



Secondary School Mathematics & Science Competition

Biology

Date : 19-05-2012

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, Subject Name, Date and Student Number in the spaces provided on the answer sheet.
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. The paper is divided into two parts. Part A consists of fifty four Multiple Choice questions and Part B two short structured questions.

Section A (Multiple Choice Questions)

- (a) You should use an HB pencil to mark all your answers on the 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 answer sheet.

Section A : Multiple Choice Questions (54 marks)

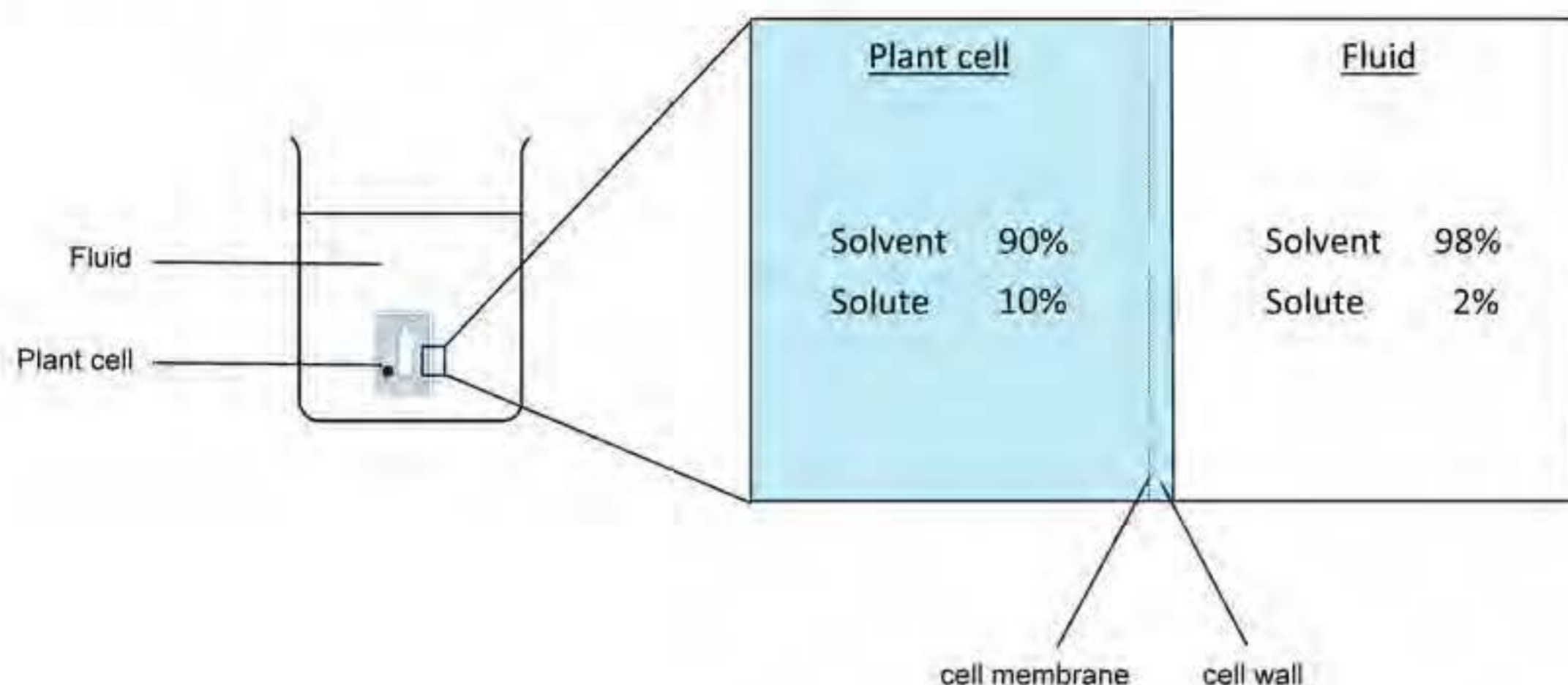
1. Which of the following has the smallest volume?
 - A. 1 cm^3
 - B. 10^{-6} m^3
 - C. 100 mm^3
 - D. $10^{12} \mu\text{m}^3$

2. Which organelle is primarily responsible for digesting food particles in amoeba?
 - A. Endoplasmic reticulum
 - B. Golgi apparatus
 - C. Pseudopodia
 - D. Lysosome

3. Which of the following is **NOT** a function of protein in the plasma membrane of a normal living cell?
 - A. Facilitating the movement of ions across the membrane.
 - B. Recognizing other cells.
 - C. Acting as binding site for specific hormones.
 - D. Synthesizing a cholesterol.

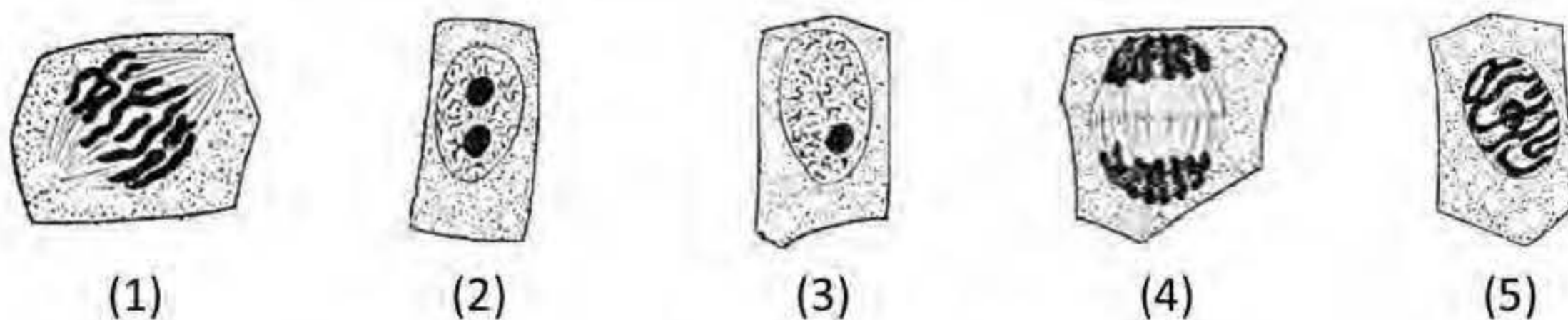
4. In a healthy person, which of the following tissues that undergoes mitotic division actively throughout life?
 - A. Blood marrow
 - B. Cardiac muscle
 - C. Epidermis of skin
 - D. Nervous tissue

5. An intact plant cell is immersed in a fluid, the concentration of the cell and fluid in terms of percentage of solvent and solute are shown in the diagram below.



Which of the following statements best describes the state of the cell after 2 hours of immersion?

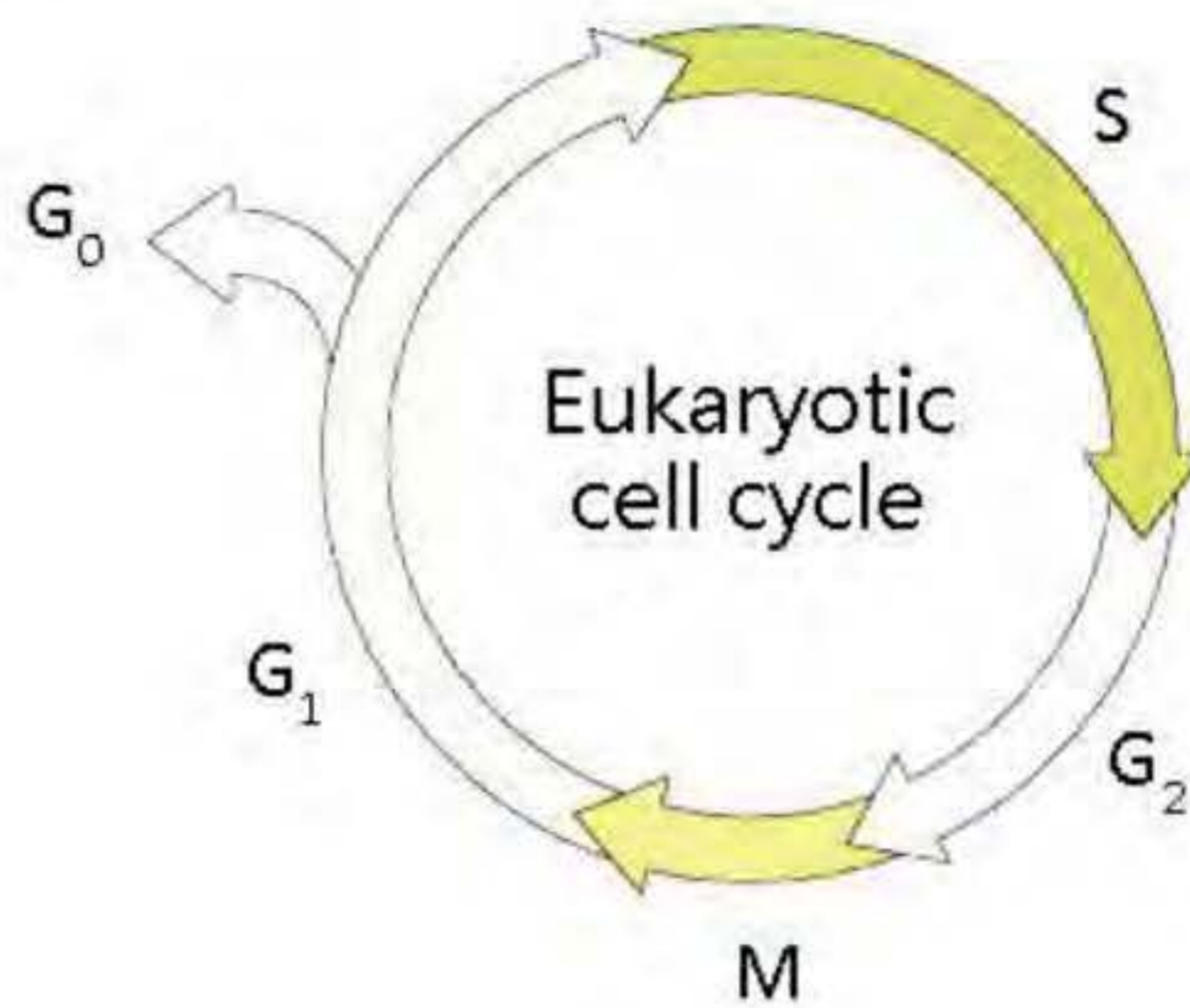
- A. There is a net movement of solutes into the cell from the fluid.
 - B. The plant cell undergoes plasmolysis.
 - C. The plant cell becomes turgid.
 - D. The solvent moves against its concentration gradient.
6. The following diagrams show the different mitotic stages of a cell.



