



Secondary School Mathematics & Science Competition

Biology

Date : 17th May, 2013 (Friday) Total no. of pages : 24
Time allowed : 9:00 - 10:15 am (1hour 15 minutes) Total marks : 70

Instructions:

1. Write your Name, School Name, Form, Date and Candidate Number in the spaces provided on the M.C. and Section B Structured Questions Answer Sheet and fill the appropriate boxes.
2. When told to open this book, you should check that all the questions are there. Look for the words '**END OF PAPER**' after the last question.
3. **ANSWER ALL QUESTIONS.**
4. Diagrams in this paper are **NOT** necessarily drawn to scale.
5. There are **TWO** sections, A and B in this Paper. Section A consists of multiple choice questions. Section B contains structured questions.

Section A (Multiple Choice Questions)

- (a) You should use an HB pencil to mark all your answers on the M.C. Answer Sheet.
- (b) Each question carries one mark.
- (c) You should mark only **ONE** answer for each question. If you mark more than one answer, you will receive NO MARKS for that question.
- (d) No marks will be deducted for wrong answers.

Section B (Structured Questions)

- (a) Answers should be written in the space provided on the Section B Answer Sheet.

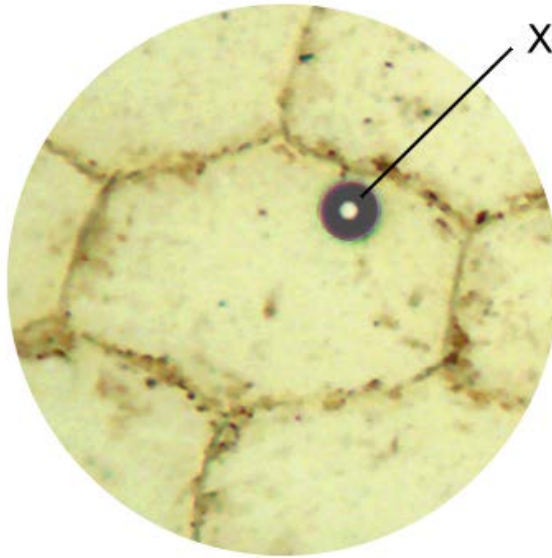
Section A : Multiple Choice Questions (55 marks)

1. Which of the followings are the derivatives of fat?
 - (1) Phospholipid
 - (2) Steroid
 - (3) Cholesterol
 - A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)

2. The monomers of DNA and RNA are
 - A. Glucose
 - B. Amino acids
 - C. Triglycerides
 - D. Nucleotides

3. Which of the following levels of organization about living things and their environment in ascending order is correct?
 - A. Atom, DNA, molecule, organelle, system, cell, organism, species, community, population, ecosystem, ecosphere
 - B. Atom, cell, molecule, tissue, organ, system, organism, species, population, community, ecosphere, biome
 - C. Atom, molecule, cell, tissue, organ, system, organism, species, population, community, ecosystem, ecosphere
 - D. Atom, compound, molecule, cell, tissue, organ, species, organisms, population, community, ecosystem, ecosphere

4. A temporary mount of onion epidermal cells is prepared freshly and observed under the light microscope. A photomicrograph is captured and shown below:

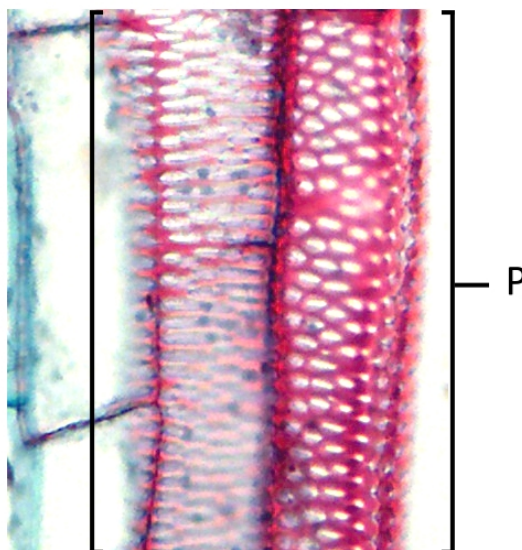


Onion epidermal cells (x200)

Structure X is

- A. a nucleus.
- B. a starch grain.
- C. a vacuole.
- D. an air bubble.

Directions: Questions 5 and 6 refer to the diagram below, which shows a structure P found in the longitudinal section of a dicotyledonous stem:



5. Which of the following are functions of structure P?

- (1) transport of water
- (2) transport of minerals
- (3) give support to the plant

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

6. Which of the following is derived from structure P over a period of time?

- A. Cork.
- B. Wood.
- C. Fruits.
- D. Aerial roots.

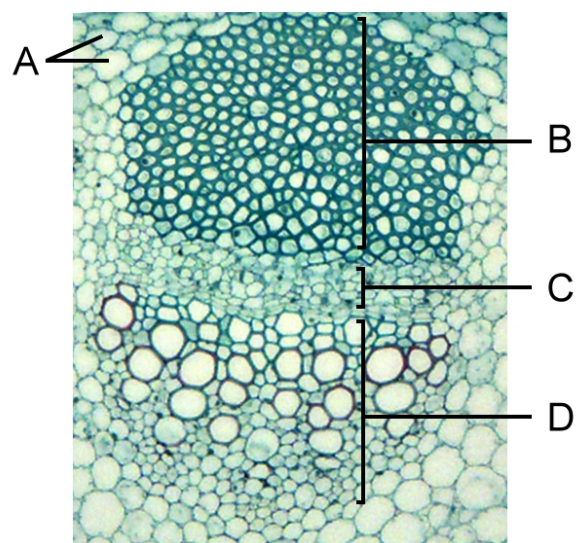
7. Diagram I shows an aphid which feeds on phloem sap of plant by inserting a tubular structure into the sieve element of a stem. Diagram II shows a cross section of a vascular bundle of the dicotyledonous stem.

