of the followings should **not** be included in this experimental design?

- Using the nectar solutions of equal concentration among the feeders.
- Preventing other species from visiting the feeders.
- Preventing successive visits by the same worker.
- Placing the four feeders with nectar dishes randomly and alternatively.
- Using live individuals as decoys.

36. An ecologist is comparing the growth of a herbaceous plant species growing in two different sites; A and B. To compare the populations from the two sites, she has harvested 30 individuals from each site, then measured the root length, root biomass, and shoot biomass of each individual. A summary of those measurements are as follows:

Location	Mean root length (cm)	Mean root biomass (g)	Mean shoot biomass (g)
Site A	27.2 ± 0.2	348.7 ± 0.5	680.7 ± 0.1
Site B	13.4 ± 0.3	322.4 ± 0.6	708.9 ± 0.2

Based on the data presented, which of the following statements is likely to be true?

- Soil water availability is lower in Site B than in Site A.
- Plant productivity is higher in Site A than in Site B.
- Soil water availability is lower in Site A than in Site B.
- Soil nutrient availability is lower in Site B than in Site A.

37. Excessive hairiness, or hypertrichosis, used to be known as the werewolf syndrome. A mild example is hairiness of the ear, inherited as an X-linked dominant trait in humans. If a man with mild hypertrichosis marries a woman without hypertrichosis, what types of children may they have?

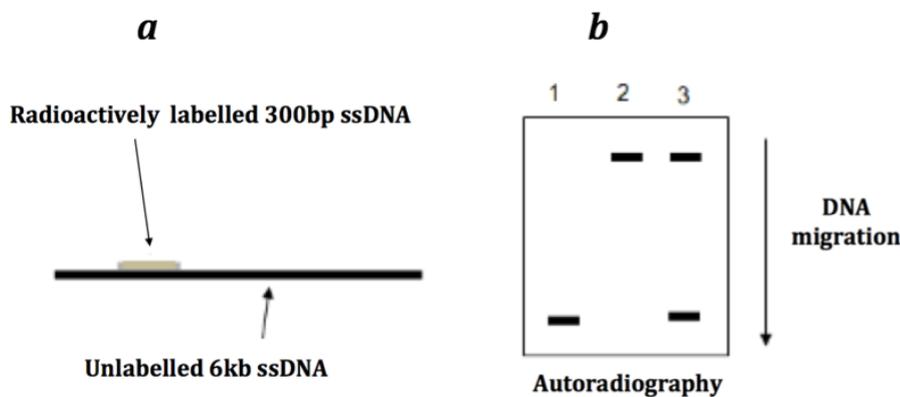
- All of their children of both sexes have hypertrichosis.
- All the sons have hypertrichosis, but none of their daughters.
- Half of their sons, but none of their daughters will have hypertrichosis.
- All the daughters have hypertrichosis, but none of their sons.
- Half of their daughters have hypertrichosis, and half of their sons.

38. DNA helicase, a key enzyme for DNA replication, separates double-stranded DNA into single-stranded DNA. The following describes an experiment to find out the characteristics of this enzyme.

A linear 6 kb ssDNA was annealed with a short (300 bp) complementary ssDNA that is labeled with radioactive nucleotides as shown in *a*. The annealed DNA was then treated in one of three ways:

- with DNA helicase.
- boiling without helicase.
- boiled helicase.