Which of the following is the **CORRECT** sequence of mitosis?

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

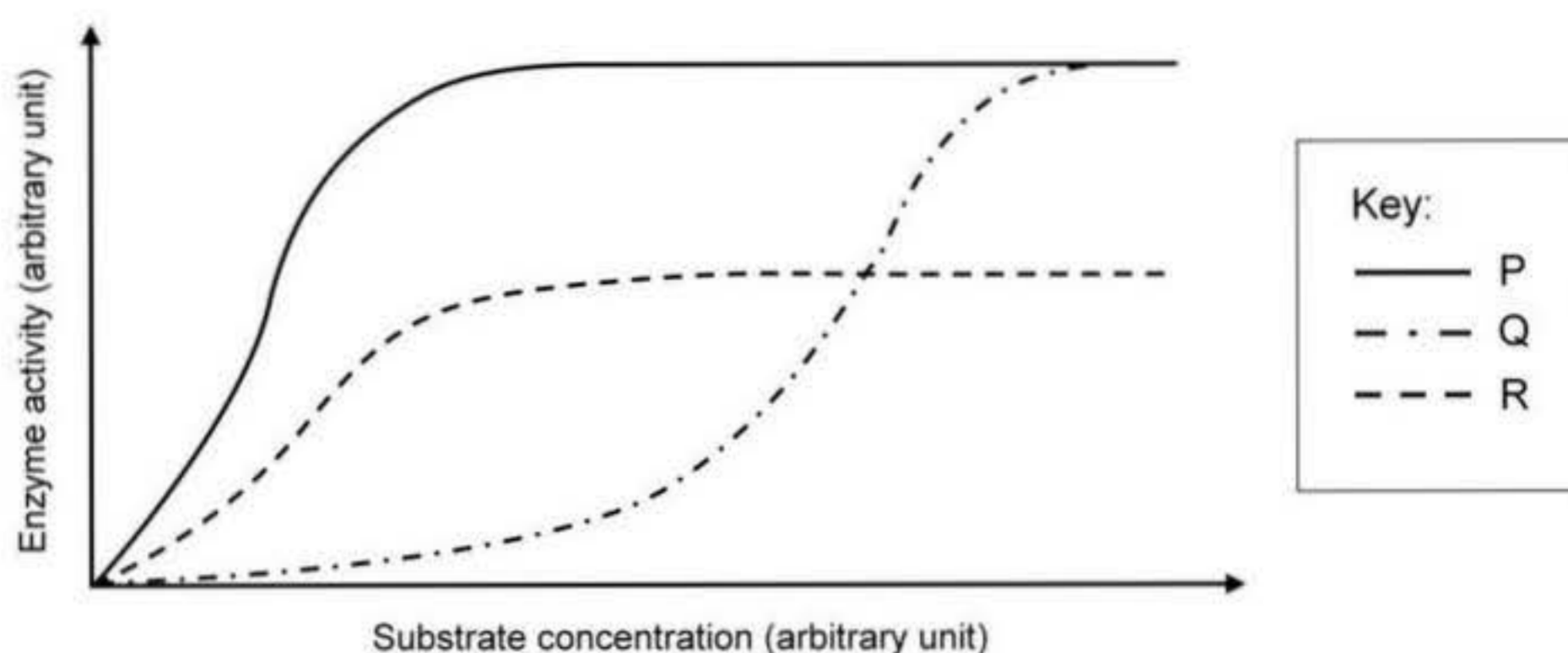
7. The following diagram shows the eukaryotic cell cycle:



The G_1 phase

- A. must enter G_0 phase after completion of one cycle.
- B. has the amount of DNA doubled.
- C. has a haploid number of chromosomes.
- D. is the phase in which new organelles and proteins are made.

8. A student wanted to study the effect of competitive inhibitor (CI) and non-competitive inhibitor (NCI) on the activity of an enzyme (E), he performed an experiment and used the data obtained to plot a graph as shown below:



Which of the following combinations correctly represented the key to the graph?

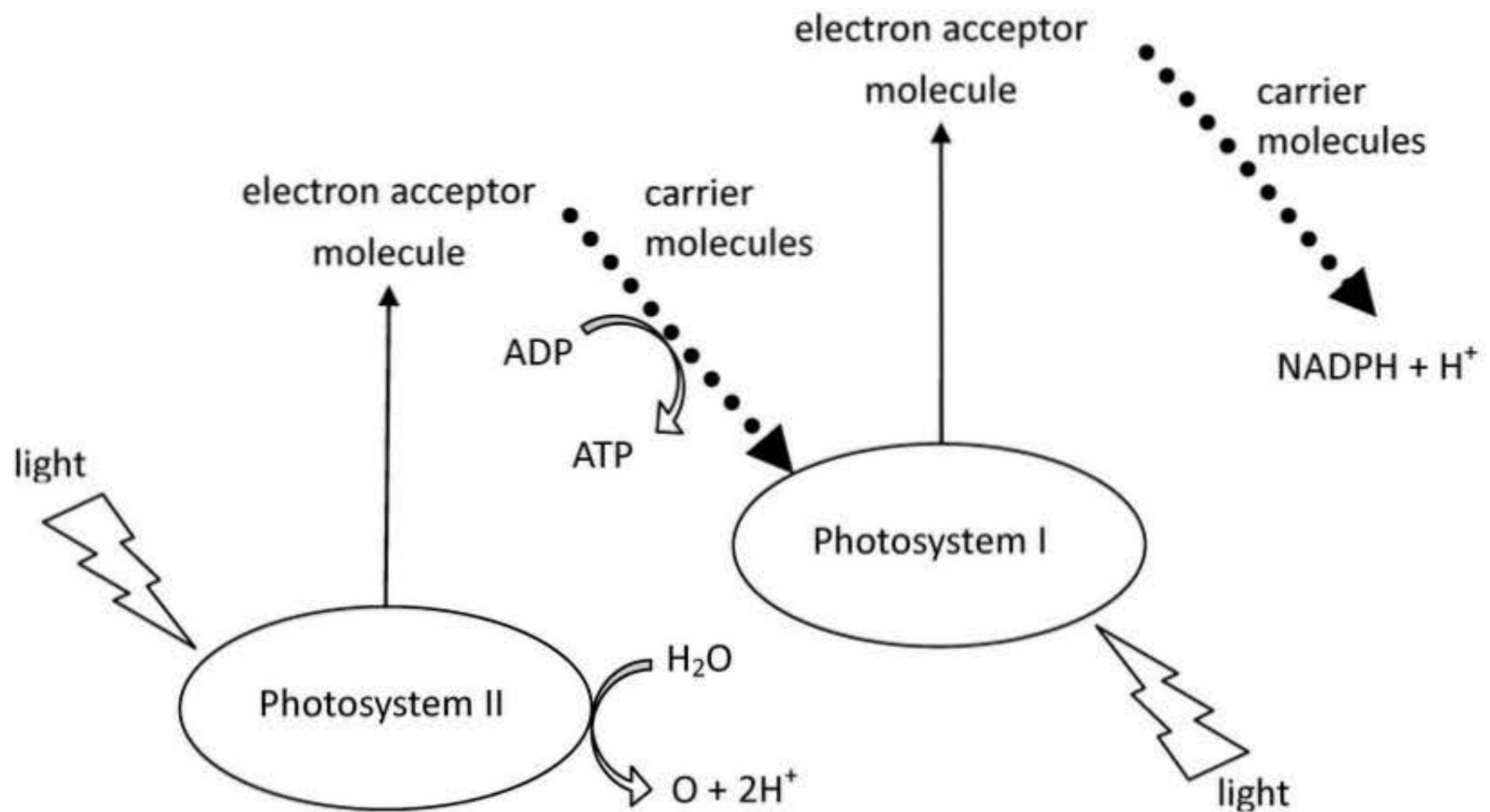
| <u>Line P</u> | <u>Line Q</u> | <u>Line R</u> |
|---------------|---------------|---------------|
| A. E + CI | E | E + NCI |
| B. E + CI | E + NCI | E |
| C. E | E + NCI | E + CI |
| D. E | E + CI | E + NCI |