Diagram I



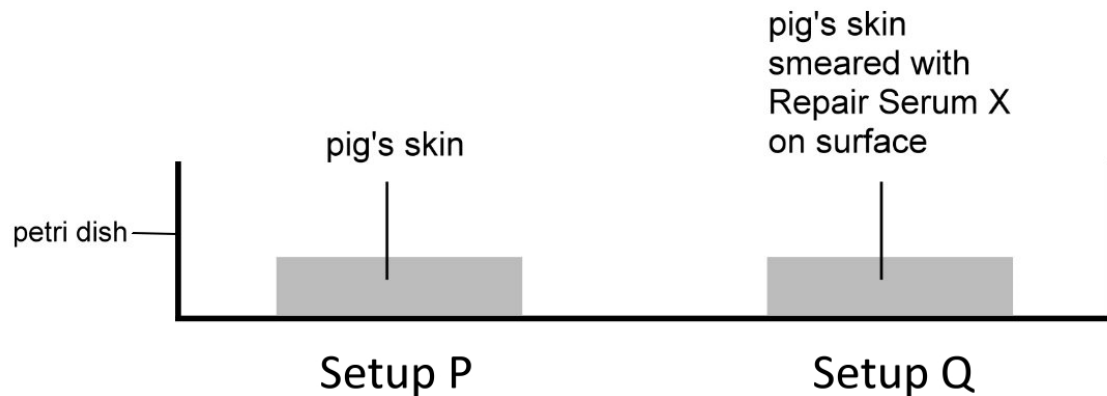
Source: Shipher Wu (photograph) and Gee-way Lin (aphid provision), National Taiwan University

Diagram II



Which part of the vascular bundle in **Diagram II** is the site where the aphid obtains the sap?

Directions: Questions 8 and 9 refer to the following situation: Mary noticed a cosmetic advertising statement '*Repair Serum X can protect the skin from wrinkle development*' and she doubted it. Then she carried out a scientific investigation which aimed to study if the advertising statement is correct or not. She made a hypothesis that 'Repair Serum X can prevent wrinkle development on skin', followed by constructing the following setup P and Q:

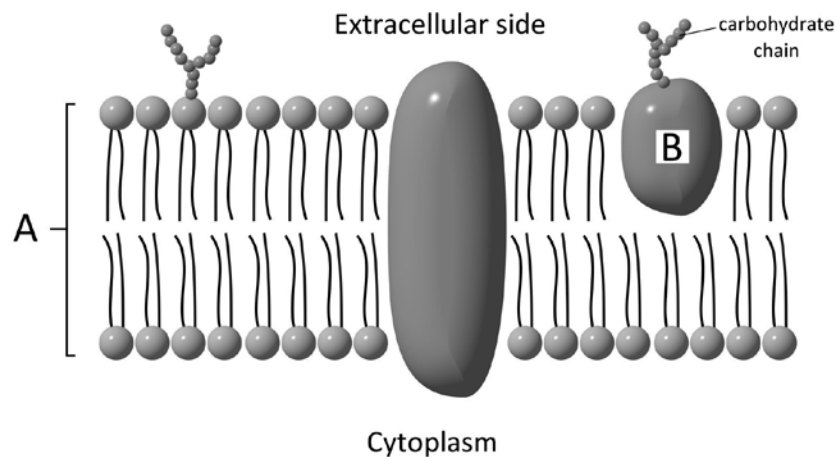


8. Assuming that all control variables are the same, what is the dependent variable and which setup is the control in the investigation?

	<u>Dependent variable</u>	<u>Control setup</u>
A.	Pig's skin smeared with Repair Serum X or not	P
B.	Pig's skin smeared with Repair Serum X or not	Q
C.	Wrinkles appear or not	P
D.	Wrinkles appear or not	Q

9. If wrinkle does **not** appear on both skins in setup P and Q, what conclusion can be made?
- A. Repair Serum X can prevent wrinkle development on skin.
 - B. Repair Serum X is not needed for the prevention of wrinkle development on skin.
 - C. The hypothesis that 'Repair Serum X can prevent wrinkle development on skin' is supported.
 - D. No conclusion can be made.

Directions: Questions 10 and 11 refer to the diagram below, which shows a fluid-mosaic model of cell membrane:



10. Which of the following is **not** a property of A?

- A. The tail region is non-polar.
- B. It allows ions (such as sodium ions) to diffuse across it directly.
- C. It is differentially permeable.
- D. The phospholipid molecules can move laterally.

11. The carbohydrate chain on B can

- A. catalyze metabolic reaction.
- B. maintain the structural integrity of the cell.
- C. be an antigen recognized by white blood cells.
- D. provide energy for active transport.