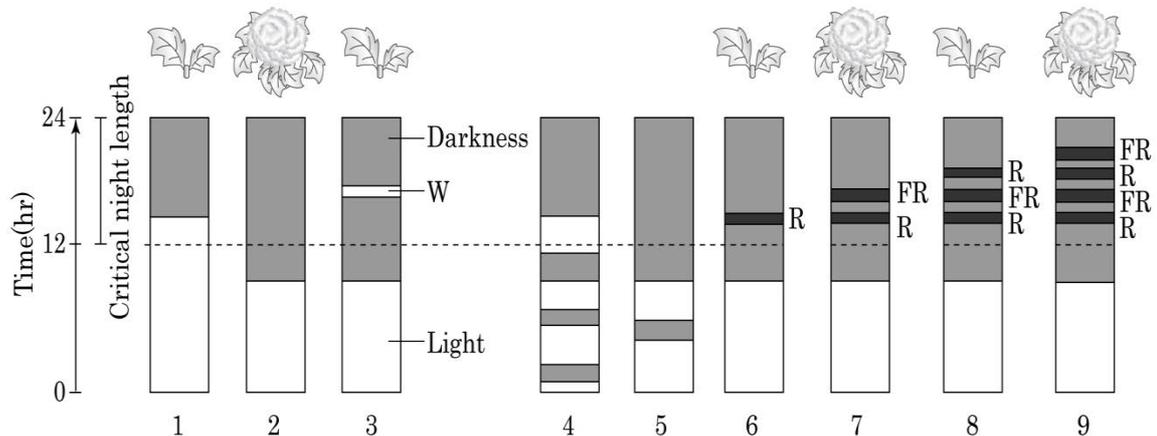
DNA fragments in the treated samples were separated using gel electrophoresis on an agarose gel. (Note: shorter fragments of DNA migrate more rapidly through the gel). The gel in *b* shows the DNA bands that could be detected in the gel by autoradiography. Note: assume that the ATP required for the reaction has been provided.



Which of the following explanation about this experiment is correct?

- a. The band appearing in the top part of the gel is the 6.3 kb ssDNA only.
- b. The band appearing in the lower part of the gel is the labelled 300 bp DNA.
- c. If the annealed DNA is treated only with DNA helicase and the reaction is complete, the band pattern looks like the lane 3 in *b*.
- d. If the annealed DNA is treated only with DNA helicase and the reaction is complete, the band pattern looks like the lane 2 in *b*.
- e. If the annealed DNA is treated only with boiled helicase, the band pattern will look like lane 1 in *b*.

39. Plants are known to have a day / night cycle, called photoperiodism. One of the plant photoreceptors involved in photoperiodism is phytochrome. This exists in two different forms: red-light absorbing P_r and far-red light absorbing P_{fr} . An investigation explored how plant flowering was affected by different light flashes [white (W), red (R), or far-red (FR) light] applied during the dark period. It also looked at the affect of darkness during the light-period. The figure below shows the experimental results for all scenarios tested except 4 and 5.



Based on these results, select the most accurate explanation (or expectation) for the control of flowering in this plant. This plant:

- flowers whenever the total dark time experiences within 24 hours exceeds a 12 hr threshold.
- is likely to be a short-day plant that requires a certain length of uninterrupted light period for flowering.
- will flower in experiment 3 if it is irradiated with a flash of far-red light, instead of white.
- will flower in experiment 4.
- will not flower in experiment 5.

Use the following information to answer questions 40 - 43.

The table below shows the data on breathing rate, heart rate and body temperature, of four different mammals; A, B, C, and D.

Animals	Breathing rate (inhalations/min)	Heart rate (beats/min)	Body temperature (°C)
A.	160	500	36.5
B.	15	40	37.2
C.	28	190	38.2
D.	8	28	35.9

Study the data and determine which of these animals has the greatest and lowest surface area per unit volume as well as the total volume of blood. Indicate your conclusions by filling in the boxes in the answer sheet with appropriate letters (A to D).