9. Which of the following statement(s) about oxidative phosphorylation is/are **CORRECT**?

- (1) It takes place at the inner membrane of mitochondrion.
- (2) $\text{NADH} + \text{H}^+$ and FADH_2 are formed.
- (3) ATP molecules are formed.

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

10. The following diagram shows the noncyclic electron pathway in photosynthesis:



Which of the followings are **NOT** electron acceptors in the pathway?

- (1) ADP
- (2) $NADP^+$
- (3) Photosystem I & II

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

11. Which of the following about DNA in eukaryote is **CORRECT**?

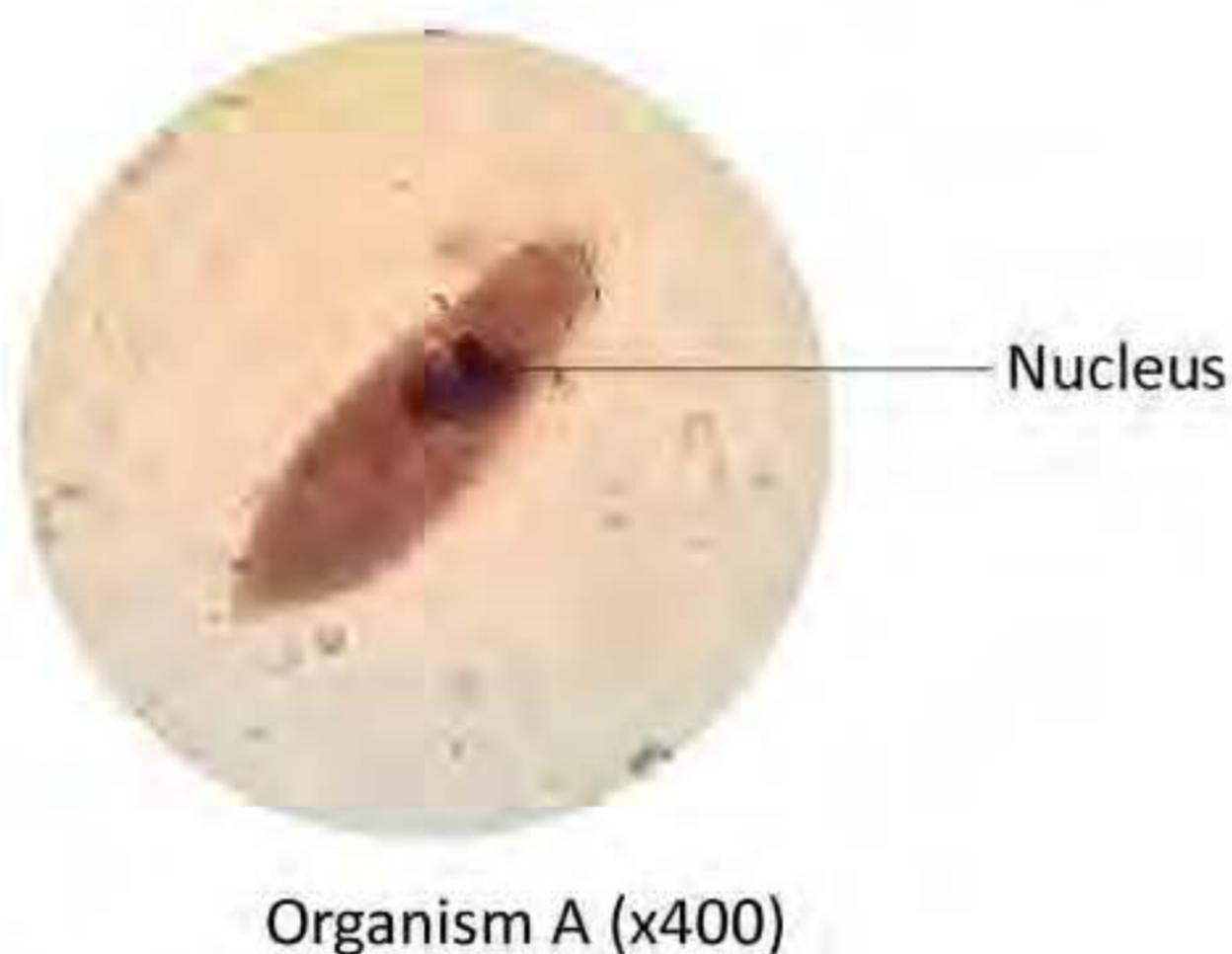
- A. The pentose sugar is oxyribose.
- B. It acts as a template for m-RNA synthesis.
- C. It has uracil as one of the bases in nucleotide.
- D. The chromosomal DNA is not enclosed by nuclear membrane.

12. Which of the following is a phenotype?

- A. A gene mutation
- B. DNA sequence of a gene
- C. Production of an enzyme
- D. A gene deletion

13. How many different gametes can a diploid cell which contains three pairs of homologous chromosomes (PpQQRr) produce?
- A. 2
 - B. 4
 - C. 6
 - D. 8
14. For the parents who are homozygous dominant and recessive of a particular trait, the chance of one of their offsprings who is also homozygous for this trait is
- A. 0 %
 - B. 25 %
 - C. 75 %
 - D. 100 %
15. The sequence on the DNA encoding strand is CAT, the respective anti-codon on t-RNA should be
- A. GTA
 - B. GUA
 - C. CAT
 - D. CAU
16. Which of the following is **NOT** useful for determining the gene sequence?
- A. m-RNA sequence of the gene
 - B. amino acid of a protein produced by the gene
 - C. complementary DNA sequence of the gene
 - D. All of the above is useful
17. The statement 'most mutations do not cause important changes in traits' can be explained by
- (1) the degenerative nature of the genetic code
 - (2) the active site of the gene product may not be altered
 - (3) most genes have two or more alleles
- A. (1) and (2) only
 - B. (2) and (3) only
 - C. (1) and (3) only
 - D. (1), (2) and (3)

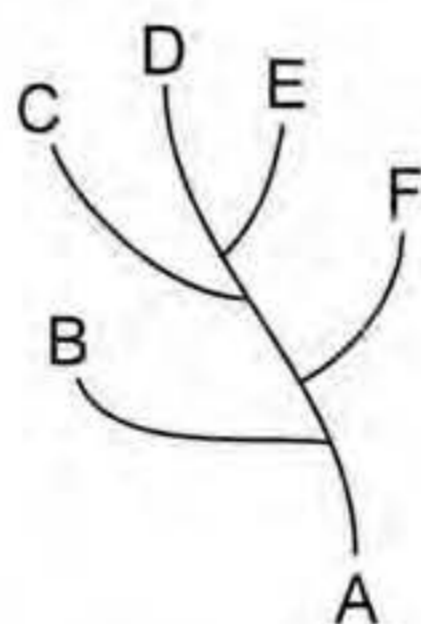
18. Peter took a drop of pond water from a field site and viewed it under a pair of microscopes, an organism A was found and shown below:



Organism A can be classified into

| | <u>Domain</u> | <u>Kingdom</u> |
|----|---------------|----------------|
| A. | Eukaryote | Protista |
| B. | Prokaryote | Protista |
| C. | Eukaryote | Monera |
| D. | Prokaryote | Monera |