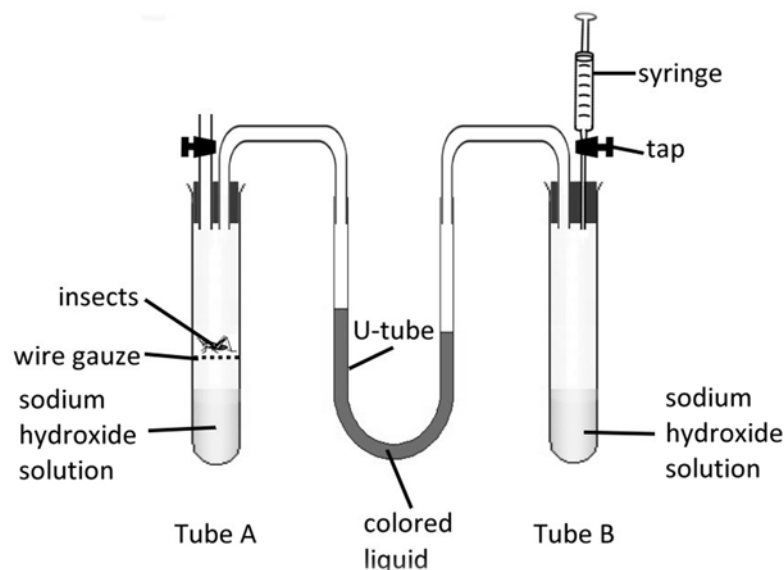
12. Which of the following factors would affect the fluidity of membrane?

- (1) Temperature
 - (2) Percentage of saturated and unsaturated tails of phospholipid molecules
 - (3) Amount of cholesterol present in the phospholipid tail region
- A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)

13. Which of the following statements about the photochemical reactions of photosynthesis is correct?

- A. Water is split and oxygen is released.
- B. $\text{NADH} + \text{H}^+$ are produced and carried to the Calvin cycle.
- C. An ATP is used to drive the reactions.
- D. No enzyme is involved during the reactions.

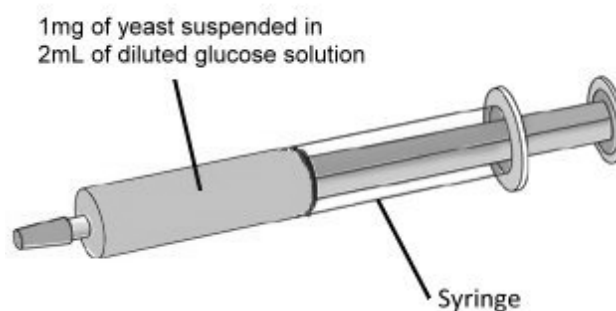
14. A respirometer is set up as shown below:



The syringe is used to equalize the level of colored liquid in both arms of the U-tube after the experiment. The volume change of the syringe directly represents

- A. the temperature change of the environment.
- B. the respiration rate of the insects.
- C. the volume of oxygen uptake by the insects.
- D. the volume of carbon dioxide released by the insects.

15. A student constructed the following experimental setup with an aim to find out the rate of anaerobic respiration of yeast:

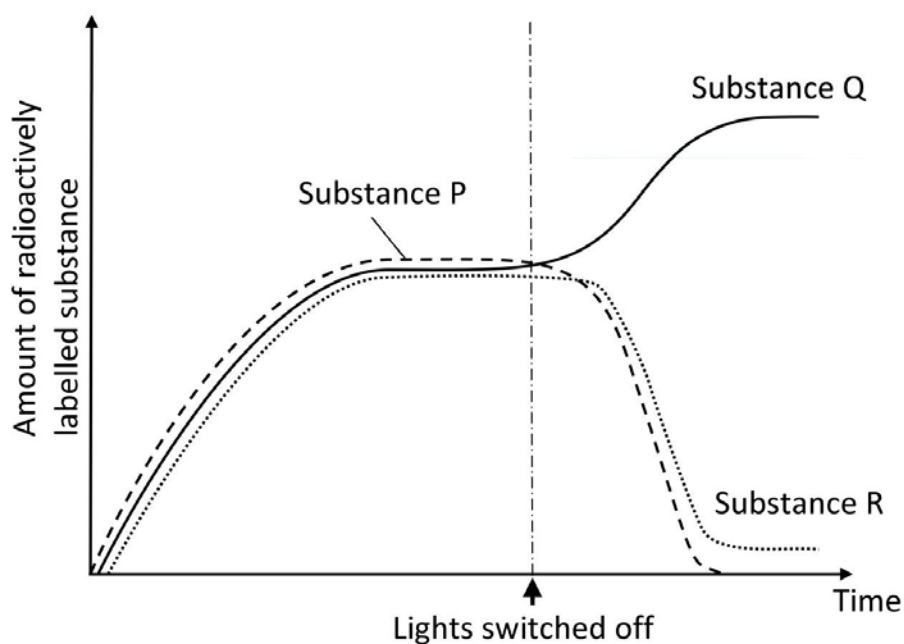


Which of the following precautions should be taken?

- (1) To ensure the setup is air-tight so that there is no leakage of gas.
- (2) A syringe with a large diameter should be used.
- (3) The glucose solution should be boiled first and then cooled down before adding yeast to it.

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

16. A student carried out the following experiment: he immersed the hydrilla (pondweed) in a beaker of water with dissolved sodium hydrogen carbonate (in which all carbon atoms are radioactive labeled as ^{14}C). After being illuminated for a period, the light was then switched off. The graph below shows the relative amount of different substances ($\text{NADPH}+\text{H}^+$, GP (3-C compound) and RuBP (5-C compound)) during the course of experiment:



Identify substances P, Q and R.