40. Which animal has the highest surface area to volume ratio? **A**

41. Which animal has the lowest surface area to volume ratio? **D**

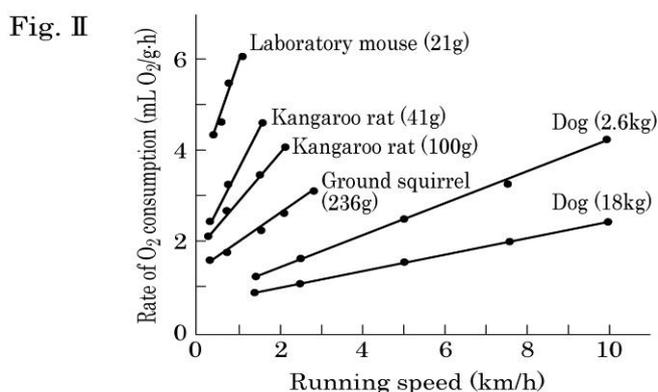
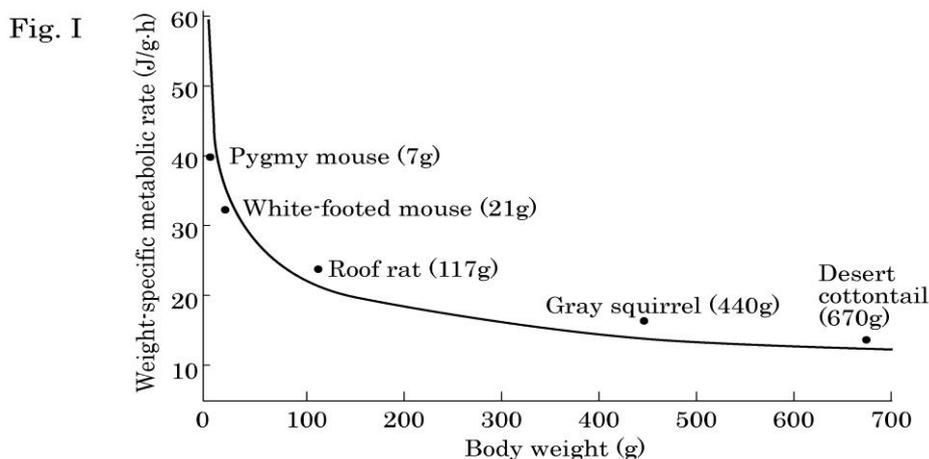
42. Which animal has the greatest volume of blood in the body? **D**

43. Which animal has the lowest volume of blood in the body? **A**

SECTION B
USE THE ANSWER SHEET PROVIDED

Use the following information to answer questions 44 - 46.

Figure I shows the relationship between weight and the specific metabolic rate of the indicated animal species, and Figure II shows the oxygen (O₂) consumption rate of the indicated species as a function of running speed (on a treadmill machine).



Read each of the following explanations, and indicate whether the explanation is true (T) or false (F) and mark the answer book.

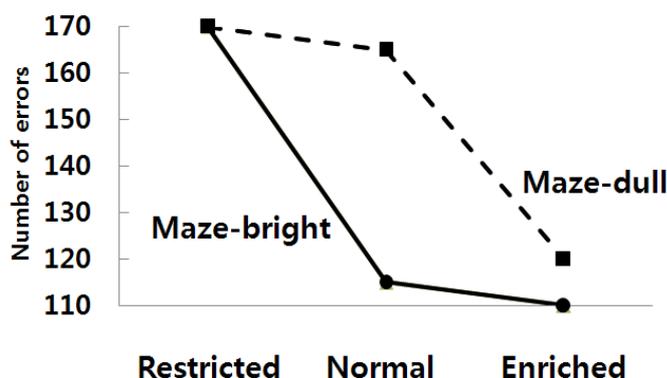
44. At rest, smaller animals consume more energy per unit of body weight than the larger animals. **T**
45. Using the same amount of food per unit body weight, a smaller animal can travel a longer distance than a larger animal. **F**
46. Using the same amount of food, larger animals generate more ATP than smaller animals. **T**

Use the following information to answer questions 47 – 50.

Over a number of generations, two strains of rats were selected in a normal environment for their increased or decreased maze-learning ability: ‘maze-bright’ rats versus ‘maze-dull’ rats.

For the experimental test, rats from each strain were reared in three environments that differed in the amount of visual stimuli present: restricted, normal, and enriched.

The graph below shows the behavioural performance of adults in terms of the number of errors committed in running a maze for the maze-bright and maze-dull rats.

