

Secondary School Mathematics & Science Competition 2015

Biology

Date : 26 April, 2015 Total no. of pages : 27
Time allowed : 9:30 - 10:45 am (1 hour 15 minutes) Total marks : 75

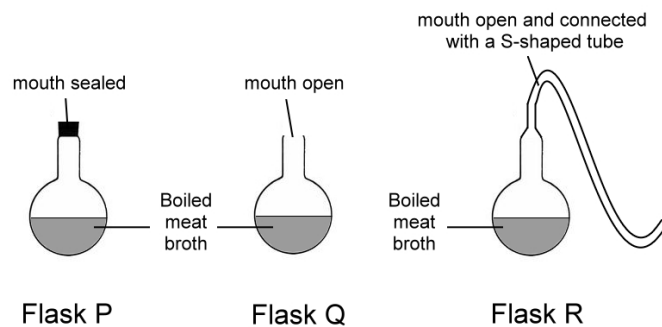
1. Write your Candidate Number, Exam Centre Number, Seat Number, Name in English, Name of School, Form, Language and Subject in the spaces provided on the Part A MC Answer Sheet and the Part B Answer Sheet.
2. When told to open this question paper, you should check that all the questions are there. Look for the words '**END OF PAPER**' after the last question.
3. Answer **ALL** questions in both Part A and Part B.
4. Part A (Multiple Choice Questions) (60 marks)
 - (a) You are advised to use an **HB** pencil to mark all your answers on the MC 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 MARK** for that question.
5. Part B (Structured Questions) (15 marks)
 - (a) Answers should be written in the space provided on the Part B Answer Sheet.
6. No mark will be deducted for wrong answers.
7. The diagrams in this paper are not necessarily drawn to scale.

Part A: Multiple Choice Questions (60 marks)

Directions for Questions 1 to 2: In the old days, people noticed that if meat broth was exposed to air, it will be contaminated. Two hypotheses were then proposed by people to explain the phenomena: spontaneous generation and germ hypothesis.

People who believed in spontaneous generation hypothesis claimed that organisms arose from non-living organic molecules in the broth while those believed in germ hypothesis claimed that it was the microorganisms that already pre-existed in the air contaminated the broth.

Later, a scientist named Louis Pasteur disagreed with the spontaneous generation hypothesis, then he constructed the following experimental setup:



Results showed that microorganisms only grew in Flask Q but not in Flask P and R.

1. Louis Pasteur tested both hypotheses by comparing
 - A. Flask P and Q only.
 - B. Flask P and R only.
 - C. Flask Q and R only.
 - D. Flask P, Q and R.

2. Which of the following characteristics of hypothesis can be deduced from Louis Pasteur's experiment above?
 - (1) It is testable.
 - (2) It is falsifiable.
 - (3) It is a fact.
 - A. (1) and (2) only
 - B. (1) and (3) only
 - C. (2) and (3) only
 - D. (1), (2) and (3)

3. Which of the following are regarded as molecules of life?

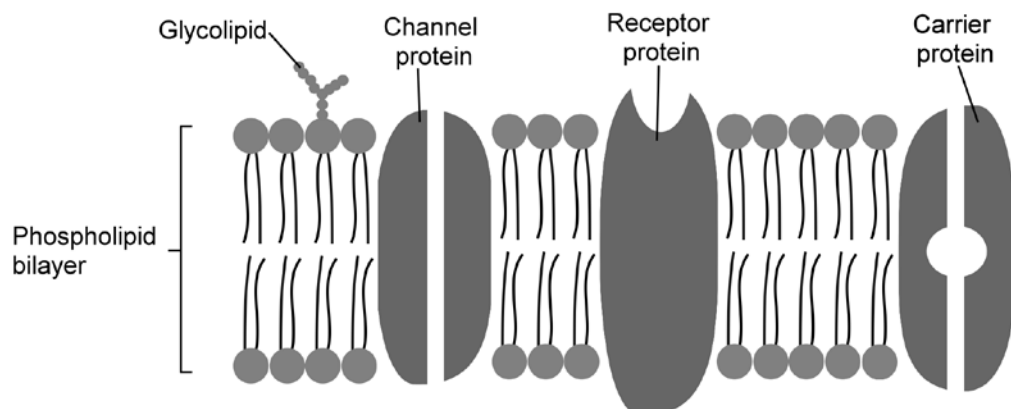
- (1) An atom (such as carbon)
- (2) A nucleotide (such as adenine)
- (3) An amino acid (such as glycine)

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

4. The bond that form between two complementary base pair of two adjacent DNA strands is

- A. phosphodiester bond
- B. hydrogen bond
- C. peptide bond
- D. disulphide bond

5. The diagram below shows the model of a cell membrane:



Which of the following factors does **not** contribute to the differential permeability of the cell membrane?

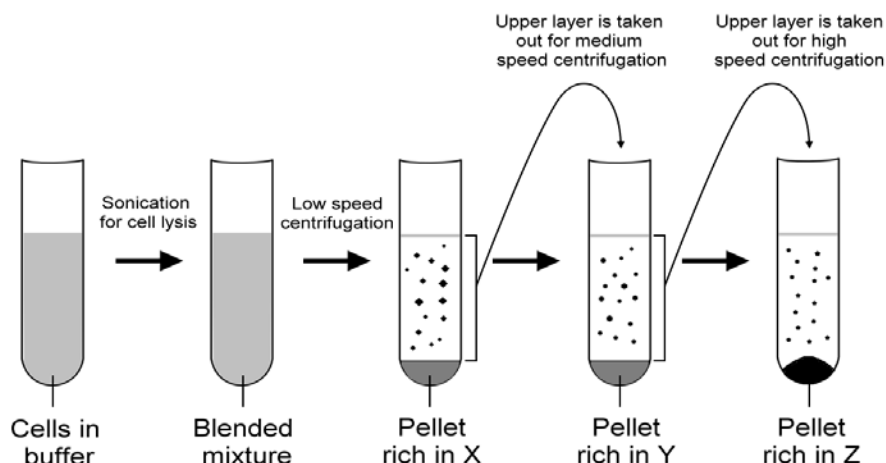
- A. The specificity of the carrier proteins.
- B. The selectivity of the transmembrane proteins.
- C. The hydrophobic barrier of the phospholipid bilayer.
- D. The presence of glycolipid on the membrane surface.

Directions for Questions 6 to 7 referring to the following scenario: A student is observing an Euglena under the light microscope. The field of view is shown in the diagram below:



6. If the Euglena is moving to the lower right hand corner as in the diagram, how should the student do to adjust the image of Euglena back to the center of the field of view?
- A. Move the slide to the left.
 - B. Move the slide to the right.
 - C. Move the slide to the upper left hand corner.
 - D. Move the slide to the lower right hand corner.
7. It is known that Euglena is unicellular organism with flagella for movement. It preys on other microorganisms and undergoes photosynthesis to obtain nutrients. Which of the following “Kingdoms” does Euglena belong to?
- A. Prokaryote.
 - B. Animalia.
 - C. Plantae.
 - D. Protista.

8. Cell fractionation is a tool for obtaining different cellular organelles according to their density. The following diagram summarizes the process:



Which of the following shows the **correct** combination of organelle X, Y and Z?