	<u>Substance P</u>	<u>Substance Q</u>	<u>Substance R</u>
A.	$\text{NADPH}+\text{H}^+$	RuBP	GP
B.	$\text{NADPH}+\text{H}^+$	GP	RuBP
C.	RuBP	$\text{NADPH}+\text{H}^+$	GP
D.	GP	$\text{NADPH}+\text{H}^+$	RuBP

17. Which of the following roles of pigments in plants and animals are correct?

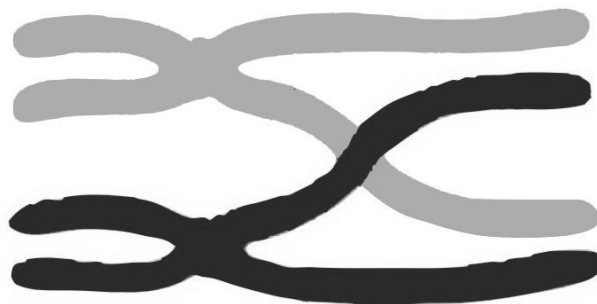
- (1) Melanin of mammals absorbs ultraviolet light and promotes formation of vitamin D.
- (2) Chlorophyll in the chloroplast of green plants absorbs light in photosynthesis. Light energy is eventually converted into chemical energy which is stored in the form of ATP and $\text{NADPH} + \text{H}^+$.
- (3) Phytochrome is the plant pigment responsible for the photoperiodic control of flowering.

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

18. Which of the following cell types has the shortest cell cycle?

- A. Nerve cells
- B. Liver cells
- C. Skin cells
- D. Bone cells

19. The following diagram shows a process called 'crossing-over'. It involves the exchange of genetic materials between a pair of homologous chromosomes:



Which stage of the meiotic cell division does 'crossing-over' take place?

- A. Prophase I
- B. Anaphase I
- C. Prophase II
- D. Metaphase II

20. If a DNA segment contains 35 % of adenine as nitrogenous bases, the percentage of cytosine in the same segment is

- A. 15%.
- B. 35%.
- C. 65%.
- D. 70%.

21. Which of the following processes involve complementary base pairing?

- (1) Cytokinesis
- (2) Protein Synthesis
- (3) Polymerase Chain Reaction (PCR)

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

22. Color blindness is an X-linked genetics disease. In a family, a mother and her son are color-blind, whereas the father has normal vision. The mother is pregnant again and she bears a female fetus. What is the probability that this female fetus is color-blind?

- A. 0%
- B. 25%
- C. 50%
- D. 100%

23. Which of the following should be the same in identical twins?

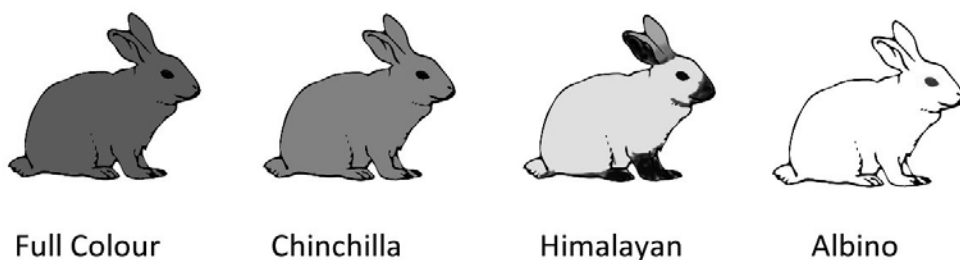
- (1) Blood group
- (2) Fingerprints
- (3) Eye color

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

24. If the blood type of a couple are B and AB, which of the following blood type is **not** possible to present in their children?

- A. Blood type A
- B. Blood type B
- C. Blood type AB
- D. Blood type O

25. The coat color of rabbits is controlled by multiple alleles. The order of dominance is C (full color) $> c^{ch}$ (chinchilla) $> c^h$ (himalayan) $> c^a$ (albino). The four types of coat color are shown below:



Predict the results of F_2 in the following cross:

<u>Phenotypes of parents</u>			<u>Phenotypes of F_1</u>			<u>Phenotypes of F_2</u>
Albino	x	chinchilla	→	Albino		
				x	→	?
Full color	x	albino	→	Full color		

- A. 100% full color.
- B. 50% full color and 50% chinchilla.
- C. 50% full color and 50% albino.
- D. 50% chinchilla and 50% albino.

26. Fungi reproduce

- A. both sexually and asexually.
- B. asexually only.
- C. sexually only.
- D. by spore formation only.

27. Which of the following is **not** a flowering plant?

- A. Pine
- B. Cactus
- C. Potato
- D. Grass

28. Comparative anatomy is one of the major sources of evidence for evolution of organisms. Consider the following pentadactyl limbs of different animals:



Limb of bat for flying



Pectoral fin of dolphin
for swimming



Limb of monkey for
grasping



Limb of mole for digging

They are collectively known as

- A. analogous structures.
- B. homologous structures.
- C. vestigial structures.
- D. living fossils.

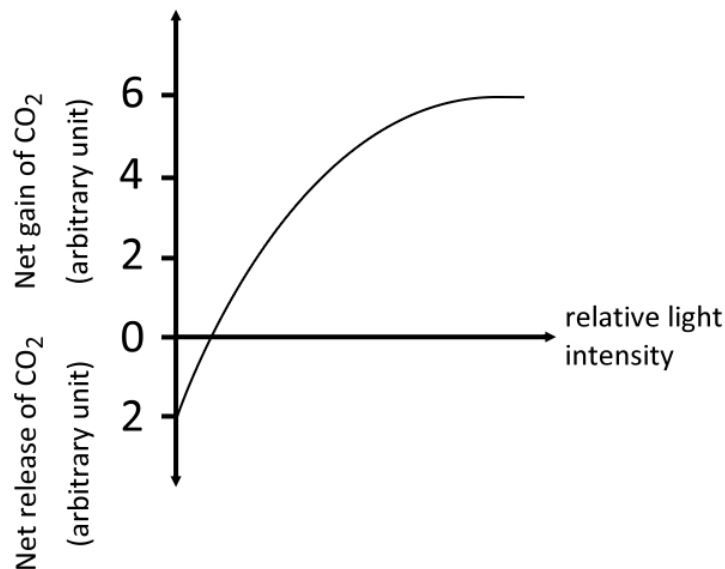
29. Selection pressure acts on organisms and produces changes in the relative frequencies of alleles in 'gene pool'. The table below shows the three types of selection pressure and their actions on population.