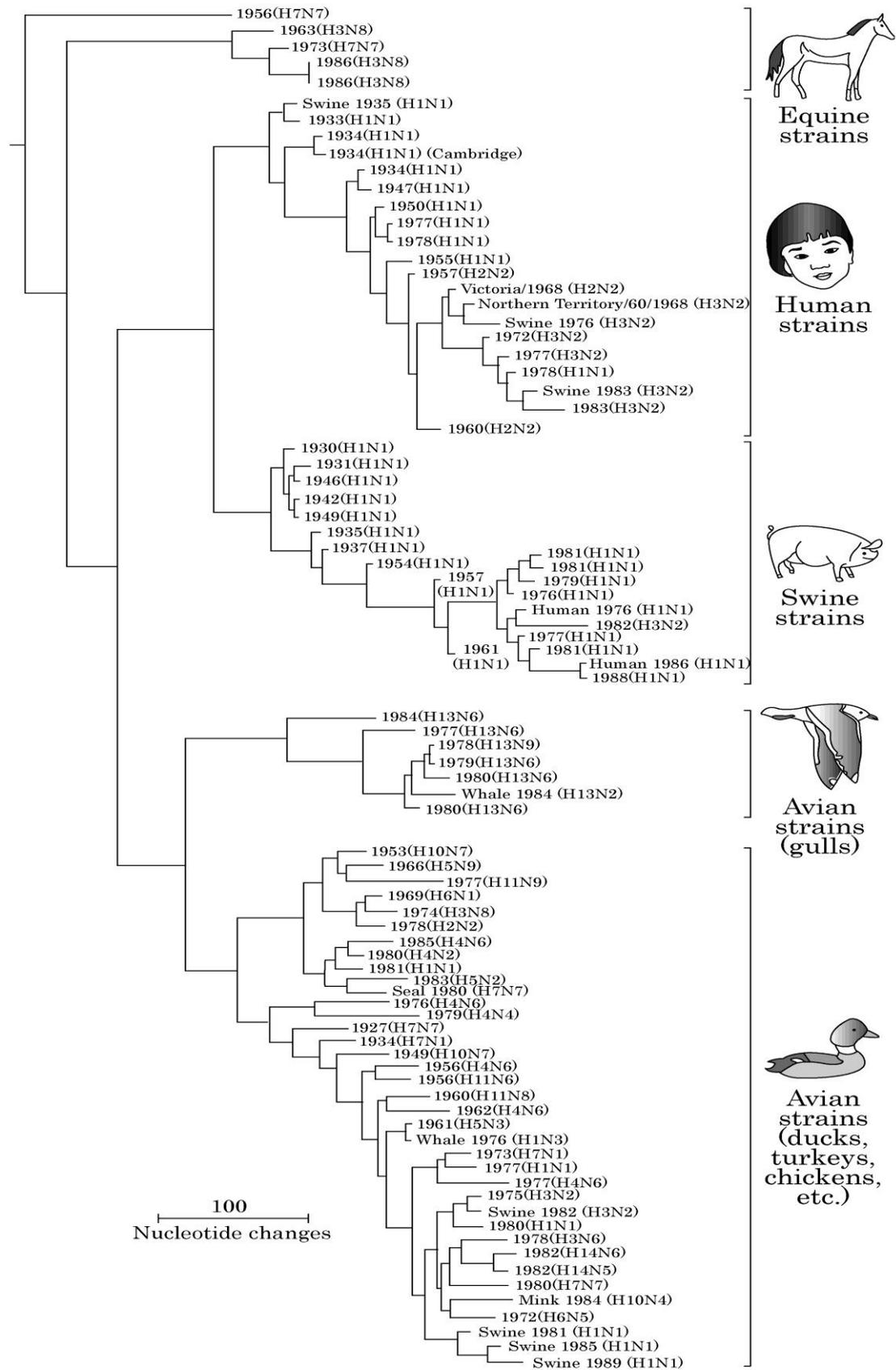


Decide whether each of the conclusions below is true (T) or false (F) and mark the answer book.

