

MJSO

Malta Junior Science Olympiad

2020 | Biology



SCIENCE CENTRE
PEMBROKE MALTA



DIRECTORATE FOR LEARNING AND ASSESSMENT PROGRAMMES
MEDE

Acknowledgments

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Instructions

- You are asked to attempt **all** questions within the four sections and write your answers clearly in the spaces provided. Whenever necessary indicate the question number to your answer.
- Show **all** steps in your working. Necessary equations are incorporated in the relevant questions.
- You are also reminded of the necessity of good English and orderly presentation of your answers.
- The use of a calculator is permitted.
- No extra foolscaps will be provided.

Section A: Multiple choice questions (15 marks)

Each question has one correct answer. Write your answer in the corresponding box at the side of the question.

Questions 1 to 2 refer to the numbered structures in the diagram of a nephron of a mammal kidney (Figure 1).

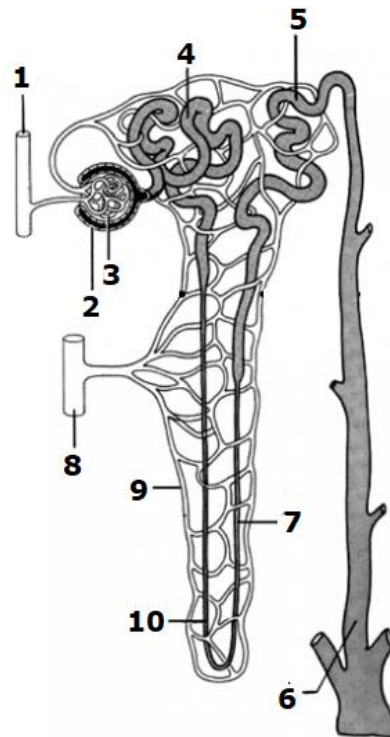


Figure 1

<https://www.purposegames.com/game/label-a-nephron-game>

1) Reabsorption of glucose occurs in part:

- A 3
- B 4
- C 5
- D 10.

2) Anti-Diuretic Hormone (ADH) works on part:

- A 10
- B 7
- C 6
- D 5.

Questions 3 to 5 refer to an investigation.

Figure 2 shows the apparatus of this investigation.

Sodium hydroxide absorbs carbon dioxide in air.

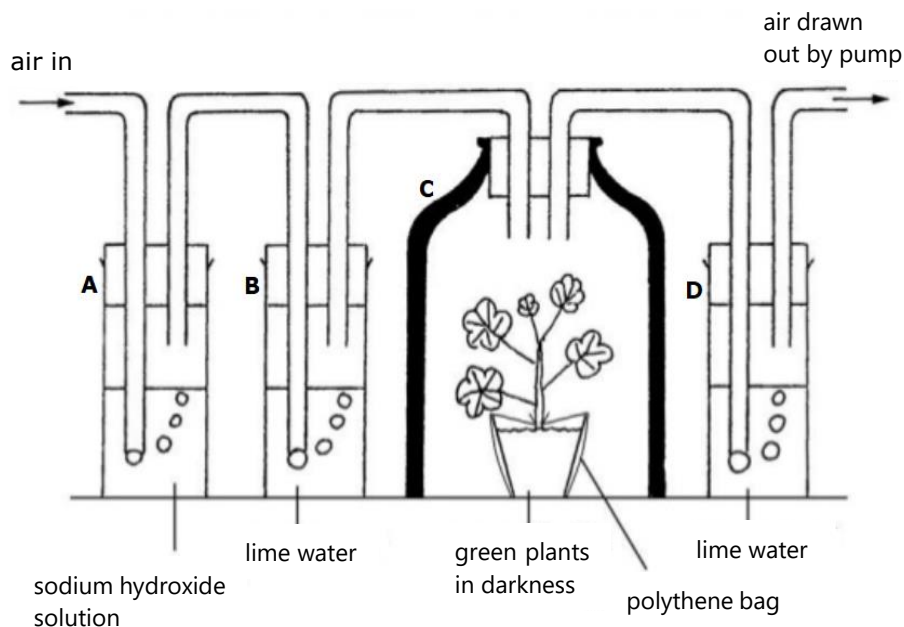


Figure 2

<https://www.slideshare.net/SEC BIO/respiration-15863663>

- 3) Flask C, containing the potted plant, is covered with aluminium foil. The purpose of the foil is to:
- A prevent respiration
 - B keep an even temperature inside the flask
 - C prevent the plant from producing carbon dioxide
 - D prevent photosynthesis.