	<u>X</u>	<u>Y</u>	<u>Z</u>
A.	ribosomes	mitochondria	nucleus
B.	mitochondria	ribosomes	nucleus
C.	ribosomes	nucleus	mitochondria
D.	nucleus	mitochondria	ribosomes

9. Which of the following has the **least** abundance of smooth endoplasmic reticulum?

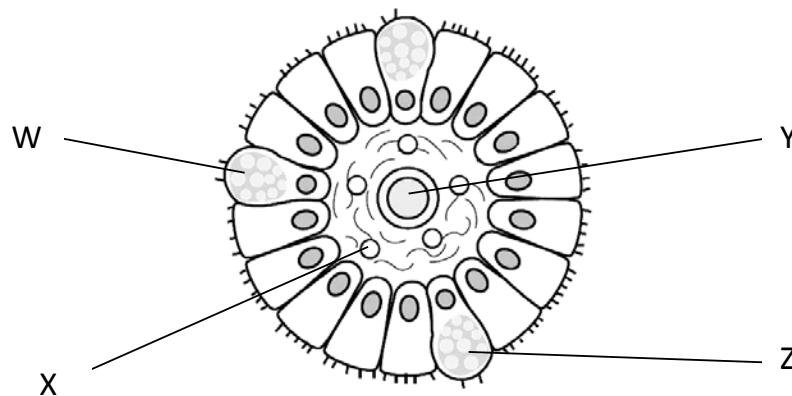
- Testes
- Ovaries
- Sebaceous gland
- Villus epithelial cells of the small intestine

10. What will a mesophyll cell and a red blood cell become when they are placed in a hypotonic solution for 30 minutes?

	<u>mesophyll cell</u>	<u>red blood cell</u>
A.	turgid	turgid
B.	lyse	turgid
C.	turgid	lyse
D.	plasmolyse	shrink

11. Which of the following processes does **not** require energy?
- Vesicular release of neurotransmitters into a synapse at the end of an axon.
 - Countercurrent exchange of respiratory gases between the water and the blood at the gills of fish.
 - Movement of protons in the electron transport chain across the inner membrane of mitochondria.
 - Engulfing of bacterium by macrophage.

Directions for Questions 12 to 13 : The diagram below shows a cross section of human villus:

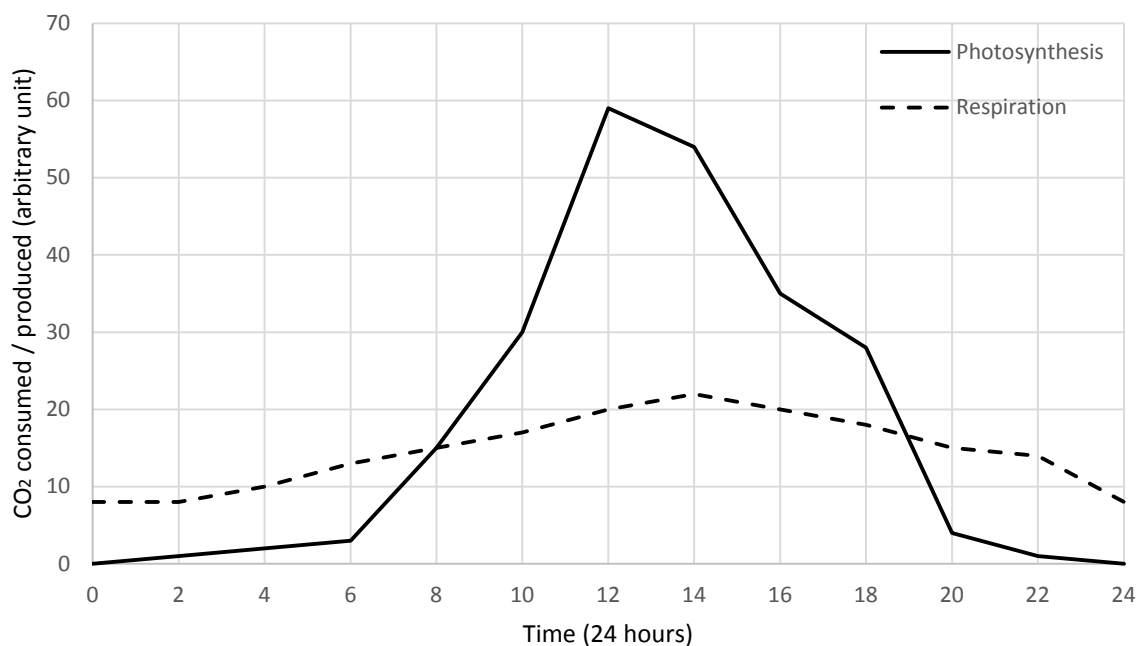


12. Food substances absorbed into structure Y will be transported to the liver by
- hepatic portal vein.
 - hepatic vein.
 - hepatic artery.
 - venae cavae.
13. Cell Z belongs to a cell type that continuously secretes mucus to protect the lining of the intestine. In which of the following body parts can this cell type also be found?
- bronchus
 - large intestine
 - lacrimal (tear) glands
- (1) and (2) only
 - (1) and (3) only
 - (2) and (3) only
 - (1), (2) and (3)

14. Which part of the human digestive system absorbs the largest proportion of water in food?

- A. Stomach
- B. Small intestine
- C. Large intestine
- D. Kidney

15. The graph below shows the change of rate of photosynthesis and respiration of a terrestrial plant over 24 hours.

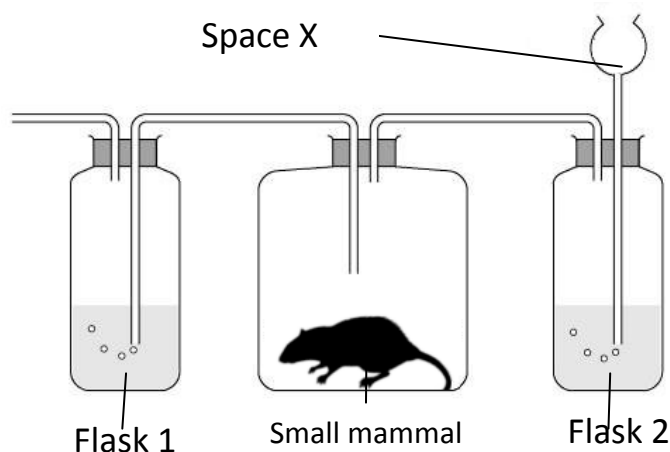


At which of the following time intervals are there a **net** consumption of carbohydrate by the plant?

- (1) 0 – 7.9
- (2) 8.1 – 18.9
- (3) 19.1 – 24

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

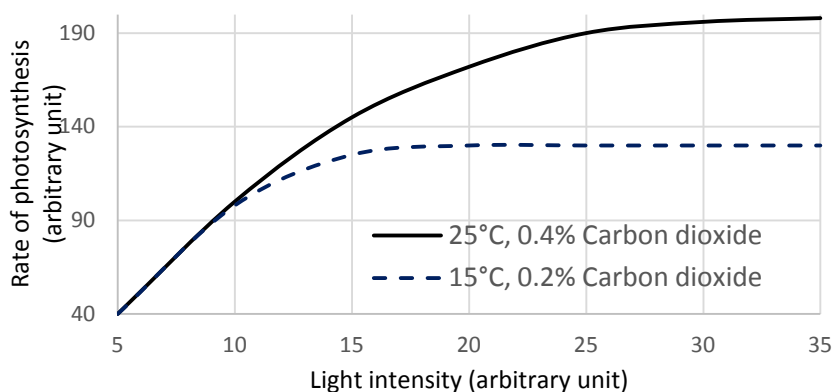
16. A student carried out an experiment with an intention to compare the amount of carbon dioxide between inhaled and exhaled air of a small mammal, he designed an experimental setup as below:



Which of the following combinations allows the student to make a successful comparison?