Type of selection pressure	Action on population
Stabilizing selection	favors individuals with intermediate characteristics
Disruptive selection	favors individuals with extreme characteristics
Directional selection	favors individuals with one extreme phenotype over the mean or other extreme

According to the above information, the emergence of antibiotic resistance bacteria is an example of

- A. stabilizing selection.
- B. disruptive selection.
- C. directional selection.
- D. disruptive and directional selection.

30. The following figure shows the uptake and release of carbon dioxide of a leafy shoot under different light intensities.



What is the maximum photosynthetic rate of the leafy shoot?

- A. 2 units.
- B. 4 units.
- C. 6 units.
- D. 8 units.

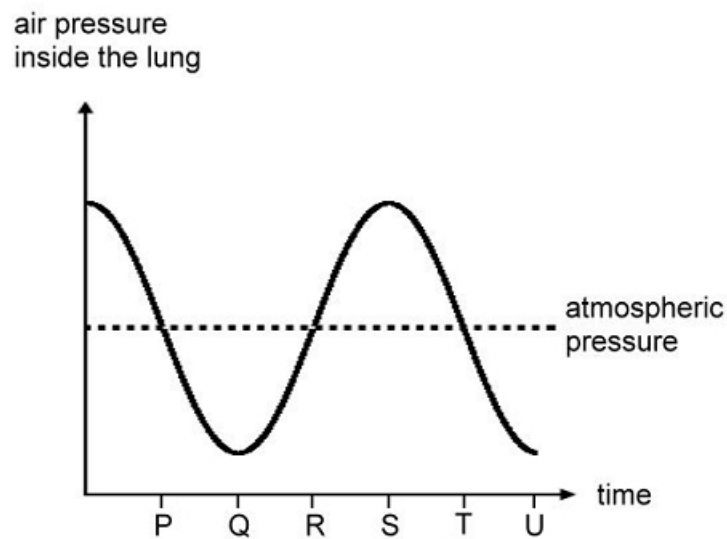
31. Where does the chemical digestion of nucleic acids in food take place in the human alimentary canal?

- A. Mouth cavity
- B. Stomach
- C. Small intestine
- D. Large intestine

32. Which of the following processes does not occur in the liver?

- A. Formation of glycogen from glucose.
- B. Digestion of starch to glucose.
- C. Deamination.
- D. Conversion of alcohol to acetaldehyde.

33. The following diagram shows the change of air pressure inside the lung at different time intervals.



What are the states of intercostal muscles and diaphragm at Q?

	<u>State of intercostal muscles</u>	<u>State of diaphragm</u>
A.	contract	flattened
B.	contract	dome-shaped
C.	relax	flattened
D.	relax	dome-shaped

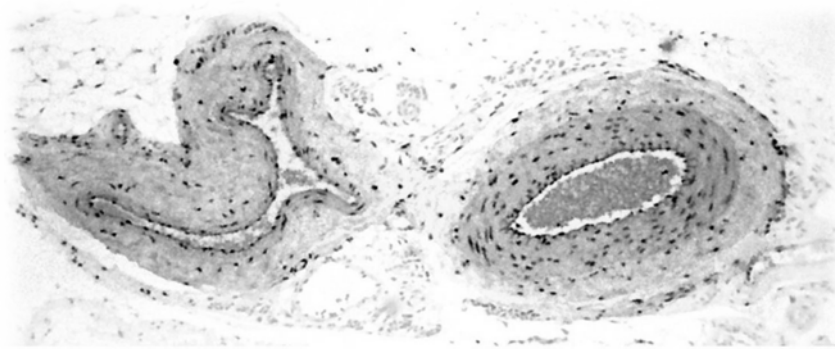
34. The table below shows two physical characteristics of three types of blood vessels:

	Vessel P	Vessel Q	Vessel R
Total cross-sectional area (cm ²)	2.5	2500.0	8.0
Internal pressure (mmHg)	100	30	10

Identify blood vessel P, Q and R.

	<u>Vessel P</u>	<u>Vessel Q</u>	<u>Vessel R</u>
A.	Aorta	Capillaries	Venae cavae
B.	Aorta	Venae cavae	Capillaries
C.	Capillaries	Aorta	Venae cavae
D.	Venae cavae	Capillaries	Aorta

35. The following diagram shows the cross-section of two types of blood vessel, X and Y.



Vessel X

Vessel Y

Vessel Y carries deoxygenated blood, which of the following could be vessel Y?