19. The following diagram shows the evolution tree of certain organisms:

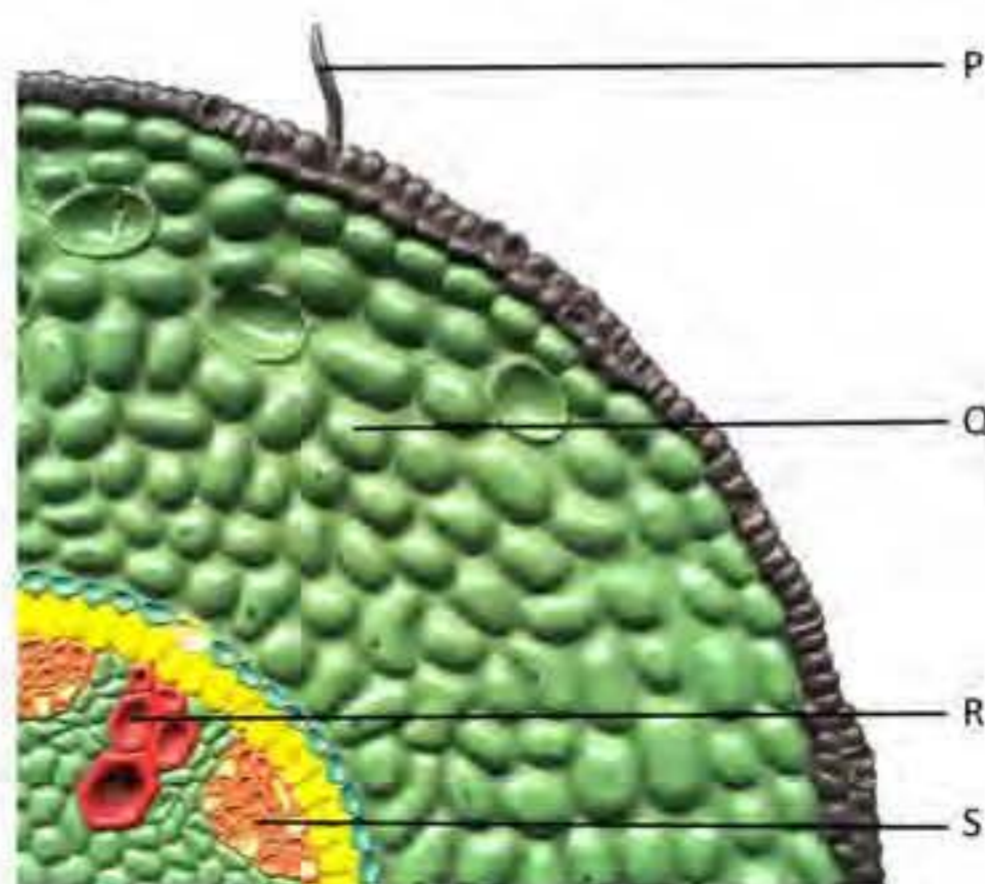


Evolution tree of certain organism

Which two organisms share the largest percentage of similarity in their genetic made-up?

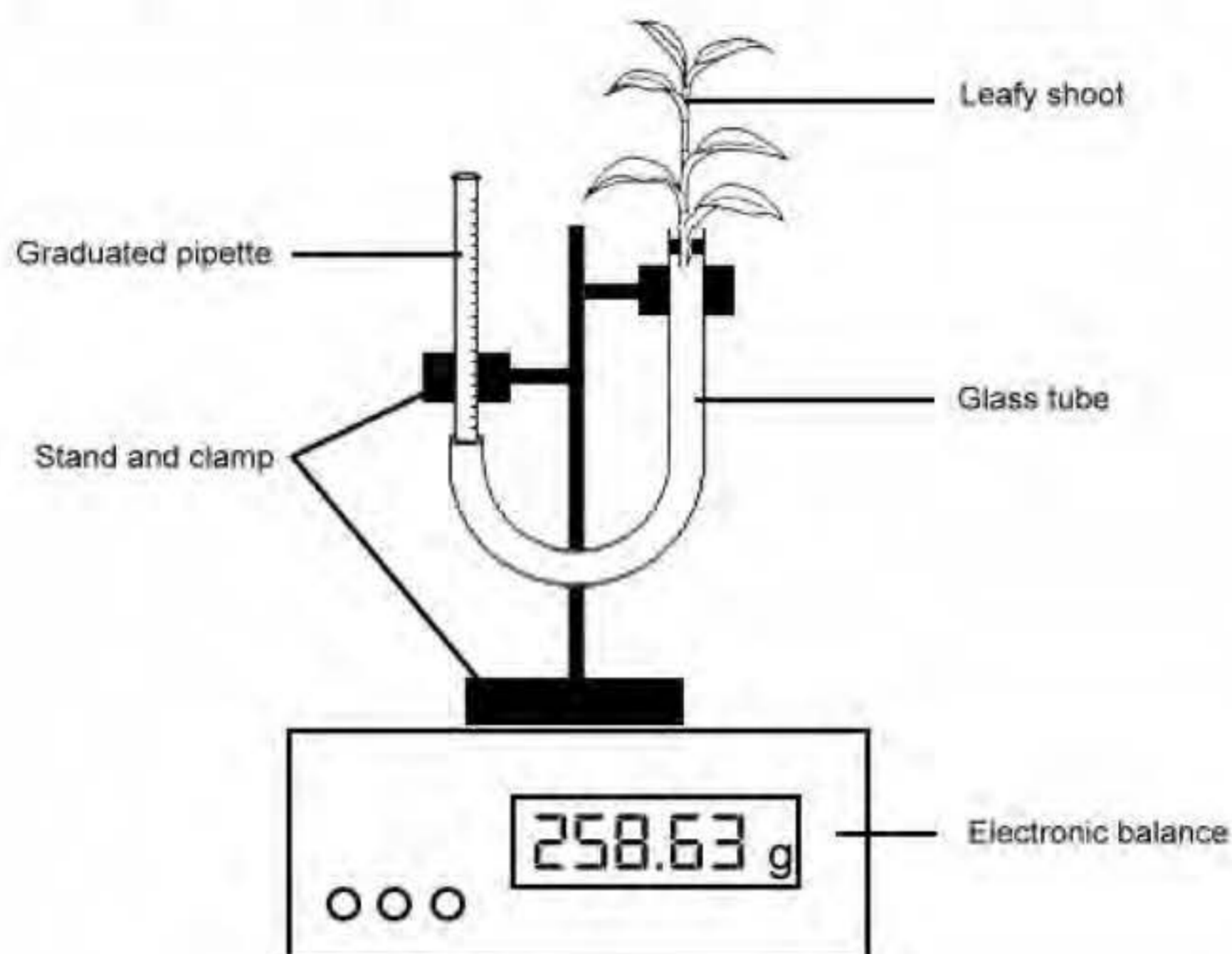
- A. A and B
- B. C and E
- C. D and E
- D. A and D

20. Which of following can be a survival mechanism of the less advantageous organisms on Earth in the course of evolution?
- A. Survival of the fittest
 - B. Artificial breeding
 - C. Cloning
 - D. Extinction
21. Natural selection occurs with
- A. genetic variation in species.
 - B. no environmental changes.
 - C. no competition for unlimited resources.
 - D. no change in population sizes
22. Which of the following type of cell(s) in a leaf **CANNOT** carry out photochemical reaction?
- A. Upper epidermal cell
 - B. Palisade parenchyma cell
 - C. Spongy mesophyll cell
 - D. Guard cell
23. The following diagram shows the transverse section of a dicotyledonous root model. Which part contains cells having the highest respiratory rate?



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

24. In order to investigate the transpiration rate of a leafy shoot under normal conditions, a potometer was setup and placed on an electronic balance. The experimental setup and a table of the data collected were shown below:



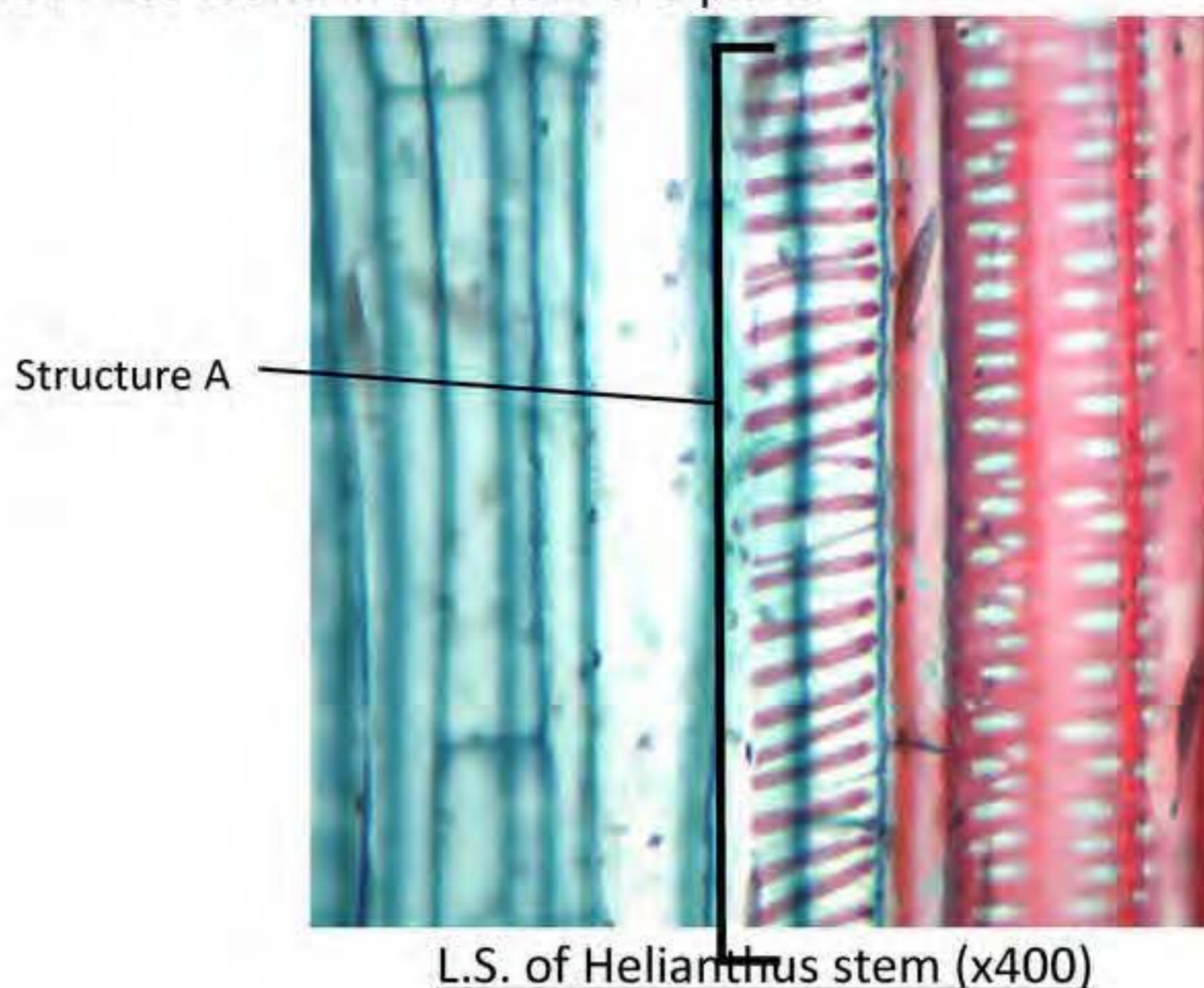
| | Initial reading (at t=0 min) | Final reading (at t=120 min.) |
|---------------------------------------|---------------------------------|----------------------------------|
| Reading on the graduated pipette (ml) | p | q |
| Reading on the electronic balance (g) | r | s |

Which of the following formula can represent the water retained by the plant after 2 hours of experiment?

(Assume 1ml of water weighs 1 g)

- A. $(p - q) \div (r - s)$
- B. $(p - q) - (r - s)$
- C. $(s - r) \div (q - p)$
- D. $(s - r) - (q - p)$

25. Structure A was found in the stem of a plant.



Which of the following are the properties and functions of structure A?

- (1) They are non-living cells.
- (2) Transportation of minerals and sucrose.
- (3) They have highly-lignified outer walls.

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

26. A student conducts a Benedict's test on a sugarcane extract, which of the following is the possible result and explanation observed in the experiment?

- A. Brick red precipitate is formed as sucrose is a reducing sugar.
- B. Orange precipitate is formed as sucrose can reduce copper (II) sulphate to insoluble copper (II) oxide.
- C. Green precipitate is formed as all of the disaccharides have reducing power.
- D. The solution remains blue in colour as the disaccharides in sugarcane do not have reducing power.

27. The following table shows the dental formula of an animal

| | Number of teeth | | | |
|-----------------------|-----------------|--------|----------|-------|
| | incisor | canine | premolar | molar |
| Half of the upper jaw | 0 | 0 | 3 | 3 |
| Half of the lower jaw | 3 | 1 | 3 | 3 |

The animal most probably is a(an)

- A. herbivore
- B. carnivore
- C. omnivore
- D. detritivore

28. Why Body Mass Index (BMI) is **NOT** recommended for use as the only measurement of fitness level?

- (1) BMI makes no distinction between fat and muscle mass.
- (2) BMI does not measure lean muscle mass.
- (3) BMI does not show the location of body fat distribution.
- (4) BMI does not differentiate between people with small frames and people with large frames.

- A. (1) and (2) only
- B. (2) and (3) only
- C. (1), (3) and (4) only
- D. (1), (2), (3) and (4)

29. Which of the following organs absorbs the largest amount of water after a normal meal?

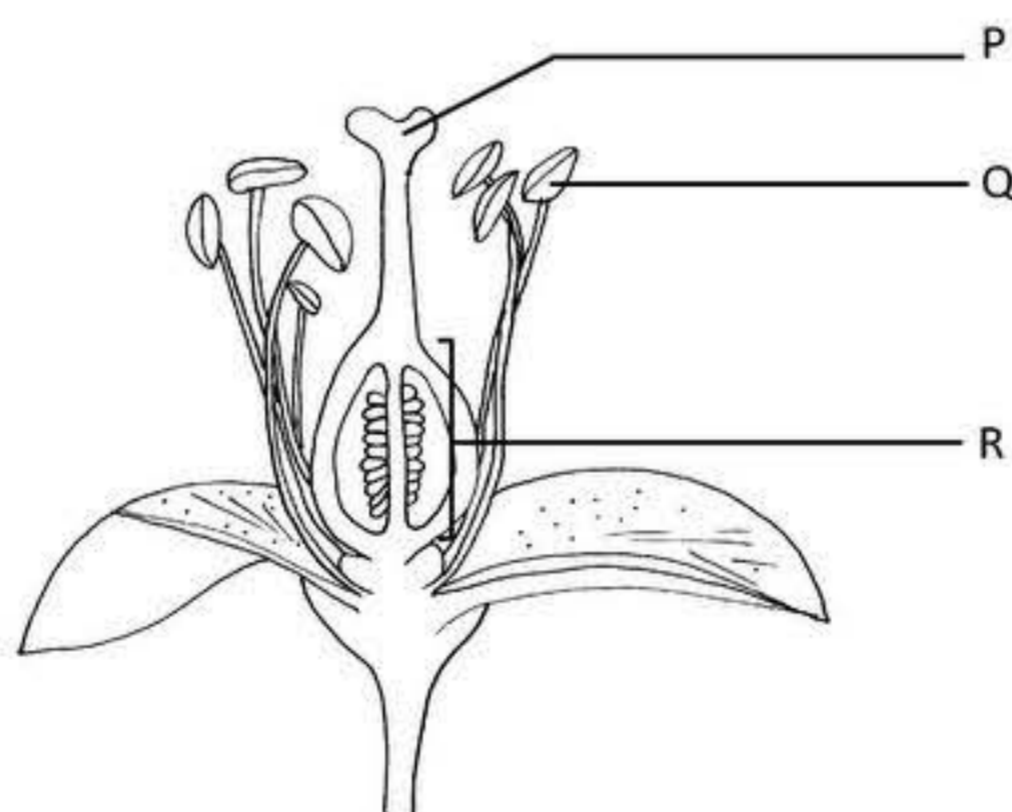
- A. Stomach
- B. Duodenum
- C. Ileum
- D. Colon

30. The stomach of an herbivorous ruminant has several chambers where the cellulose-digesting microorganisms called *Entodinium* are normally found. *Entodinium* carries out fermentation to produce organic acids, carbon dioxide and methane. The relation between the ruminant and *Entodinium* can be regarded as
- parasitic
 - mutualistic.
 - communalistic.
 - competitive.
31. When Peter is in a state of rest, his heart rate is measured at 75bpm (beats per minute). When he performs an intense physical exercise, which of the following is (are) the possible change(s) in his cardiac cycle?

- The cardiac cycle lasts about 0.6s when the heart rate is 120 bpm.
- Duration of the cardiac cycle shortens when the heart rate fasts.
- Diastole shortens at fast heart rate.

- (1) and (2) only
- (2) and (3) only
- (1) and (3) only
- (1), (2) and (3)

32. The diagram below shows a longitudinal section of a flower. Germination of pollen grains is found at structure P.



Meiosis occurs in structure

- P and Q only.
- Q and R only.
- P and R only.
- P, Q and R.