- 47. This experiment proves that selection for a behavioural trait leads to genetic differences between strains. **F**
- 48. If the two strains of rats are raised in a normal environment, the two strains make a similar number of errors. **F**
- 49. This experiment shows that exposure to visual cues during early development influences behavioural performance in adult rats. **T**
- 50. The threshold amount of visual stimuli that markedly improves adult behavioural performance is different for maze-dull and maze-bright rats. **T**

Use the following information to answer questions 51 – 54.

The phylogeny of influenza viruses



A virus contains DNA or RNA surrounded by a protein coat. The Influenza A virus is responsible for annual influenza (flu) epidemics and for occasional flu pandemics.

- Influenza A is composed of eight RNA strands that code for 11 proteins.
- Influenza A strains can be classified based on the combination of two coat proteins, Hemagglutinin (H1 - H13) and Neuraminidase (N1 - N9).
- In this way, various flu types such as H1N1, H3N1, H7N2 etc., can be recognized, described and their spread monitored across the world in humans and other animals.
- The different strains of the virus can be classified by the host animal (for example, avian or bird flu).
- The figure on page 28 represents the phylogeny of flu viruses based on the nucleoprotein gene of the flu virus genome. For each viral strain, the phylogeny shows the host species from which it was isolated, the year, and the type of Hemagglutinin and Neuraminidase it carries.

Indicate whether the following statements are true (T) or false (F) and mark the answer book.

- 51.** The avian flu virus consists of the most diverse types, and some avian flu types also are found in some mammalian species such as whales and dolphins. Therefore, the avian flu virus represents the most archaic type of flu virus. **F**
- 52.** The phylogenetic tree suggests that the host shift and genetic recombination of flu virus have occurred between birds and pigs. **T**
- 53.** The virulence of virus can be changed rapidly by host shifts and mutations. Therefore, vaccine developments are relatively difficult compared to other common diseases. **T**
- 54.** Swine flu strains are phylogenetically more closely related to the human flu strains than to other strains. **T**

Use the following information to answer questions 55 – 58.

While studying the frogs of a certain species in their natural habitat during the mating season, you observe a chorus of male frogs in which some individuals are calling while others remain silent. On further observation, you see the silent frogs always sit close to those that are calling, whereas calling frogs show no preference.

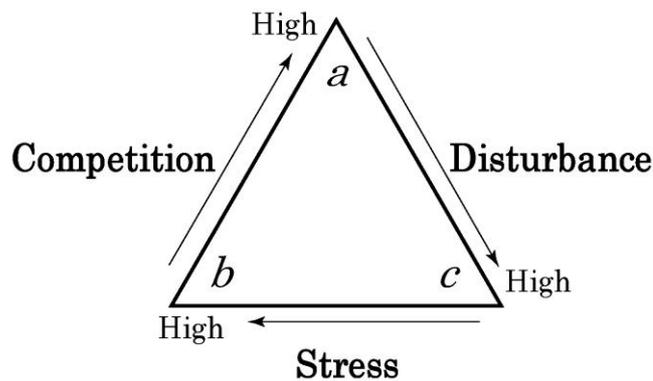
To explain this observation about the frog behaviour determine whether each of the following statements are true (T) or false (F) and mark the answer book.

- 55.** The individuals who are not calling are staggering their calls with the calling frogs and are likely to call later in the season after the latter have finished mating. **F**
- 56.** The silent frogs are close genetic relatives of the calling individuals and do not expend valuable energy in calling as the matings that the latter will receive would provide adequate indirect fitness to them. **F**
- 57.** The silent frogs have determined that their calls are inadequate in attracting females, as compared to those of the calling individuals, and lie in wait to sneak matings with the females that approach the calling males. **T**
- 58.** The silent frogs do not expend energy calling as the female frogs that are attracted to the calls of the calling males are likely to visually inspect the closely-spaced males and then choose their mating partners. **F**

Use the following information to answer questions 59 – 61.

The figure below depicts life-history strategies for three plant species (*a-c*) along 3 axes: strength of competition with other organisms, level of disturbance in the habitat, and level of environmental stress in the habitat.