- (1) pulmonary artery
- (2) pulmonary vein
- (3) umbilical artery

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

36. Which of the following is **not** the second sexual characteristic in human female?

- A. Growth of pubic hairs
- B. Production of ovum
- C. Widening of hips
- D. Enlargement of breasts

37. Which of the following hormones does pregnancy test kit usually test for?

- A. Estrogen
- B. Prolactin
- C. Progesterone
- D. Human Chorionic Gonadotropin

38. Which of the following is the most reliable contraceptive method?

- A. safe period
- B. condom
- C. contraceptive pill
- D. intrauterine device

39. The grey matter of the spinal cord consists of

- (1) interneurons
- (2) cell bodies and dendrites of motor neurons
- (3) axon terminal of the sensory neurons

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

40. Which of the following is **not** the function of cerebellum?

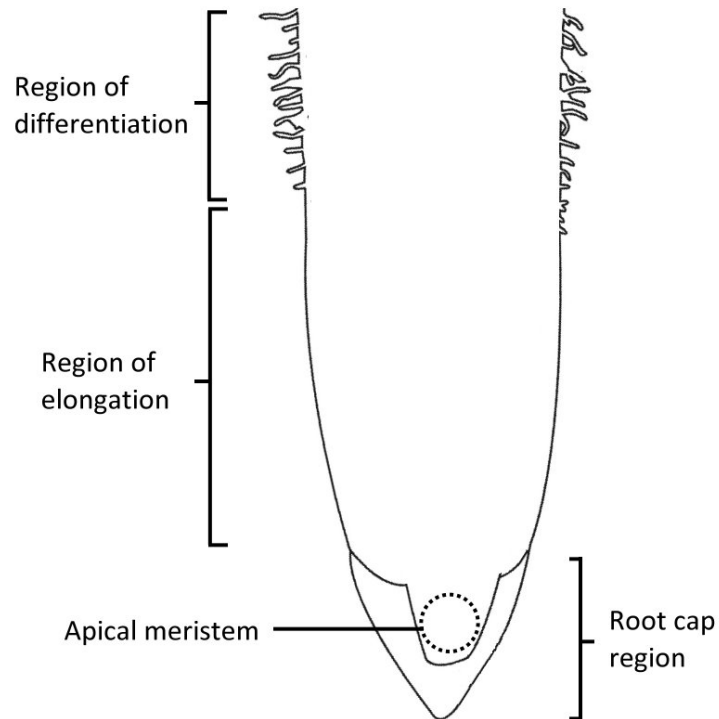
- A. Initiate body movement
- B. Maintain body balance
- C. Hold body position
- D. Coordinate body movement

41. Which of the following eye defects can be corrected by LASIK (Laser-Assisted *in-situ* Keratomileusis)?

- (1) Short-sightedness
- (2) Long-sightedness
- (3) Astigmatism

- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

42. Which of the following regions of root is most sensitive to auxins?



- A. Root cap region
- B. Apical meristem
- C. Region of elongation
- D. Region of differentiation

43. Which of the following should **not** be present in the urine of a healthy person?

- A. White blood cell
- B. Urea
- C. Bile
- D. Calcium

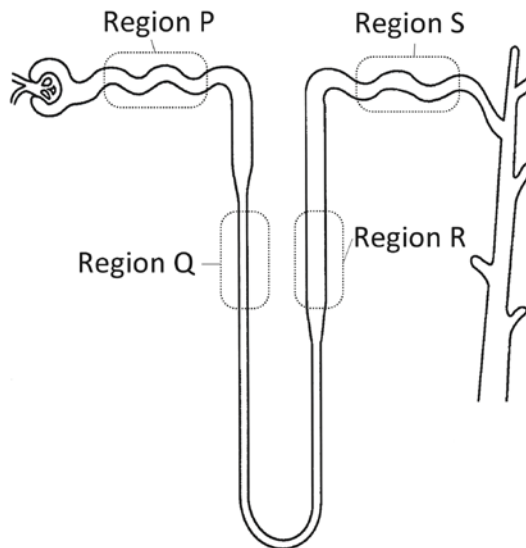
44. Which of the following endocrine glands produces a hormone which directly affects the heart rate?

- A. Thyroid gland
- B. Adrenal gland
- C. Thymus gland
- D. Pancreas

45. Which of the following is **not** the function of kidney?

- A. Regulation of hydrogen-ion concentration of blood.
- B. Maintenance of osmotic concentration of blood.
- C. Removal of carbon dioxide.
- D. Secretion of hormones.

46. The diagram below shows the structure of a nephron:



Which part of the nephron does **not** absorb water?

- A. Region P
- B. Region Q
- C. Region R
- D. Region S

47. Which of the following is **not** a benefit of exercise?

- A. Reduces the risk of dying prematurely from heart disease and stroke.
- B. Helps in weight control.
- C. Reduces the risk of developing high blood pressure.
- D. Prevent the occurrence of cancers.

48. Which of the following diseases is caused by bacteria?

- A. Influenza
- B. Tetanus
- C. Severe Acute Respiratory Syndrome (SARS)
- D. Chickenpox

49. Which of the following ways of disease transmission is most difficult to control?

- A. Airborne
- B. Food borne
- C. Waterborne
- D. Transmission by vectors

50. Which of the following statements about inflammation is **not** correct?

- A. Vasodilation of arterioles causes more blood to flow through the site.
- B. Migration of leukocytes and some proteases to the tissues.
- C. Histamine increases the permeability of the capillaries in order to allow more phagocytes to engulf pathogens at the infected tissues.
- D. Histamine initiates the inflammatory response.