- 4) The objective of the polythene (plastic) bag covering the pot in flask C is to:
- A stop the release of oxygen into flask C
 - B stop the release of water into flask C
 - C stop the release of carbon dioxide into flask C
 - D stop the release of mineral ions into the soil.

- 5) The investigation was left running for one day. The following observation was made.

The lime water in tube D turned milky while that in tube B remained clear.

A conclusion that can be drawn from this result is that:

- A the plant absorbs carbon dioxide in the dark
- B the plant produces carbon dioxide in the dark
- C the plant produces oxygen in the dark
- D the plant produce oxygen during respiration.

Questions 6 to 7 refer to Figure 3.

A visking tubing is permeable to small molecules but not to large molecules.

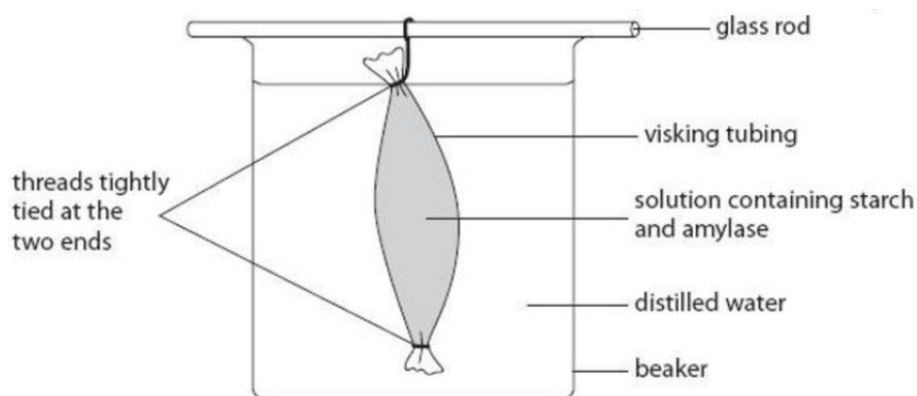


Figure 3

<https://slideplayer.com/slide/14808099/>

- 6) The apparatus above was left standing for two hours. After this time, a sample of the water surrounding the visking tubing was tested using Iodine and Benedict's solution. Which of the following results were obtained?

	Iodine Test	Benedict's Test
A	Brown	Blue
B	Blue black	Reddish brown precipitate
C	Brown	Reddish brown precipitate
D	Blue black	Blue

- 7) Diffusion stops when:
- A the concentration of maltose inside and outside the visking tubing is the same
 - B all the starch has diffused into the distilled water
 - C all the maltose has diffused into the distilled water
 - D the concentration of starch inside and outside the visking tubing is the same.

Questions 8 – 10 include three statements. Answers are subject to the instructions below.

A	Parts a, b and c correct
B	Parts a and b correct
C	Parts b and c correct
D	Only part a correct

- 8) General characteristics of Bryophytes (mosses) include:
- a plants do not have proper roots, stem and leaves
 - b size is limited to the presence of vascular tissue
 - c reproduction does not need a watery medium.

- 9) Insects have:
- a one pair of wings
 - b three pairs of jointed legs
 - c body divided to head, thorax and abdomen.

- 10) When comparing bacteria to protists:
- a both are single cell organisms
 - b both contain mitochondria
 - c bacteria have a true nucleus while protists do not.

Questions 11 to 15 refer to different topics.

11) One example of mutualism is:

- A a spider spinning a web around branches of a tree
 - B hookworms attached to the inner lining of mammal's intestines, absorbing food nutrients
 - C the black walnut tree secretes a chemical that kills the grasses growing in the tree's root region
 - D oxpeckers (birds) land on zebra and eat ticks and other parasites on the skin of the zebra.
-

12) The flow diagram (Figure 4) below shows the process of thermoregulation.