	<u>Space X</u>	<u>Flask 1</u>	<u>Flask 2</u>
A.	Sodium hydroxide pellets	Sodium hydroxide solution	Lime water
B.	Sodium chloride pellets	Lime water	Lime water
C.	Sodium hydroxide pellets	Lime water	Lime water
D.	Sodium chloride pellets	Sodium hydroxide solution	Bicarbonate indicator

17. A student performed an experiment in order to investigate the effect of light intensity on the rate of photosynthesis at different temperatures. The graph below shows his experimental results:



Which of the following conclusion can be drawn from the graph above?

- Rate of photosynthesis is limited by carbon dioxide concentration.
- Rate of photosynthesis is limited by the temperature.
- Rate of photosynthesis increases with light intensity.
- No conclusion can be drawn.

18. The complete oxidation of glucose requires

- (1) glycolysis.
- (2) The Krebs cycle.
- (3) oxidation of pyruvate.

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

19. Inside a chloroplast, the highest concentration of protons (H^+) can be found at the

- A. outer membrane
- B. inner membrane
- C. stroma
- D. thylakoid space

20. ATP synthase can be found at

- (1) inner membrane of mitochondria
- (2) nuclear membrane
- (3) thylakoid membrane of chloroplast

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

21. Which of the following about lactic acid fermentation is **not** correct?

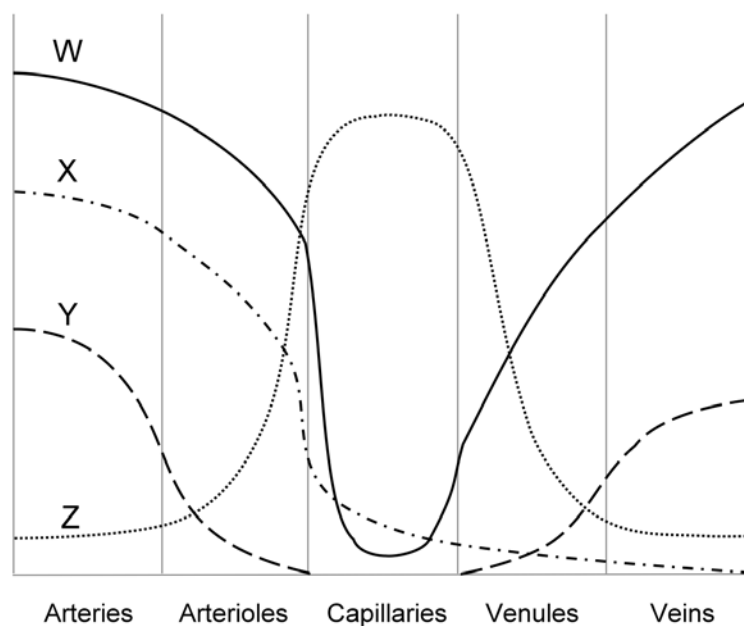
- A. CO_2 is not produced during the process.
- B. It takes place at cytoplasm.
- C. It donates electrons to the electron transport chain.
- D. 2 ATP are yielded.

22. Which of the following characteristics about blood of normal people is **correct**?

- (1) The color of oxygenated blood is red while that of deoxygenated blood is blue.
- (2) The average volume of blood for male and female are ranged from 5 to 6 and 4 to 5 liter respectively.
- (3) The pH of blood is ranged from 7.35-7.45.

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

23. The graph below shows the changes in blood flow rate, total cross-sectional area, blood pressure and amount of elastic fibers along various blood vessels of the circulatory system:



Which of the following combinations is the **correct** matching of the key to the graph?

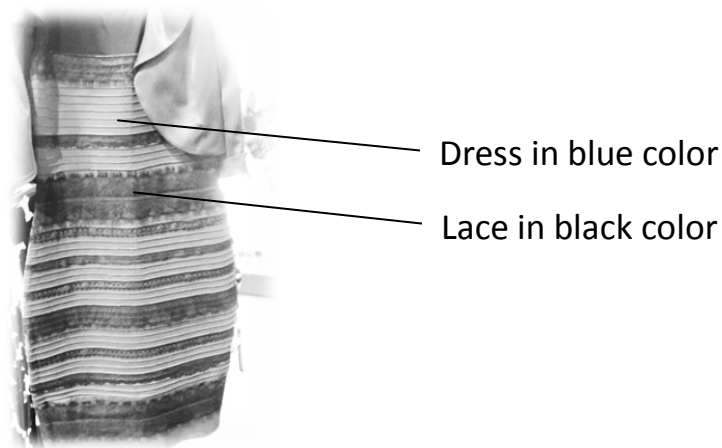
	<u>Blood flow</u> <u>rate</u>	<u>Total</u> <u>cross-sectional area</u>	<u>Blood</u> <u>pressure</u>	<u>Amount of</u> <u>elastic fibres</u>
A.	X	W	Z	Y
B.	Y	Z	W	X
C.	W	Z	X	Y
D.	W	Z	Y	X

24. Which of the following are examples of an effector in nervous co-ordination in mammals?

- (1) gland
- (2) muscle
- (3) cerebrum

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

25. The following dress became a hot topic recently. The fact is that the dress is blue in color with black lace. However some people claimed that it was a white dress with gold lace instead.

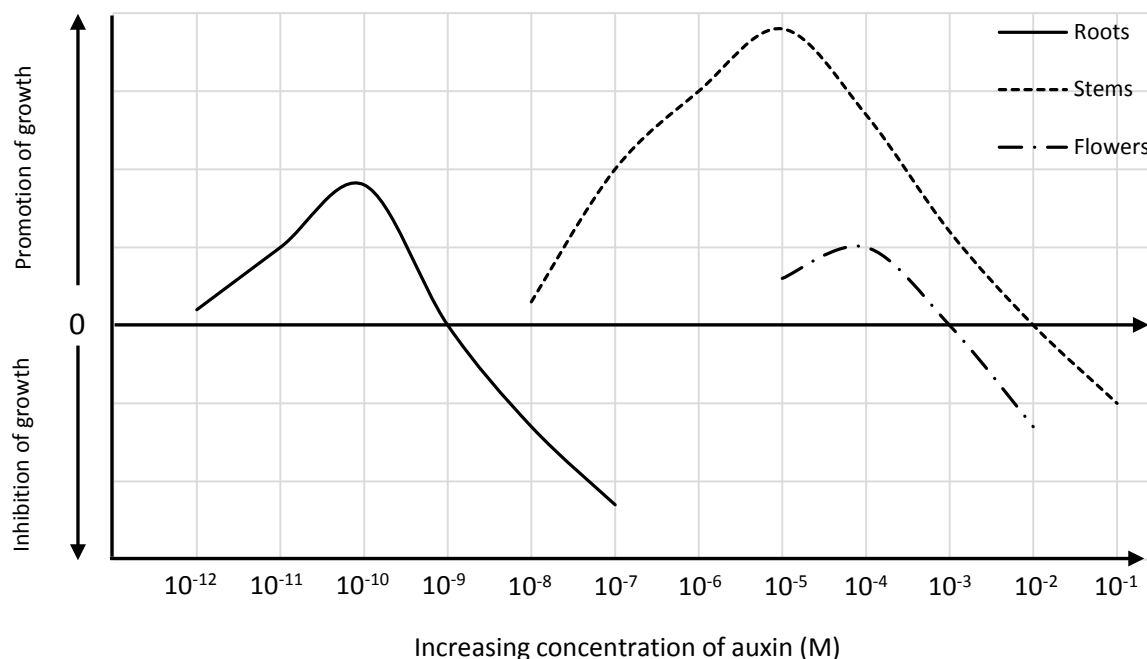


Why some people perceived it as white dress with gold lace?