51. Which of the following substances is **not** directly related to humoral immune response?

- A. Memory B cell
- B. Antibody
- C. Phagocytes
- D. Plasma cell

52. Which of the following **cannot** be recycled in an ecosystem?

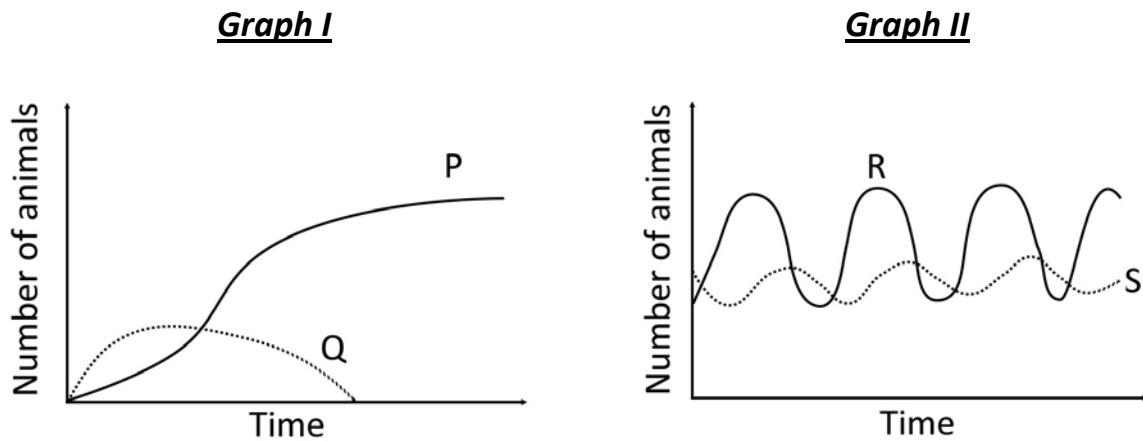
- A. Energy
- B. Carbon
- C. Nitrogen
- D. Water

53. The following instrument is used in a field study, which of the following abiotic factor can be measured by it?



- A. Distance between two points
- B. Salinity
- C. Light intensity
- D. Dissolved oxygen

54. Graph I and II below shows two different types of interactions between organisms.



Which of the following combinations correctly describes the interaction of organisms represented in each graph?

	<u>Graph I</u>	<u>Graph II</u>
A.	Predation	Competition
B.	Competition	Predation
C.	Mutualism	Predation
D.	Competition	Mutualism

55. Which of the following statements about *Nitrosomonas* (a group of nitrifying bacteria) are correct?

- (1) They are chemoautotrophs.
- (2) They are commonly used in sewage treatment.
- (3) They oxidize ammonia into nitrite.

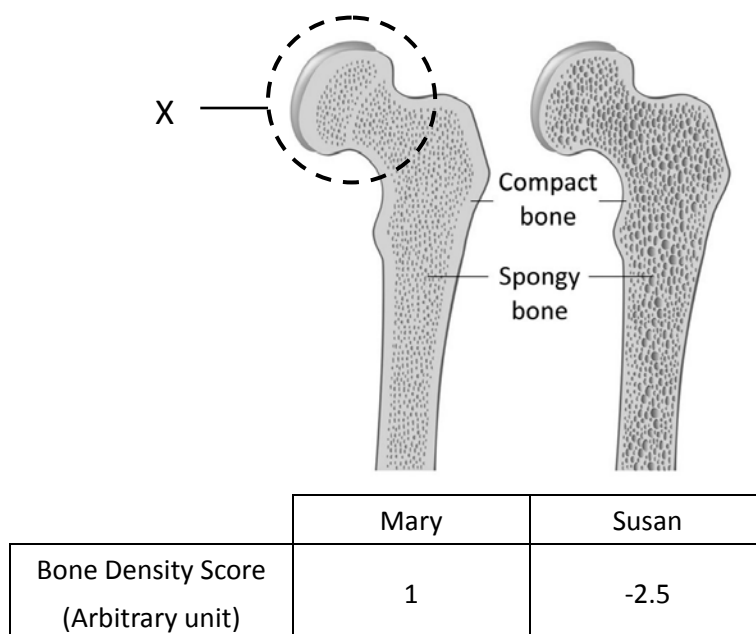
- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

End of Section A

Section B : Structured Questions (15 marks)

Answers to all questions should be written in the spaces provided on Section B answer sheet.

1. The diagram below shows the longitudinal section of femurs in Mary and Susan:



(a) What type of joint is X? (1 mark)

(b) Who, Mary or Susan, is more likely to develop osteoporosis? Explain your answer. (2 marks)

(c) Why do women usually suffer from osteoporosis more severely than men after age 50? (2 marks)

2. In an exhibition, John had a chance to look at the frozen body of a baby mammoth.

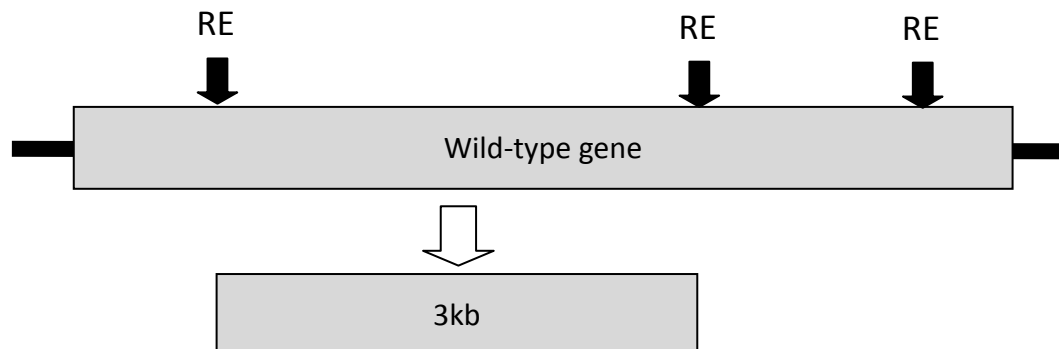


The fossils are sources of evidence to prove that life has evolved from ancestor.