33. The umbilical artery is called an artery because it carries

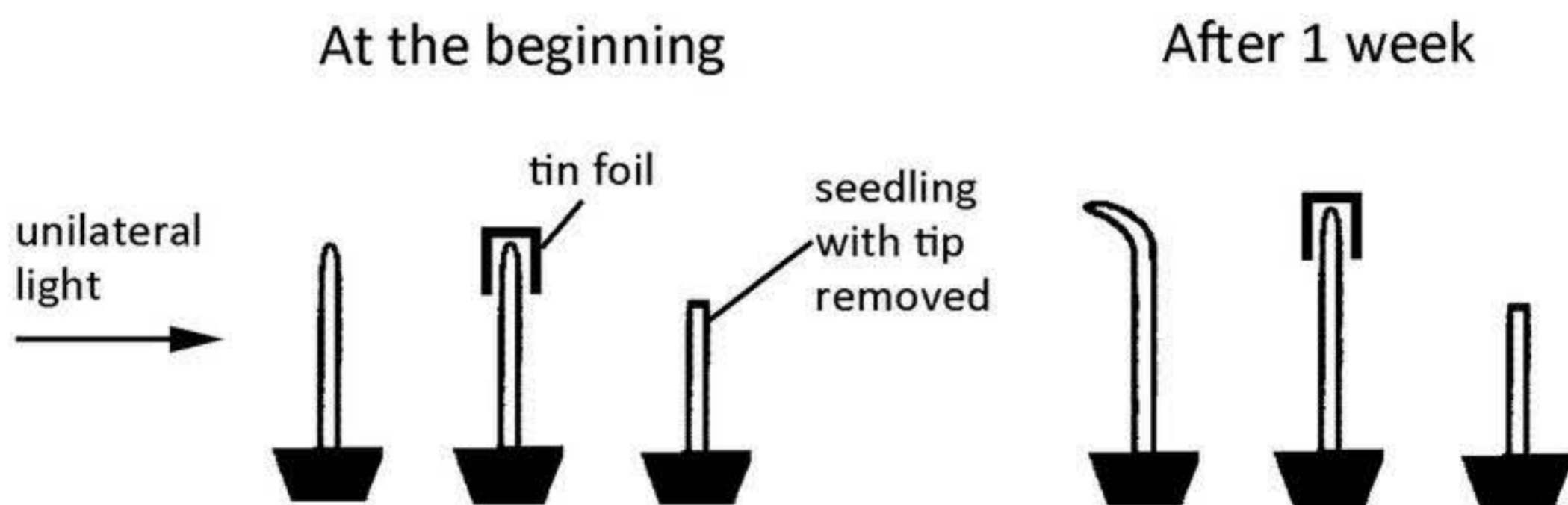
- A. oxygenated blood away from the mother's heart.
- B. oxygenated blood away from the fetal heart.
- C. deoxygenated blood away from the mother's heart.
- D. deoxygenated blood away from the fetal heart.

34. Which of the following organism(s) would show metamorphosis in their life cycle?

- (1) Toad
- (2) grasshopper
- (3) Mosquito

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

35. John wants to investigate the growth response of three coleoptiles seedlings from the same species to a unilateral light. The diagram below shows his experimental setup and the result after one week.



From the result, John can conclude that

- (1) tip of the seedling is necessary for growth.
- (2) auxin is produced at shoot tips.
- (3) tip of the seedling is sensitive to unilateral light.

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

36. If an object moves closer to us, which of the following changes takes place in our eyes?

- A. The lens becomes more convex.
- B. The ciliary muscle is relaxed.
- C. The suspensory ligaments is pulled tight.
- D. The image is focused on the area of the optic nerve.

37. Why do we feel uncomfortable in our ears when we are in an ascending airplane?

- A. The outer ear has a lower pressure than the middle ear.
- B. The three ear bones produce a high pressure to the oval window.
- C. The endolymph in the cochlea produces higher stimuli to the sensory hair cells.
- D. The endolymph in the semi-circular canal displaces more of the sensory hair cells in the opposite direction.

38. The function of the highly-folded surface of a human brain is to

- A. provide a large surface area for the exchange of nutrients.
- B. increase the speed of impulse transmission.
- C. accommodate more neurons.
- D. allow a person to react faster.

39. When a person is cycling, which parts of the brain involved?

- (1) Cerebrum
- (2) Cerebellum
- (3) Medulla oblongata

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

40. If a young adult is suffering from osteoporosis, which of the following treatments and cares should be recommended?

- (1) Intake of calcium and vitamin D supplements
- (2) Prevention of falls
- (3) Weight-bearing exercise

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

41. A scientist investigated the relationship between the blood glucose and two hormones (insulin and glucagon). He injected a dog with glucose solution and took its blood sample at regular time interval to monitor the changes of the concentrations of three substances with time. The results were shown in the table below:

| | | Time after injection (minute) | | | | | |
|--|----------|-------------------------------|-----|-----|-----|----|-----|
| | | 0 | 20 | 40 | 60 | 80 | 100 |
| Concentration in blood (arbitrary unit) | Glucose | 250 | 200 | 150 | 100 | 95 | 88 |
| | Insulin | 260 | 50 | 55 | 60 | 52 | 55 |
| | Glucagon | 5 | 1 | 0.3 | 0.4 | 1 | 1.2 |

In order to show the results of the experiment properly, the correct arrangement of independent and dependent variables should be

- | | |
|--|---|
| <u>Independent variable (s)</u> | <u>Dependent variable (s)</u> |
| A. Time after injection | Glucose, insulin & glucagon concentration |
| B. Glucose, insulin & glucagon concentration | Time after injection |
| C. Glucose concentration | Insulin & glucagon concentration |
| D. Insulin & glucagon concentration | Glucose concentration |

42. Which of the following is **NOT** an example of a positive feedback mechanism?

- A. Uterine contraction to expel the baby.
- B. Regulation of blood glucose levels by insulin
- C. Regulation of lactation by prolactin
- D. Regulation of blood clotting by blood platelets

43. Which of the following are the characteristics of hormones?

- (1) Most of them are protein in nature.
- (2) They combine with specific receptors on cell membrane to initiate cellular response.
- (3) They are chemical messengers that are transported by blood.

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

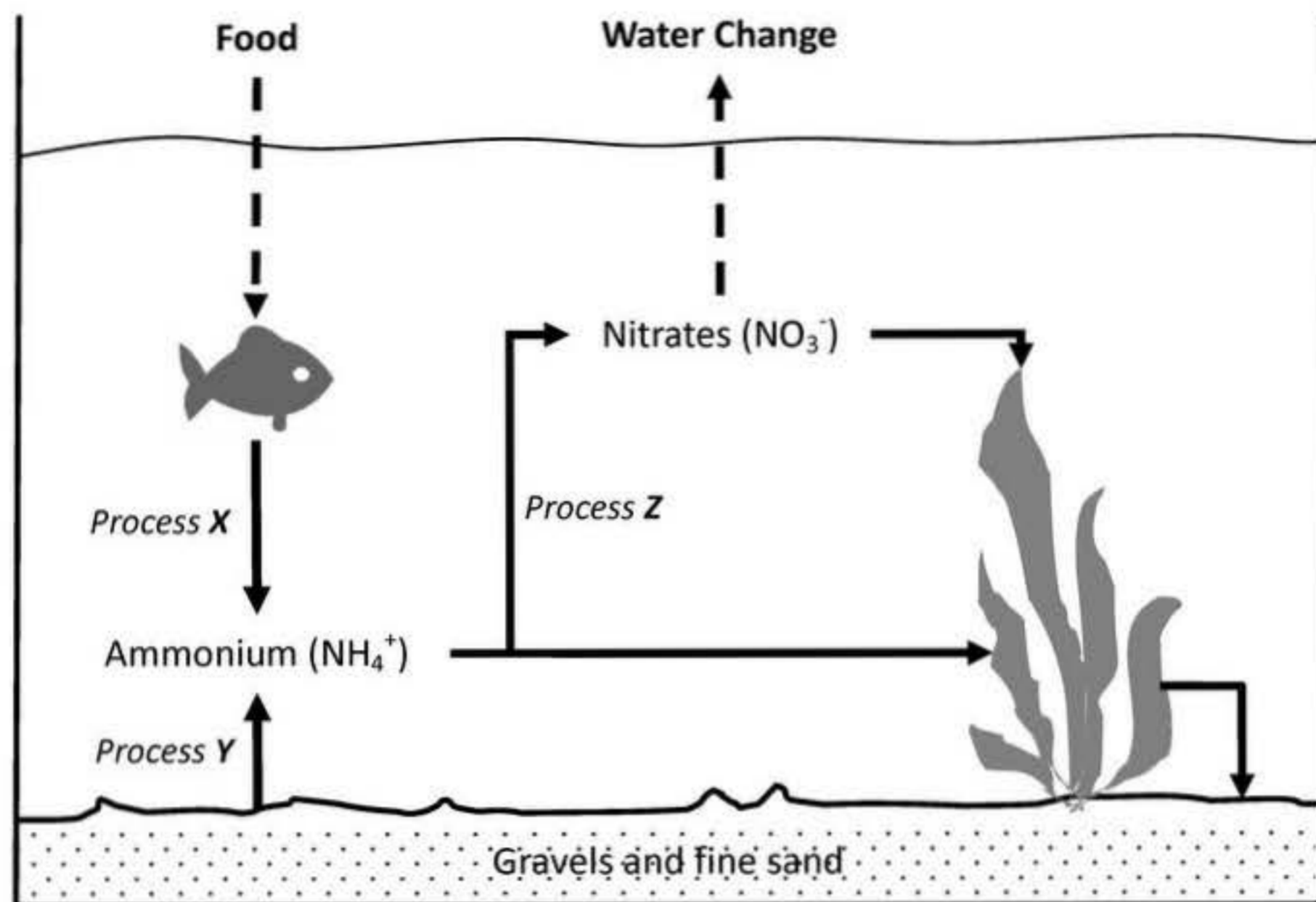
44. If a healthy person is deprived of food for two weeks, but has as plenty of water to drink. A medical check-up may show which of the following results at the end of the period.