- A. They are color-blinded.
- B. They are short-sighted.
- C. Their cone cells only perceived white and gold color.
- D. Their brains subtracted the color of the light source from the actual color of the dress.

26. Anatomical receptors are specialist structures located close to sensory nerve cells which allow us to detect physical changes in external environment. Which of the following are anatomical receptors found in the human body?
- (1) Thermoreceptors
 - (2) Mechanoreceptors
 - (3) Photoreceptors
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
27. Which of the following activities are predominated by parasympathetic nervous system?
- (1) urination and defecation
 - (2) digestion
 - (3) embarrassment
- A. (1) and (2) only
B. (1) and (3) only
C. (2) and (3) only
D. (1), (2) and (3)
28. Which of the following hormones is **not** produced by the anterior lobe of the pituitary gland?
- A. Thyroid-stimulating hormone (TSH)
B. Antidiuretic hormone (ADH)
C. Prolactin
D. Luteinizing hormone (LH)
29. Susan has eaten a meal that is high in carbohydrates. As a result, her blood glucose level tends to increase. Which of the following will help maintain glucose homeostasis in this instance?
- A. Glucagon is released to lower blood glucose.
B. Cortisol promotes the removal of glucose from the blood.
C. Glucagon is released to stimulate the liver to break down glycogen.
D. Insulin is released to promote cellular uptake of glucose.

Directions for Questions 30 to 31: Auxin is a plant growth hormone which exerts influence on different plant organs at different concentrations. The graph below shows the results of an investigation:



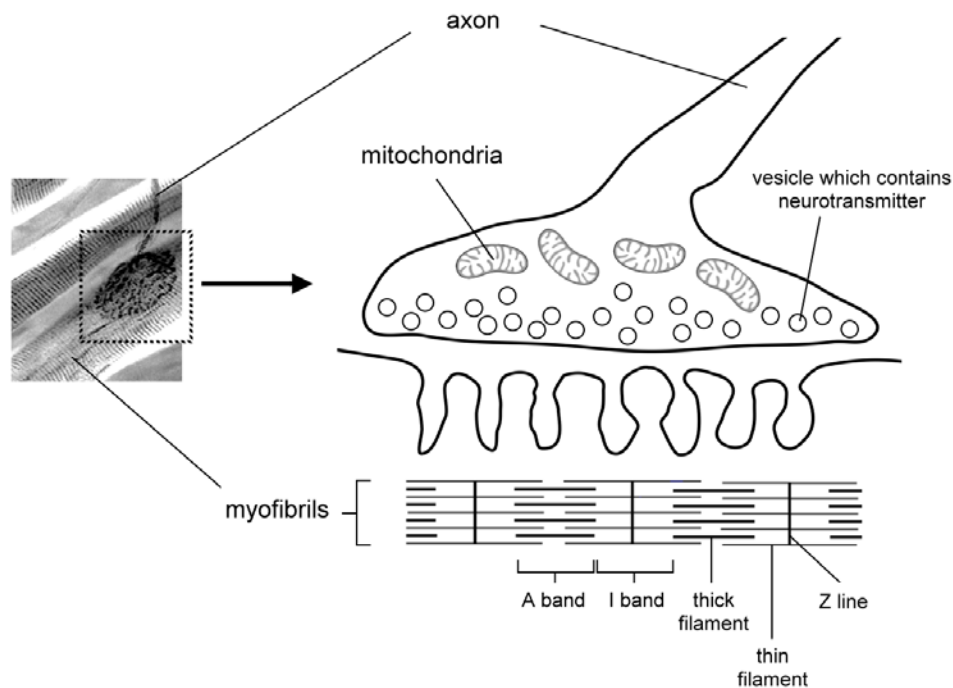
30. Which of the following is the appropriate title of the graph above?

- A. The inhibitory and promoting effect of auxin on the development of plant.
- B. How auxin affects the growth of various important plant organs.
- C. The optimal auxin concentration for the growth of different plant organs.
- D. The relationship between the auxin concentration and its effect on the development of plant organs.

31. Which of the following can be deduced from the graph above?

- A. A concentration of 10^{-3} M of auxin will inhibit both stem and flower growth.
- B. A concentration of 10^{-5} M of auxin will promote both stem and flower growth.
- C. A concentration of 10^{-6} M of auxin will promote stem growth but exerts no effect on root.
- D. A concentration of 10^{-8} M of auxin will inhibit both stem and root growth.

Directions for Questions 32 to 33 referring to the following scenario: The following diagram shows a neuromuscular junction and its enlarged part:



32. The neurotransmitter involved in the transmission of nerve impulse across the neuromuscular junction is

- A. Acetyl-CoA
- B. Acetylcholine
- C. Noradrenaline
- D. Dopamine

33. Which of the following components of the sarcomere will **not** be shortened during muscle contraction?

- (1) Thin filament
- (2) I band
- (3) A band

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

Directions for Questions 34 to 35: The diagram bellow shows a plant with its flower and leaves in a garden:



34. Which of the following properties of the flower can be deduced from the diagram?

- (1) It is an insect-pollinated flower.
- (2) It has scent and produce nectar to attract insects.
- (3) It is a bisexual flower which contains both male and female reproductive structures.

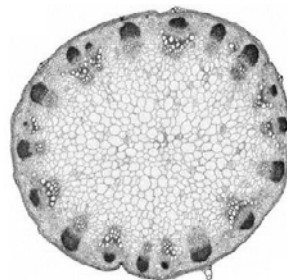
- A. (1) and (2) only
- B. (1) and (3) only
- C. (2) and (3) only
- D. (1), (2) and (3)

35. Which of the following is the most probable cross-sectional diagram of the young stem of the above plant?

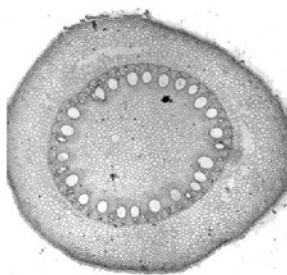
A.



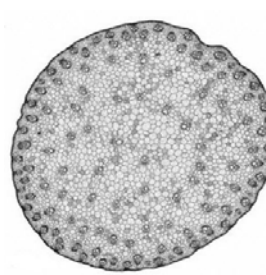
B.



C.



D.