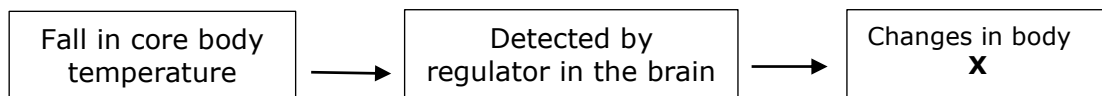


Figure 4

The change in body X can be

- A hair erector muscles relax, hairs become flat
 - B vasodilation
 - C vasoconstriction
 - D secretion of sweat .
-

13) In the food chain, below:



- A the plants supply the consumers only with oxygen
 - B all the energy absorbed by the plants will eventually pass to the consumers
 - C the number of birds is more than that of insects
 - D mites supply insects with food.
-

14) Some plants do not grow in sandy soil as:

- A sandy soil does not hold enough water
 - B sandy soil does not hold sufficient air for the roots
 - C sandy soil is rich in nutrients
 - D sandy soil have the smallest particle size.
-

15) Seed dispersal reduces competition between the parent plant and the germinating seedlings. However, it does NOT reduce competition in:

- A space
 - B water
 - C oxygen
 - D light.
-

Total: 15 marks

Section B: Short answer questions (30 marks)

1) This question is on the leaf structure and transpiration.

a) In an investigation on transpiration, a student made the following incorrect observation.

'The rate of transpiration decreases when the humidity increases because the temperature of the environment decreases with increasing humidity'.

Explain why this observation is incorrect.

(3)

b) The table below shows the size of guard cells and their stomata as well as the average number of stomata in one square millimetre of leaf surface area.

		Name of plant			
		Dicots		Monocots	
		<i>Impatiens sultani</i> (Busy Lizzie)	<i>Primula sinensis</i> (Chinese primrose)	<i>Zea mays</i> (Maize/Corn)	<i>Triticum sativum</i> (Common wheat)
Lower leaf surface of plant	Size of Guard cell (μm)	20 x 16	42 x 31	36 x 27	62 x 30
	Size of Pore (μm)	9 x 3	20 x 4	19 x 3	34 x 3
	Average no. of stomata per mm^2	143	84	101	21
Upper leaf surface of plant	Size of Guard cell (μm)	17 x 14	0	33 x 19	65 x 29
	Size of Pore (μm)	6 x 3	0	19 x 3	39 x 3
	Average no. of stomata per mm^2	29	0	60	46

Adapted from https://www.jstor.org/stable/2434979?seq=13#metadata_info_tab_contents

i) Name the plant with the smallest stomata.

(1)

ii) Name the tissue (layer) of the leaf that has guard cells and stomata.

(1)

- iii) What conclusion can be made when comparing the size of guard cell and pore to the number of stomata of the lower leaf surface of the *Impatiens sultani* and *Triticum sativum*?

(2)

- iv) The rate of transpiration of *Zea* and of *Triticum* is very similar but the number of stomata and the size of the pores vary significantly. Using the table, give a justification and explanation for this fact.

(3)

Total 10 marks

- 2) In an investigation on energy transfer of food, the energy released from several food items was calculated. The diagram (Figure 5) shows the apparatus used in this investigation.

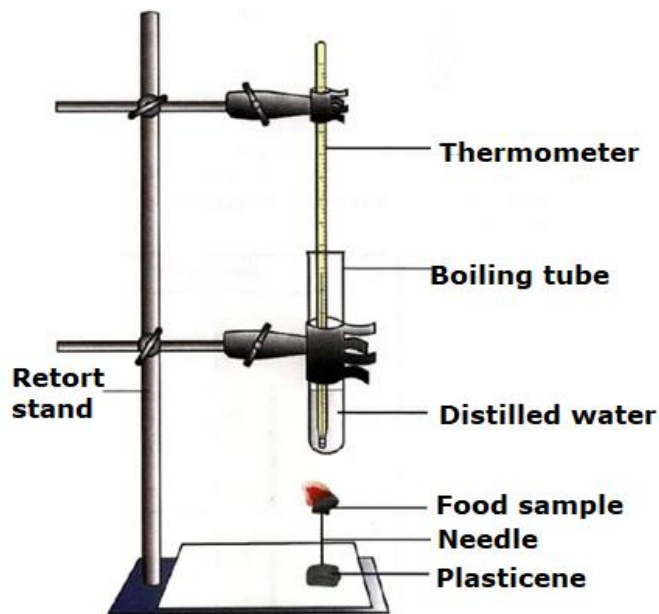


Figure 5

<https://www.scribd.com/doc/311467844/Biology-Form-4-Paper-3-Quiz-Ans>

- a) List ONE controlled variable in this investigation.

(1)

b) Give the independent variable of this investigation.