- A. a decrease in the rate of breakdown of proteins.
- B. a decrease in plasma concentration of glucagon.
- C. an increase in the rate of breakdown of food substance in the order of carbohydrate, protein and fat.
- D. an increase in the rate of formation of glucose from amino acid in liver.

45. Which of the following mainly causes global warming?

- A. deforestation
- B. using plastic bags or polythene containers
- C. incomplete burning of fuels
- D. exhaust fumes from factories and auto-mobiles

46. Below is a Nitrogen Cycle in an aquarium,



What is the correct combination of process X, Y and Z respectively?

| <u>Process X</u> | <u>Process Y</u> | <u>Process Z</u> |
|------------------|------------------|-------------------|
| A. Diffusion | Decomposition | Nitrification |
| B. Excretion | Ammonification | Nitrogen fixation |
| C. Diffusion | Decomposition | Denitrification |
| D. Excretion | Ammonification | Nitrification |

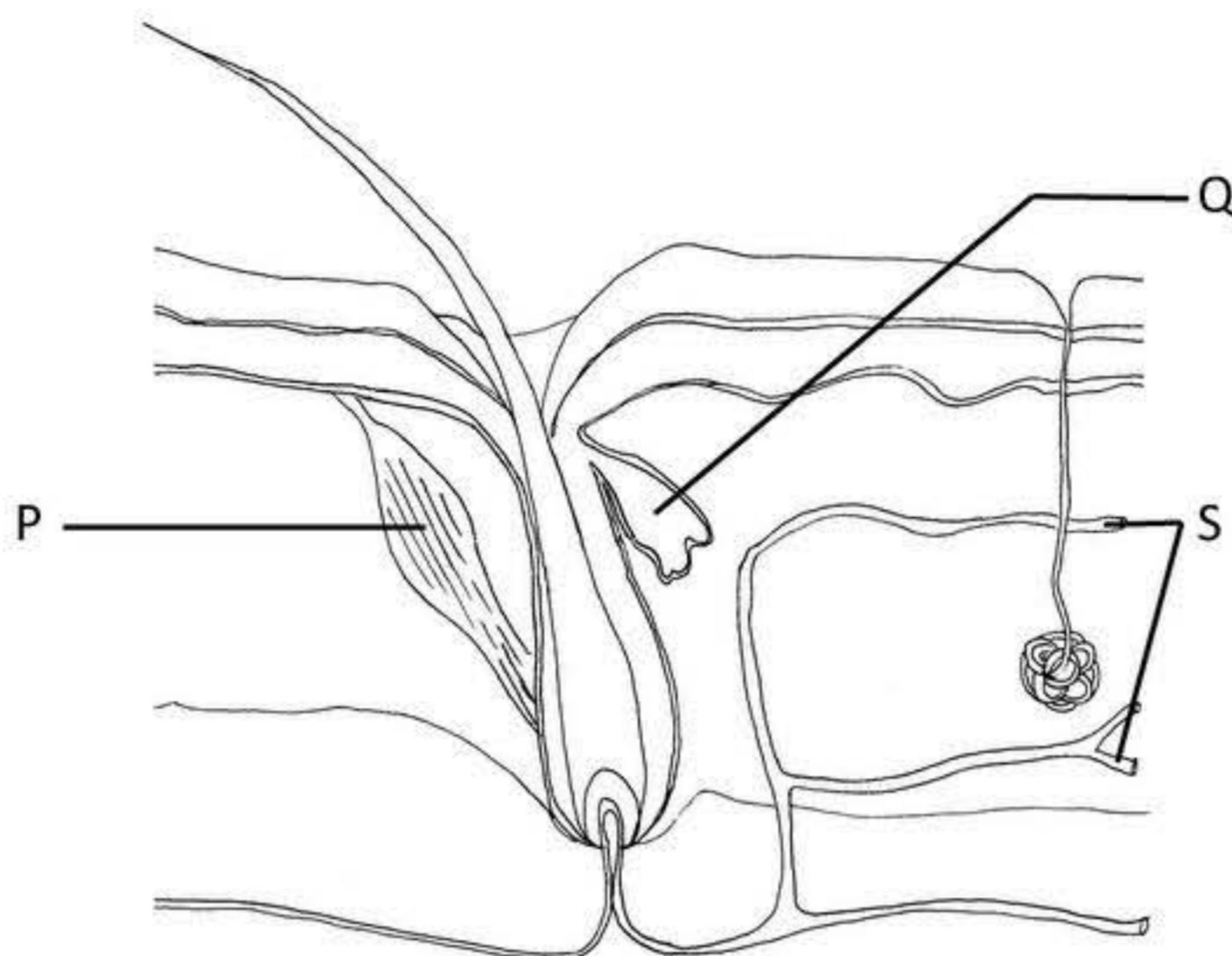
47. Which of the followings may be carcinogenic, i.e. causes cancer?

- (1) a single nucleotide change in DNA
- (2) genetic changes by viral infection
- (3) suppressed immune system

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

48. In a vaccine manufacturing process, antibiotics may be used to prevent contamination by bacteria. Which phase of the bacterial growth is most sensitive to the antibiotics?
- A. Lag phase
 - B. Exponential phase
 - C. Stationary phase
 - D. Death phase
49. An injection of Hepatitis B vaccine to a newborn baby is an example of
- A. natural active immunity.
 - B. natural passive immunity.
 - C. artificial active immunity.
 - D. artificial passive immunity.
50. To perform peritoneal dialysis, a dialysis fluid is used. Which of the following are the common ingredients of the dialysis fluid?
- (1) Electrolytes
 - (2) Urea
 - (3) Glucose
 - (4) Albumin
- A. (1) and (2) only
 - B. (1) and (3) only
 - C. (1), (3) and (4) only
 - D. (1), (2), (3) and (4)
51. Which of the following may cause reabsorption of more water by the kidneys in a healthy person?
- A. increased blood volume
 - B. decreased blood pressure
 - C. increased respiratory rate
 - D. decreased secretion of anti-diuretic hormone (ADH)

52. The following diagram shows a longitudinal section (L.S.) of a normal human skin structure:



In response to a rise in body temperature, which of the physiological change listed below may occur?

- (1) decrease in tension of P
- (2) increase in diameter of S
- (3) increase secretion by Q

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

53. Which of the following sex hormones can be found in both male and female?

- (1) Follicle stimulating hormone
- (2) Oestrogen
- (3) Testosterone
- (4) Progesterone

- A. (1) and (2) only
- B. (3) and (4) only
- C. (1), (2) and (3) only
- D. (2), (3) and (4) only

54. Stem cells can be found in

- (1) Umbilical cord blood of a newborn baby
- (2) Frozen embryo
- (3) Bone marrow of an adult

- A. (1) and (2) only
- B. (2) and (3) only
- C. (1) 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 in the answer sheet.

1. An inexperienced traveler walked on a high mountain trail (over 8,000 feet), he felt light-headed (dizzy) and hard to breathe.