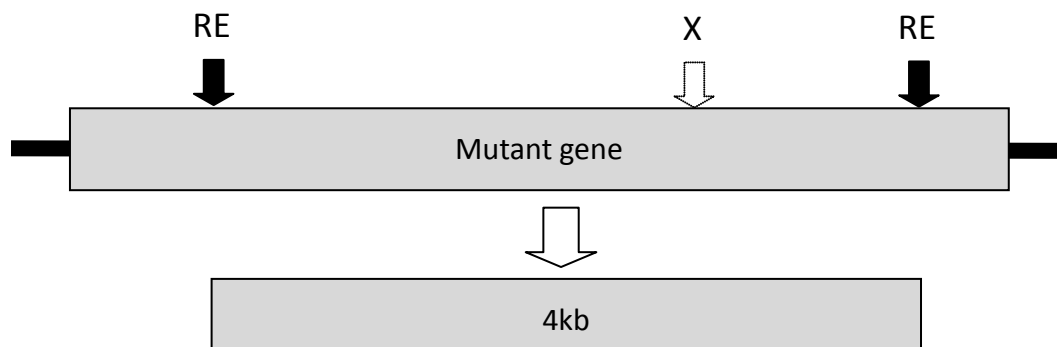
- (a) How this fossil was formed? (2 marks)
- (b) State **two** methods that could be used to determine the age of the fossil? (2 marks)
- (c) Other than comparative anatomy, suggest **one** method that could be used to investigate the relationship with the elephant nowadays. (1 mark)

3. Hemophilia is a sex-linked blood clotting disorder. The disease is caused by many single-nucleotide mutations in a gene. Researchers have found that restriction enzyme (RE) digestion can be used to identify between the wild-type gene and the gene with one of the mutations. This can be illustrated as follow:

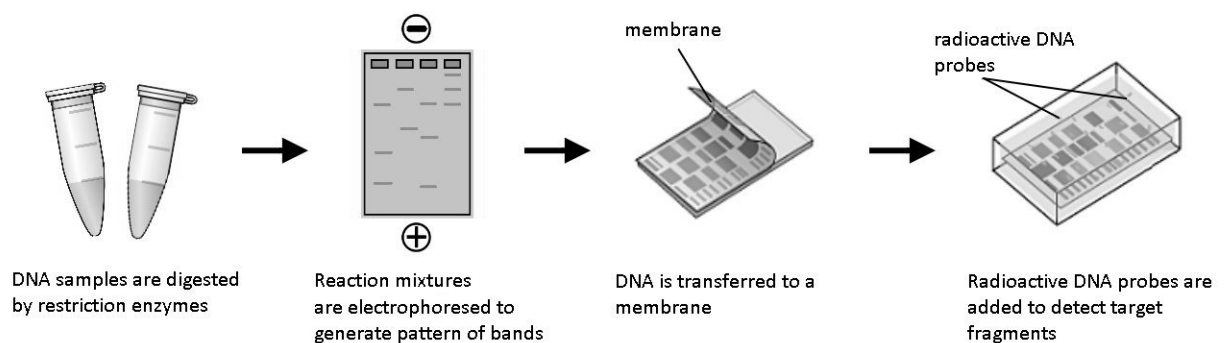
Wild-type gene digested by restriction enzyme (RE) yields a 3 kilobase (kb) restriction fragment:



Mutant gene digested by restriction enzyme (RE) yields a 4 kilobase (kb) restriction fragment:

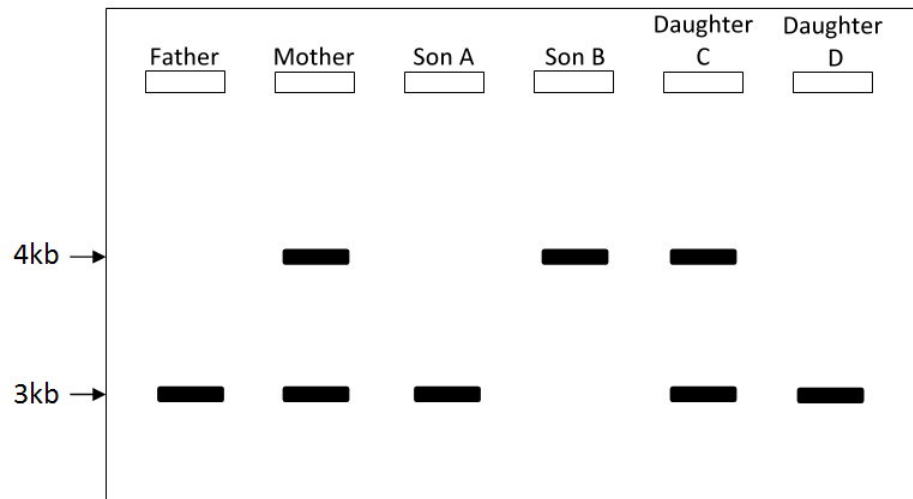


The digestion mixtures were then electrophoresed and transferred to a membrane. The two types of restriction fragments were further detected by specific radioactive DNA-probes as shown below:



- (a) Why the mutant gene can no longer be cut by the restriction enzyme at point X? (2 marks)

In a family, the DNA of each member is obtained and analyzed. The following diagram shows the results of the analysis:



- (b) From the results, deduce the genotype of the mother and that of the father. Define the symbols you used. (2 marks)
- (c) If Son B married a hemophiliac carrier, what is the probability of having a normal male as their child? (1 mark)

END OF PAPER