(1)

c) State ONE precaution for this investigation and a reason to justify this precaution.

(2)

d) The student performed two trials for each food stuff. Give ONE reason why the experiment was repeated twice for each food item.

(1)

e) The following food stuffs were used in the investigation: peanut, candlenut, cereal bites, biscuit and cheese puff. The table below, shows the results obtained for the candlenut.

Candlenut	Initial temperature (°C)	Final temperature (°C)	Mass (g)	Energy content (kJ/g)
Trial 1	25	76	0.5	8.57
Trial 2	28	80	0.5	
Average				

Use the formula below to find the energy content of the second trial. Work out the average of the energy content in kJ/g of the candlenut. The mass of water is 20g.

$$\frac{\text{Mass of Water} \times \text{Change in temperature} \times 4.2}{\text{Mass of food}}$$

Show your working in the space below.

(2)

- f) The bar chart below (Figure 6) compares the energy content of the food stuffs tested.

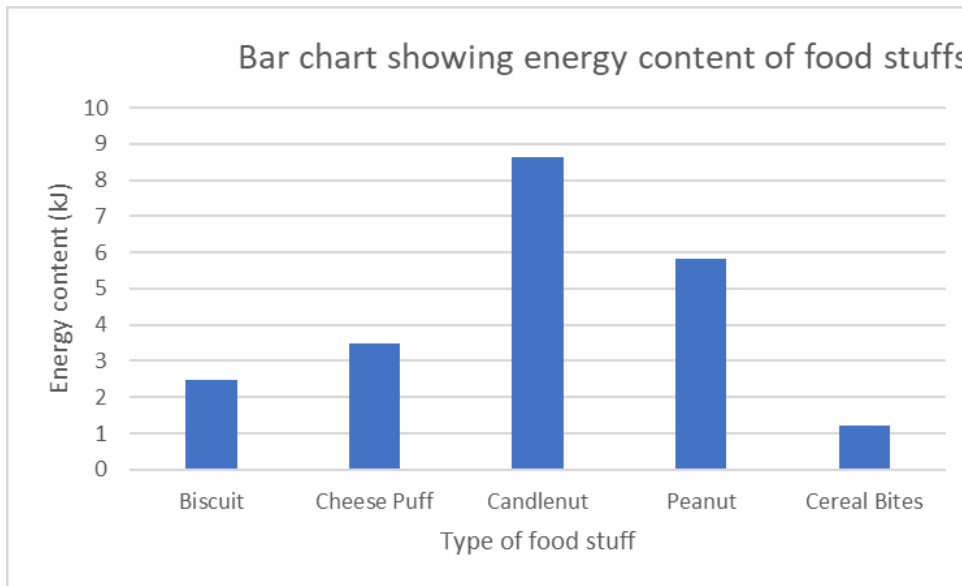


Figure 6

- i) What is the best time to eat a portion of candlenuts?

(1)

- ii) What conclusion can be derived from these results?

(1)

- g) Describe ONE modification to this investigation that increases accuracy of results.

(2)

Total 11 marks

3) A student decided to test the germination of seeds in different solutions. The student chose bean seeds and put three sets of 10 beans in the following aqueous solutions: distilled water, hydrogen peroxide, malt, potassium nitrite and humic acid.

A description of each solution is listed hereunder:

Distilled water	Water from which particles and ions have been removed.
Hydrogen peroxide	An unstable liquid that breaks down in the presence of light into water and oxygen.
Malt solution	A solution of dried barley (grain/cereal) mash.
Potassium nitrite solution	An ionic salt of potassium ions (K^+) and nitrate ions (NO_3^-). It is considered as a source of nitrogen.
Humic acid solution	Humic acid is produced from humus. It is an extract of tissues from dead organisms.

The results attained showed that the beans in distilled water, hydrogen peroxide and humic acid germinated while those in malt and potassium nitrite did not.

The beans in hydrogen peroxide germinated first, followed by those in humic acid and finally those in distilled water.

a) Explain why and how germination occurs.

(3)

b) From the information above, state ONE reason why beans in hydrogen peroxide germinated first.

(2)

c) Explain the role of humus in nutrient recycling.

(2)

d) Give ONE reason why seeds in potassium nitrite and malt did not germinate.

(1)

e) State ONE constant (controlled) variable in this investigation.

(1)

Total 9 marks

Section C: Comprehension (20 marks)

Read the text below and answer the questions that follow.