(a) How does the air pressure change with altitude? (1 mark)

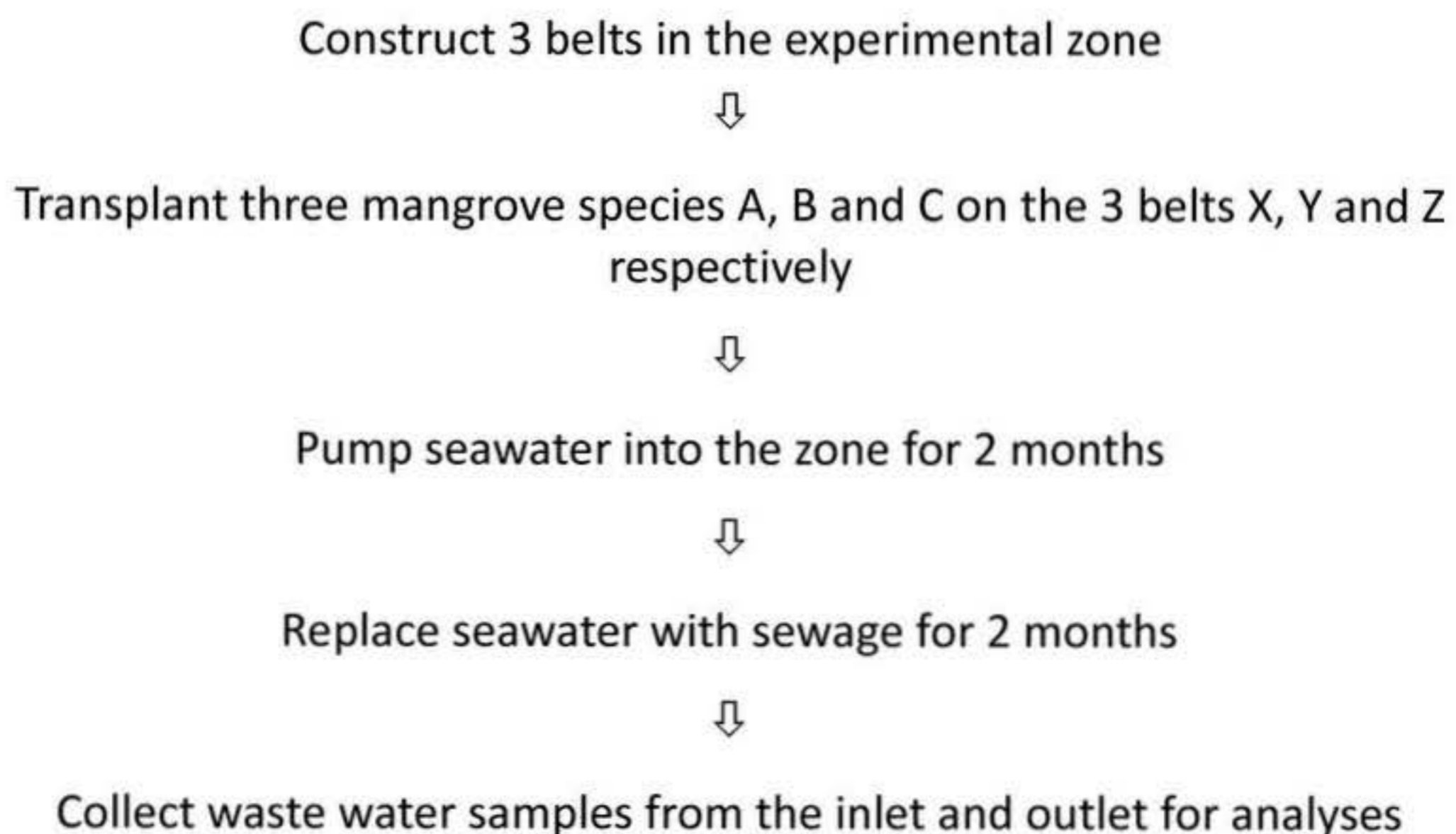
(b) Why the traveler felt light-headed? (2 marks)

After resting for a few days in a camp nearby, he found his body had adapted to the environment and decided to continue his hiking trip.

(c) State **TWO** changes that took place in his body to cope with the environment. (2 marks)

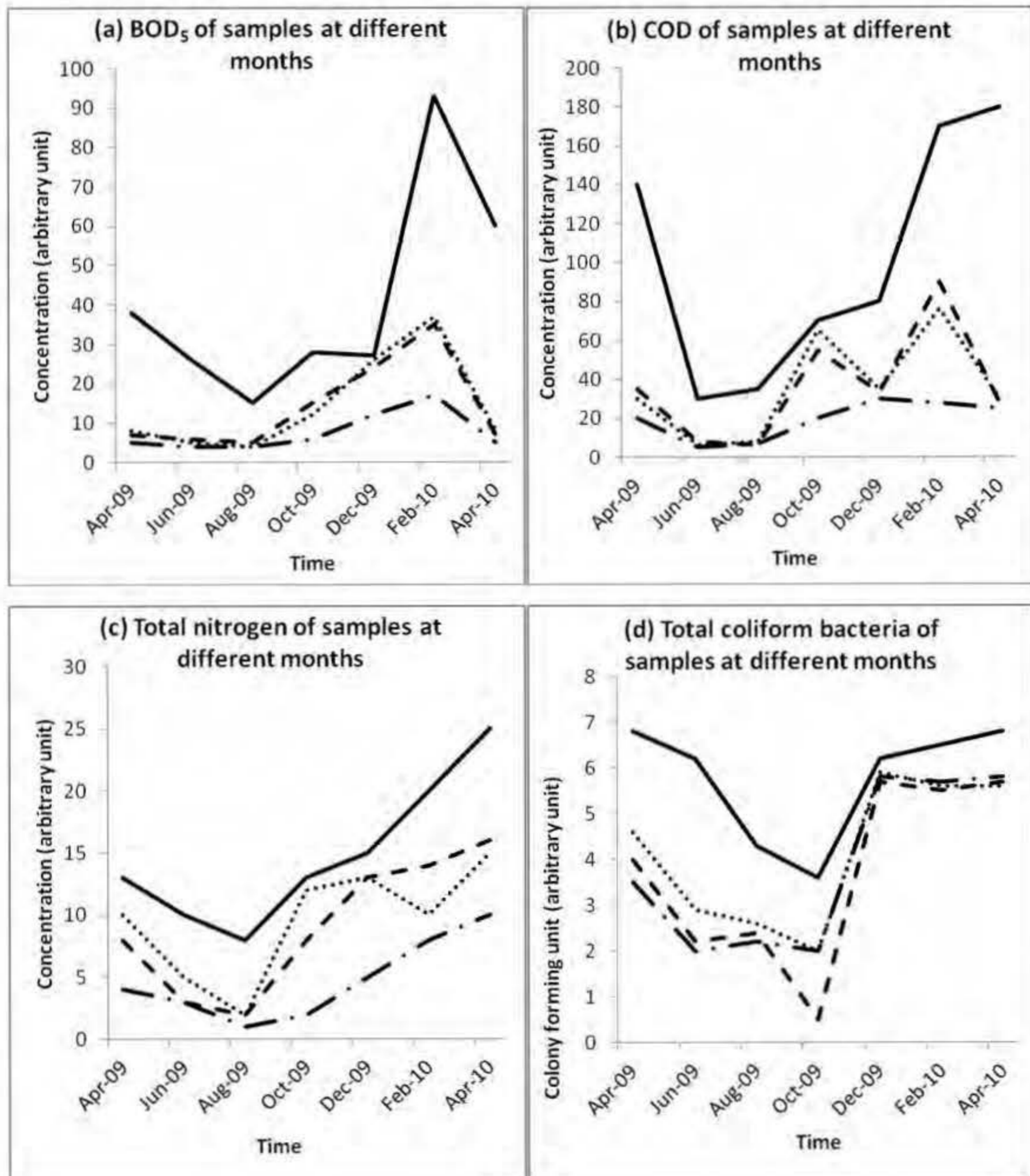
2. Scientists suggested that mangrove wetland can be used for sewage treatment. An investigation was done by using one foreign species (A) and two native mangroves species (B and C) to study the efficiency in the removal of organic wastes in sewage. Figure 2.1 shows the design of the investigation.

Figure 2.1: Flowchart showing the investigation design



During the investigation, water samples from the sewage influent and effluent of the 3 belts were collected and analyzed. The analysis included determination of BOD_5^1 , COD^2 , total nitrogen and total coliform bacteria in the water sample. Results were shown in Figure 2.2.

Figure 2.2: Different analysis of water samples



Key:

— Sewage influent

..... Effluent from species B

— • Effluent from species A

— — Effluent from species C

¹ BOD_5 : 5-day Biochemical Oxygen Demand

² COD: Chemical Oxygen Demand

2. (a) Why BOD₅ is commonly used as an indicator to evaluate the efficiency of wastewater treatment? (2 marks)
- (b) What is the purpose of pumping seawater into the experimental zone for 2 months? (1 mark)
- (c) From the results above, which species would you suggest for sewage treatment? Explain your answer. (3 marks)
- (d) As one species was a foreign species, state **ONE** threat it may pose to the local habitat if used for sewage treatment. What precautionary measure(s) should be taken? (2 marks)
- (e) Based on the results of Figure 2.2 (d) (Total coliform bacteria of samples at different months), there is one problem if mangroves are used for sewage treatment. State the problem and suggest a feasible solution to it. (2 marks)

END OF PAPER