- Species *a* grows in habitats where competition among species is high but disturbance and stress are low.
- Species *b* grows in habitats with high environmental stress but with low interspecies competition.
- Species *c* grows in highly disturbed habitats with low environmental stress.

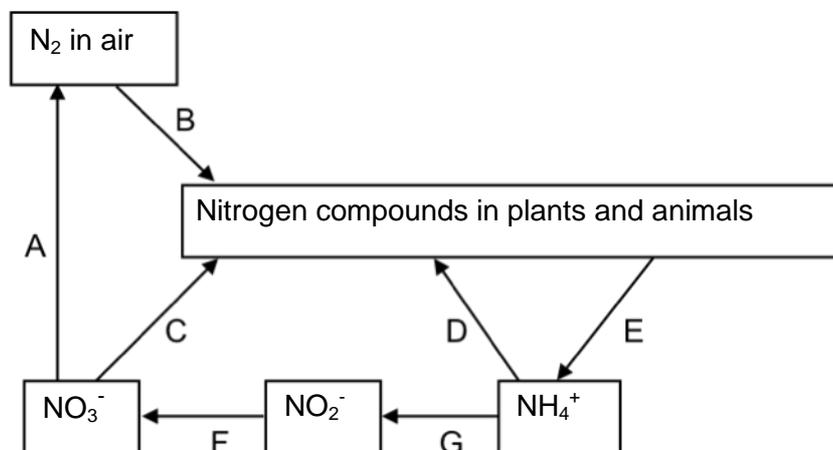


Determine whether each of the statements below are true (T) or false (F) and mark the answer book.

59. Characteristics of ‘*a*-type’ plants are slow growth rate and short-lived leaves. **F**
60. Desert annual plants are ‘*b*-type’ species. They have rapid growth and produce large amounts of seeds in a short time after rains. **T**
61. Most plants belonging to ‘*c*-type’ species would be herbaceous while ‘*a*-type’ and ‘*b*-types’ species are likely to be trees or shrubs. **T**

Use the following information to answer questions 62 – 64.

The following diagram shows the cycle of nitrogen compounds in an ecosystem. The processes A to G represent conversions of one form of nitrogen into another.



62. Bacteria are involved in many processes (A to G) in the nitrogen cycle. In which of the processes do bacteria NOT participate? Choose TWO from A to G. **C, D**
63. Which of the processes may include a symbiotic relationship between a species of plant and a species of bacterium? **B**
64. Which of the processes do farmers want to inhibit in agricultural land? **A**

Use the following information to answer question 65.

The following table shows the net primary productivity and biomass without soil organic matter in five ecosystems.

Ecosystem	Net primary productivity (g/m ² /year)	Biomass (kg/m ²)
Tropical rainforest	2200	45
I	2000	15
II	1200	30
III	900	4
Boreal forest	800	20

65. Choose from A to F in the table below the most appropriate combination of ecosystems for I, II and III above. **F**

	I	II	III
A.	African dry savanna	Tropical swamp & marsh	Temperate deciduous forest
B.	African dry savanna	Temperate deciduous forest	Tropical swamp & marsh
C.	Temperate deciduous forest	African dry savanna	Tropical swamp & marsh
D.	Temperate deciduous forest	Tropical swamp & marsh	African dry savanna
E.	Tropical swamp & marsh	African dry savanna	Temperate deciduous forest
F.	Tropical swamp & marsh	Temperate deciduous forest	African dry savanna

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For a brief overview of this story, see also NASA Science News, at:

<http://science.nasa.gov/science-news/science-at-nasa/>

Figure of the Miller-Urey experiment, freely available at Wikipedia:

http://upload.wikimedia.org/wikipedia/commons/thumb/5/54/Miller-Urey_experiment-en.svg/500px-Miller-Urey_experiment-en.svg.png

Questions have been drawn from many sources, adapted, and developed by staff. One of the questions was adapted from the UMAT website at <http://www.nie.edu.au/umatSampleQs.html>

Integrity of Competition

If there is evidence of collusion or other academic dishonesty, students will be disqualified. Markers' decisions are final