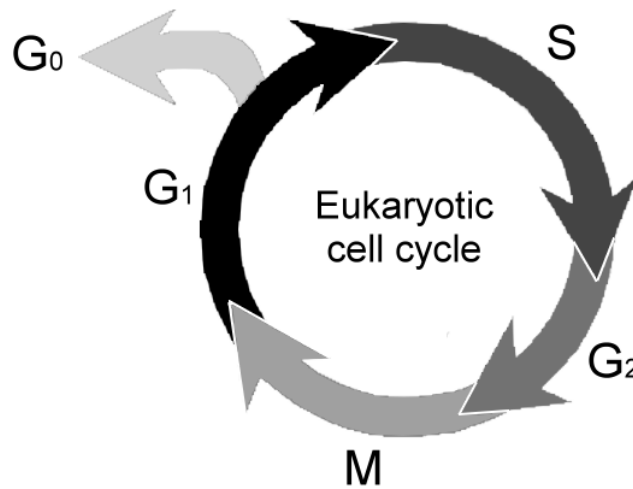


Directions for Questions 36 and 37: the following picture shows a cross section of a peach:



36. The seed of peach is likely to be dispersed by
- A. wind.
 - B. animals.
 - C. water.
 - D. mechanical ejection.
37. Which of the following descriptions about the genotype of the cells in the peach is **correct**?
- A. Cells of X and Y have the same genotype and are different from that of Z.
 - B. Cells of X and Z have the same genotype and are different from that of Y.
 - C. Cells of X, Y and Z have the same genotype.
 - D. Cells of X, Y and Z have the genotype different from each other.
38. The process of duplicating chromosomes prior to cell division is called
- A. replication.
 - B. repetition.
 - C. remodeling.
 - D. reassembling.

39. The following diagram shows a eukaryotic cell cycle:



Which of the following cell types does **not** complete the cell cycle and enter G₀ and permanently arrested there?

- A. Cancer cell
- B. Liver cell
- C. Nerve cell
- D. Skin cell

40. Which of the following is the term given to the cells of the body except the reproductive cells (sperm and oocytes)?

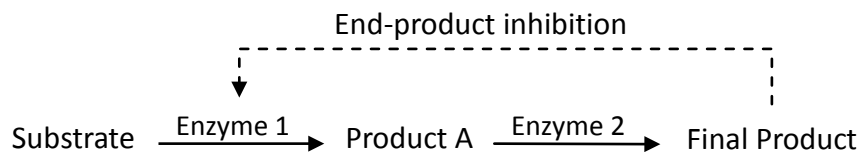
- A. Core cells
- B. Somatic cells
- C. Corpus cells
- D. Main cells

41. If a cell lacked the enzyme DNA polymerase, it could **not**

- A. maintain the integrity of the nuclear envelope.
- B. form complementary sequences of DNA.
- C. link segments of DNA together.
- D. form spindle fibers.

Directions for Questions 42 to 43: A metabolic reaction is usually regulated by several enzymes.

Below is an example:



42. The universal codon table below can be used to determine the amino acid sequence from the mRNA codon.

Universal codon table

First base in the codon	Second base in the codon				Third base in the codon
	U	C	A	G	
U	Phe	Ser	Tyr	Cys	U
	Phe	Ser	Tyr	Cys	C
	Leu	Ser	STOP	STOP	A
	Leu	Ser	STOP	Trp	G
C	Leu	Pro	His	Arg	U
	Leu	Pro	His	Arg	C
	Leu	Pro	Glu	Arg	A
	Leu	Pro	Glu	Arg	G
A	Ile	Thr	Asn	Ser	U
	Ile	Thr	Asn	Ser	C
	Ile	Thr	Lys	Arg	A
	Met	Thr	Lys	Arg	G
G	Val	Ala	Asp	Gly	U
	Val	Ala	Asp	Gly	C
	Val	Ala	Glu	Gly	A
	Val	Ala	Glu	Gly	G

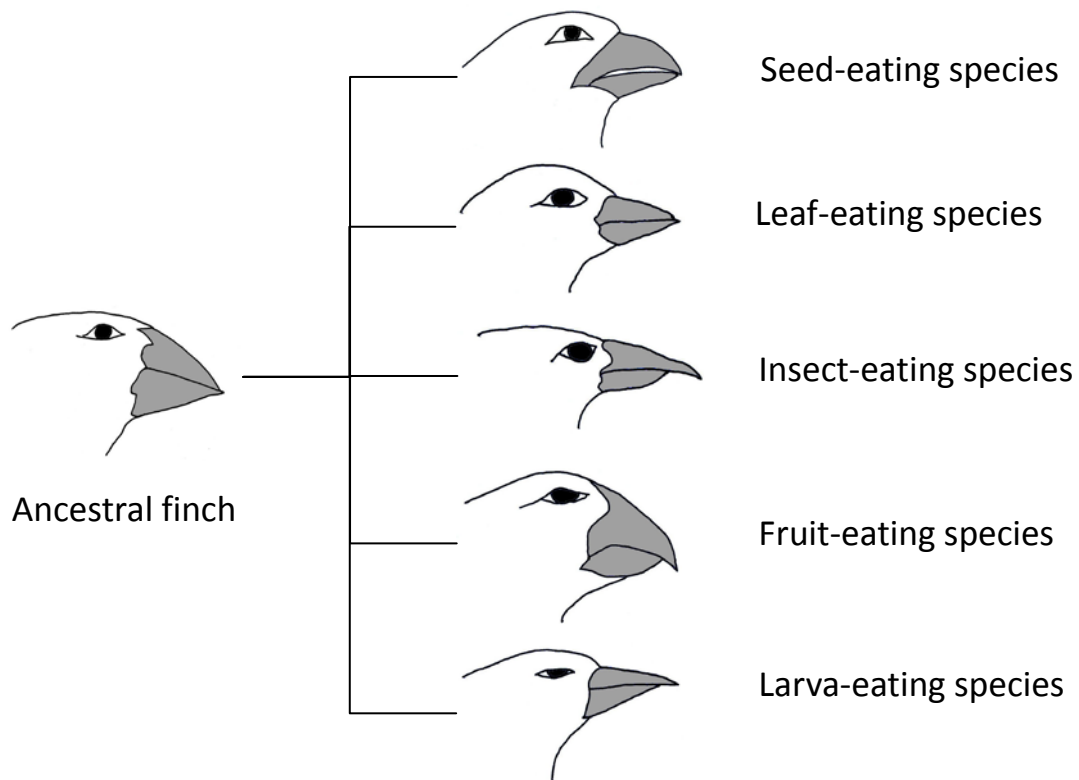
(U, C, A and G represent the 4 different bases in nucleotides.)

A part of the nucleotide sequence of a gene which is responsible for forming the active site of Enzyme 1 is CGGGCGACCGGA. According to the universal codon table, the respective amino acid sequence encoded is

- A. Arg-Ala-Thr-Gly
- B. Arg-Gly-Gly-Ala
- C. Ser-Pro-Leu-Ala
- D. Ser-Arg-Leu-Trp

43. What will happen if a substitution point-mutation happens and the mutated sequence becomes CGGGCGACTTGA?
- The amount of product A will increase.
 - The amount of substrate will increase.
 - The amount of final product will decrease first and then increase.
 - The reaction will remain unchanged.
44. If a pea plant has 3 pairs of unlinked alleles Tt Rr Aa, how many types of gamete genotype does it have?
- 3
 - 6
 - 8
 - 9
45. Phenylketonuria is an inherited recessive trait which is caused by a defective gene on autosomes. Two unaffected individuals have a first child with the disease. What is the probability that their next two children will **not** have the disease?
- 6%
 - 56%
 - 75%
 - Insufficient information provided.
46. 'Red-eye' and 'white-eye' are two alleles which control eye pigmentation in the fruit fly. In a cross, two red-eye fruit flies produced 80 red-eyed males, 79 white-eye males and 162 red-eye females. The white-eye allele is
- dominant and located on autosome.
 - recessive and located on autosome.
 - dominant and located on sex chromosome.
 - recessive and located on sex chromosome.

Directions for Questions 47 to 48: The finches that Charles Darwin studied on Galápagos Islands had been evolved into different species as shown in the diagram below:



47. Each species was adapted for different types of food. This is an example of

- A. adaptive radiation.
- B. coevolution.
- C. competitive exclusion.
- D. convergent evolution.

48. Which of the following factors could contribute to the above phenomenon?

- (1) Mutation
- (2) Isolation mechanism
- (3) Natural selection

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

49. Secondary succession can begin right after

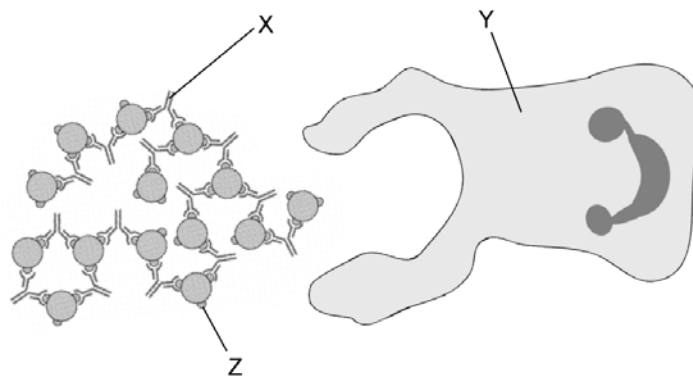
- (1) primary succession.
- (2) a forest fire.
- (3) volcanic eruption of an island.

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

50. Which of the following is **least** likely to be found in fossil record?

- A. Jelly fish
- B. Pollen grains
- C. Shark tooth
- D. Spider

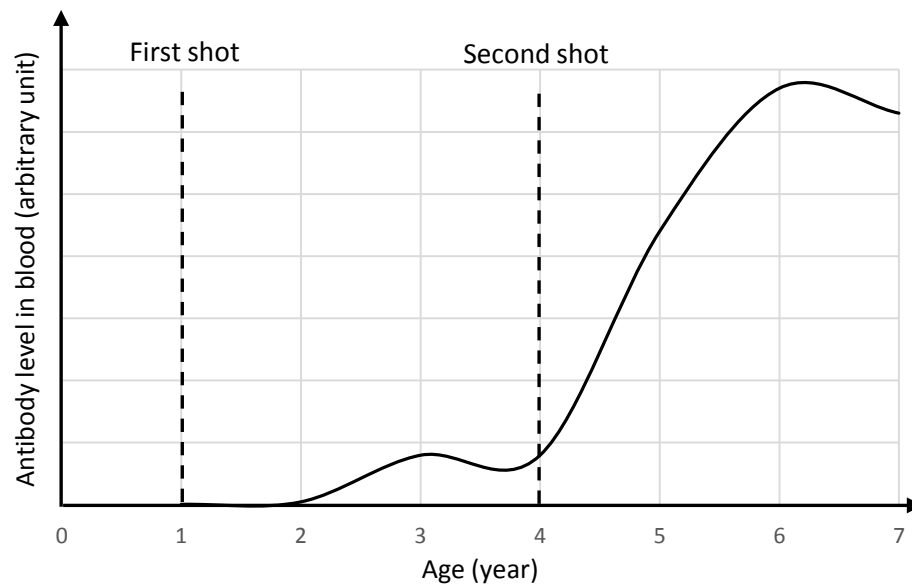
51. The diagram below shows a white blood cell engulfing some pathogens.



Identify X, Y and Z.

- | | <u>X</u> | <u>Y</u> | <u>Z</u> |
|----|-----------------|-----------------|-----------------|
| A. | Antigen | Anitbody | Pathogen |
| B. | Anitbody | Antigen | Pathogen |
| C. | Antigen | Phagocyte | Antibody |
| D. | Antibody | Phagocyte | Antigen |

52. Peter has taken two shots of vaccination. The graph below shows the change in the antibody level in his blood:



Based on the graph above, which of the following comparisons about the primary and secondary response to the vaccine is **incorrect**?

- A. The primary response is faster.
- B. The secondary response is stronger.
- C. The primary response has a longer latent period.
- D. The secondary response lasts longer.

53. Which of the following comparisons about immunity is **correct**?

	<u>Active immunity</u>	<u>Passive immunity</u>
A.	Exposure to an infectious agent	Breast feeding
B.	Injected the serum with antibodies	Vaccination
C.	Exposure to an infectious agent	Vaccination
D.	Injected the serum with antibodies	Breast feeding

54. Which of the following type of cell can kill the pathogens directly?

- A. Killer T cell
- B. Helper T cell
- C. Memory T cell
- D. Memory B cell

55. Which of the following sentences about insulin-dependent diabetes is **correct**?

- (1) Blood insulin level lower than normal.
- (2) Usually occurs early in life.
- (3) Insulin-producing cells in the pancreas are destroyed.

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

56. Which of the following diseases can be cured by antibiotics?

- A. Ebola
- B. Influenza
- C. Cholera
- D. Dengue fever

57. Malaria is a vector-borne disease which is caused by infection with a

- A. bacterium.
- B. mosquito.
- C. protozoan.
- D. virus.

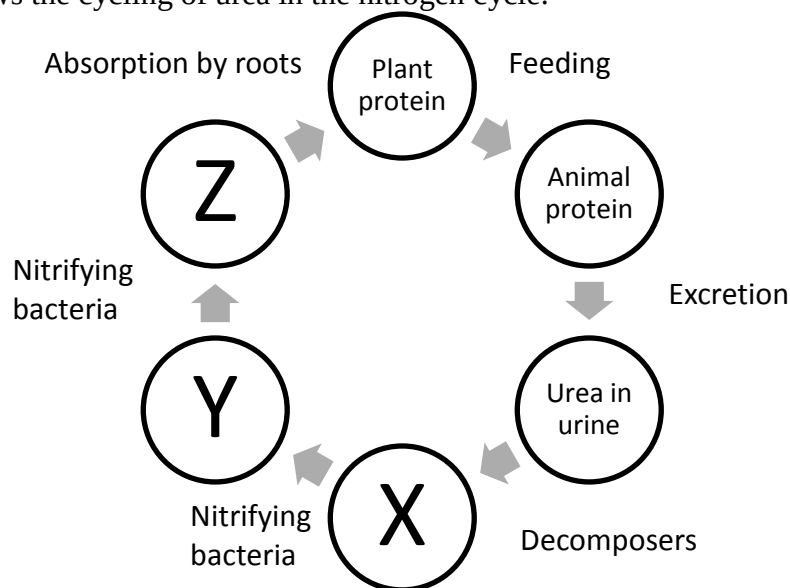
58. Biomass is anything that made from living or recently dead plant or animal materials.

Which of the following advantages of using biomass are **not** always true?

- (1) It increases biodiversity.
- (2) It is renewable.
- (3) It reduces greenhouse gas emission.

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

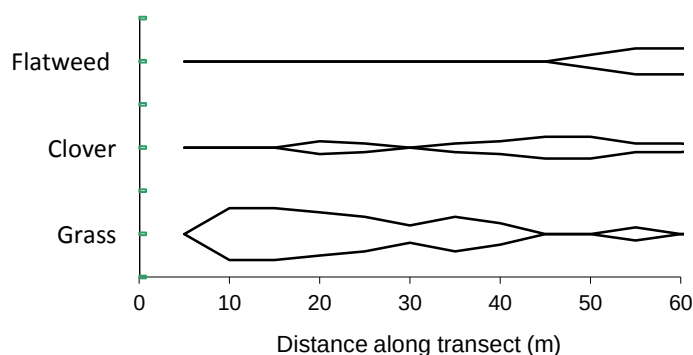
59. The diagram shows the cycling of urea in the nitrogen cycle:



What is X, Y and Z respectively?

	<u>X</u>	<u>Y</u>	<u>Z</u>
A.	NH_3	NO_2^-	NO_3^-
B.	NO_2^-	NH_3	NO_3^-
C.	NO_3^-	NO_2^-	NH_3
D.	NH_3	NO^{2-}	NO^{3-}

60. In an ecological investigation, a student has drawn a kite diagram below to represent the distribution of different plants:



Which of the following can be revealed from the above diagram?

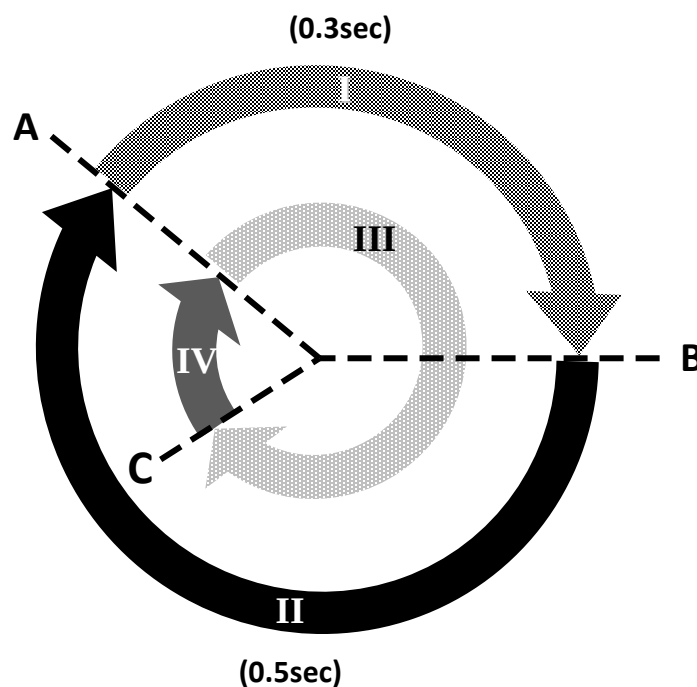
- A. The total number of different species in the habitat.
- B. Physical factors which affect the distribution of different species.
- C. Biotic factors which affect the distribution of different species.
- D. Zonation of the different species.

End of Part A

Part B: Structured Questions (15 marks)

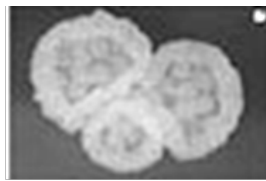
Answer **ALL** questions in Part B. Answers should be written in the spaces provided on Part B answer sheet.

1. The following diagram shows the muscle events (**I** to **IV**) that happen in a human cardiac cycle with a constant heart rate. The outer and inner circles represent the events that happen in ventricles and atria respectively. A, B and C are the time points within the cardiac cycle.

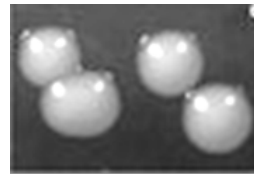


- | | |
|---|----------|
| (a) Determine the heart rate (show calculation steps). | (1 mark) |
| (b) Which event (I to IV) generates the cardiac output? | (1 mark) |
| (c) Which time point(s) produce(s) the heart sounds? | (1 mark) |
| (d) State the heart valve(s) which is/are closed in event II ? | (1 mark) |
| (e) Describe one physiological significance for the events II and IV . | (1 mark) |

2. A genus of bacteria has two species, A and B. These two species can be distinguished by their morphological features as shown below:

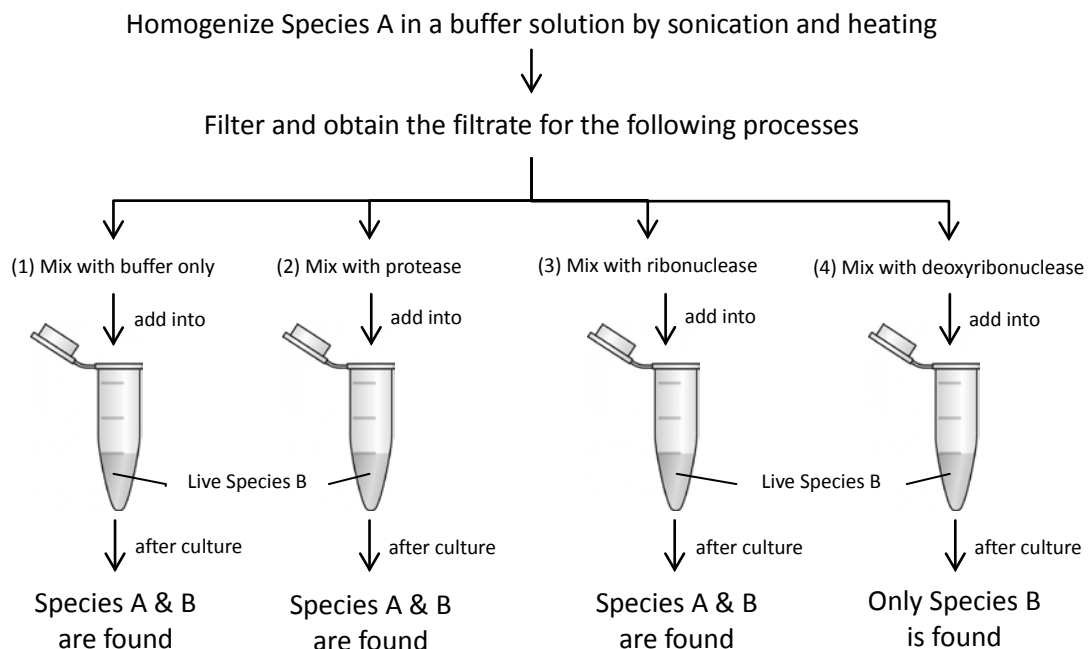


Colonies of
Species A



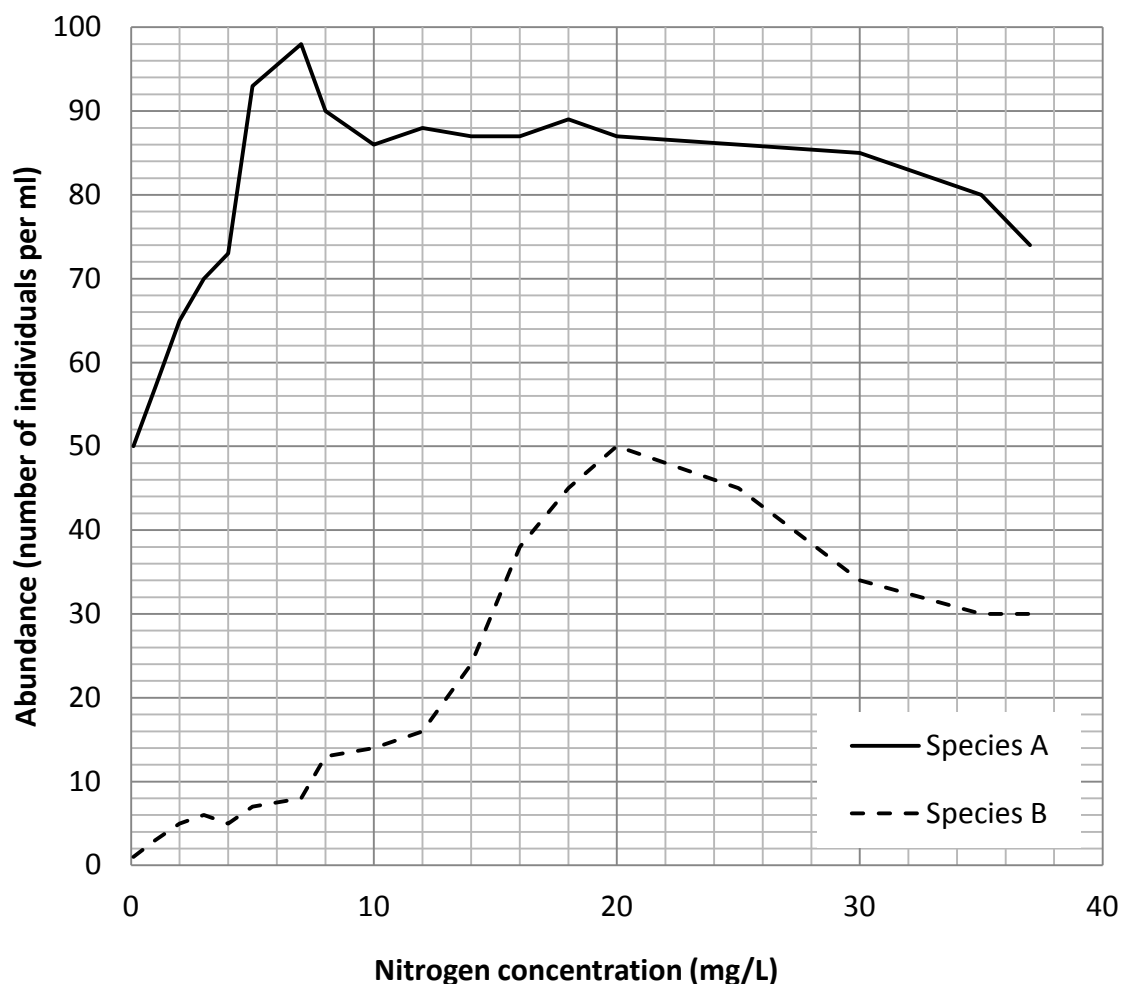
Colonies of
Species B

A student carried out an investigation with an aim to find out what determines the morphological appearance of the bacteria. The following diagram summarizes his experimental procedures and results:



- (a) From the experimental procedure above,
- (i) what kind of molecules in the filtrate determine the morphological appearance of the bacteria? (1 mark)
 - (ii) suggest **two** properties of the molecules in (a)(i) with reference to the preparation of the filtrate. (2 marks)
- (b) Which setup is the control experiment? (1 mark)
- (c) What is the biological term given to the process in which the bacterial cells take up molecules mentioned in (a)(i) and hence change their morphological appearance? (1 mark)

3. The graph below shows the abundance of two microalgae (Species A and B) in the water of a fish farm at different nitrogen concentration. The presence of Species A above 70 individuals per ml is positively related to the growth of fish while the presence of Species B at 20 individuals per ml or above begins to cause large number of fish deaths.

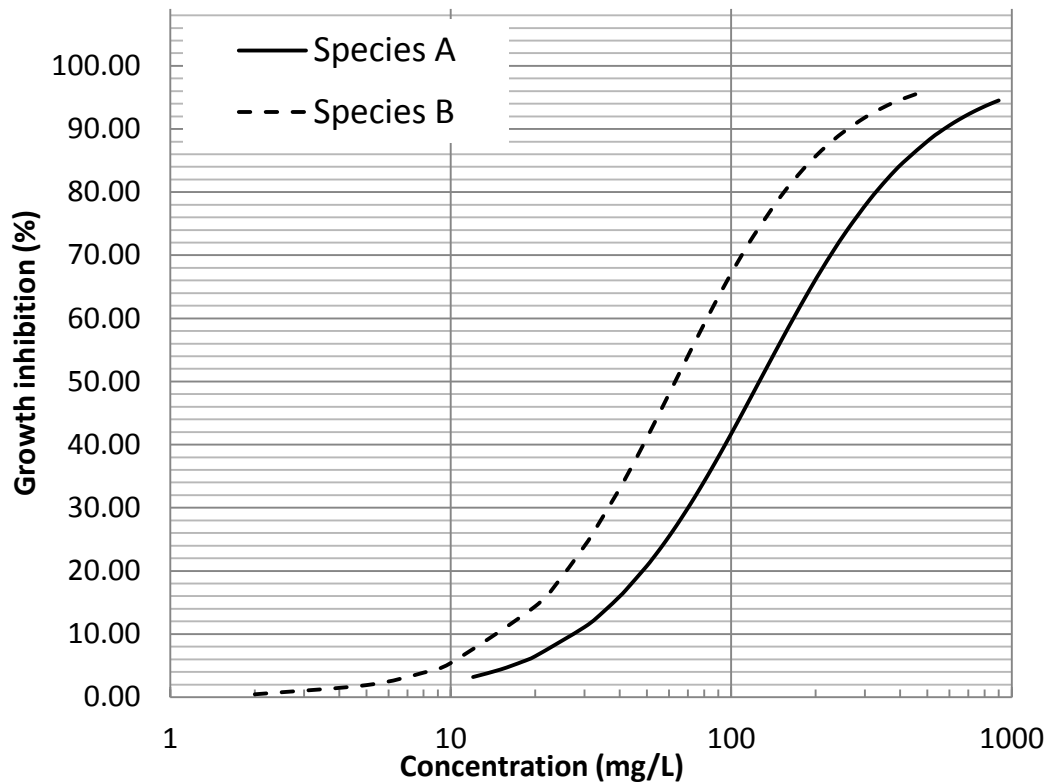


- (a) Determine the optimum concentration of nitrogen for fish growth based on the density of Species A and B. (1 mark)

Nitrogen concentration in water was found to be related with the density of fish. For economic reason, the fish-farming should run with at least 20 fish per m^3 . It was also determined that every 2 fish per m^3 of water will constitute to an increase of 1 mg/L nitrogen concentration.

- (b) With all the information provided above, suggest the optimum fish density in fish farm for maximizing profit. (1 mark)

3. The graph below shows the growth inhibition profile of the two microalgae species in response to a pesticide.



(c) Which microalgae species is more easily affected by the pesticide? (1 mark)

- (d) If the fish farm applied 30 mg/L of pesticide in its water to control algal growth, what will be new optimum fish density in the fish farm for maximizing profit?

[Note: at 30 mg/L of pesticide, Species A will have 10% lower abundance and Species B will have 25% lower abundance]

(2 marks)

END OF PAPER