Synthetic blood cells mimic natural ones and have new abilities

Scientists have tried to develop synthetic red blood cells that mimic the favourable properties of natural ones, such as flexibility, oxygen transport and long circulation times. But so far, most artificial red blood cells have had one or a few, but not all, key features of the natural versions. Now, researchers reporting in ACS Nano, have made synthetic red blood cells that have all of the cells' natural abilities, plus a few new ones.

Red blood cells (RBCs) take up oxygen from the lungs and deliver it to the body's tissues. RBCs are highly flexible, which allows them to squeeze through tiny capillaries and then bounce back to their former shape. The cells also contain proteins on their surface that allow them to circulate through blood vessels for a long time without being gobbled up by immune cells. The researchers Wei Zhu, C. Jeffrey Brinker and their colleagues wanted to make artificial RBCs that had similar properties to natural ones, but that could also perform new jobs such as therapeutic drug delivery, magnetic targeting and toxin detection.

The researchers made the synthetic cells by first coating donated human RBCs with a thin layer of silica. They layered positively and negatively charged polymers over the silica-RBCs, and then etched away the silica, producing flexible replicas. Finally, the team coated the surface of the replicas with natural RBC membranes. The artificial cells were similar in size, shape, charge and surface proteins to natural cells, and they could squeeze through model capillaries without losing their shape. In mice, the synthetic RBCs lasted for more than 48 hours, with no observable toxicity. The researchers loaded the artificial cells with either haemoglobin, an anticancer drug, a toxin sensor or magnetic nanoparticles to demonstrate that they could carry cargoes. The team also showed that the new RBCs could act as decoys for a bacterial toxin. Future studies will explore the potential of the artificial cells in medical applications, such as cancer therapy and toxin biosensing, the researchers say.

Adapted from <https://www.sciencedaily.com/releases/2020/06/200603122955.htm>

- a) From the text, find the term that fits each of the following statements:
- large molecules that contain the elements carbon, hydrogen, oxygen, nitrogen and sulfur.

(1)

- structure that separates the contents of cells from the surrounding environment.

(1)

b) Explain how red blood cells perform their function when squeezing through capillaries. (line 9)

(3)

c) Describe the shape of a red blood shape.

(1)

d) Synthetic red blood cells are not 'gobbled up by immune cells'. (line 12)

i) Name the process that specific white cells use to gobble up red blood cells.

(1)

ii) Explain why immune cells might destroy synthetic cells entering the blood.

(2)

e) In the trials, the artificial RBC was loaded with haemoglobin. (line 26)

i) Describe the structure of haemoglobin.

(2)

ii) Give ONE reason why the scientists loaded the artificial cells with haemoglobin.

(2)

f) Give ONE reason why the surface proteins on the artificial cells are similar to those of natural cells. (line 22)

(2)

- g) A regular blood flow is necessary for the transfer of cargoes by the artificial cells. Blood flow is the movement of blood through a vessel, tissue, or organ. The graph below (Figure 7) shows the velocity of the blood flow from arteries to veins.

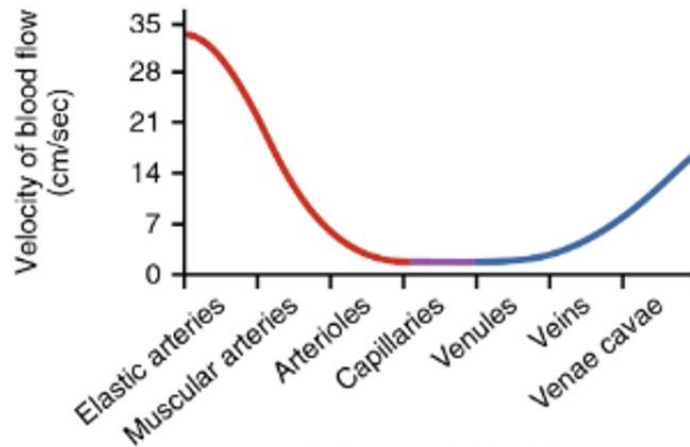


Figure 7

<https://opentextbc.ca/anatomyandphysiology/chapter/20-2-blood-flow-blood-pressure-and-resistance/>

- i) What are the vena cava/e?

_____ (1)

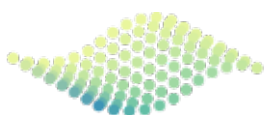
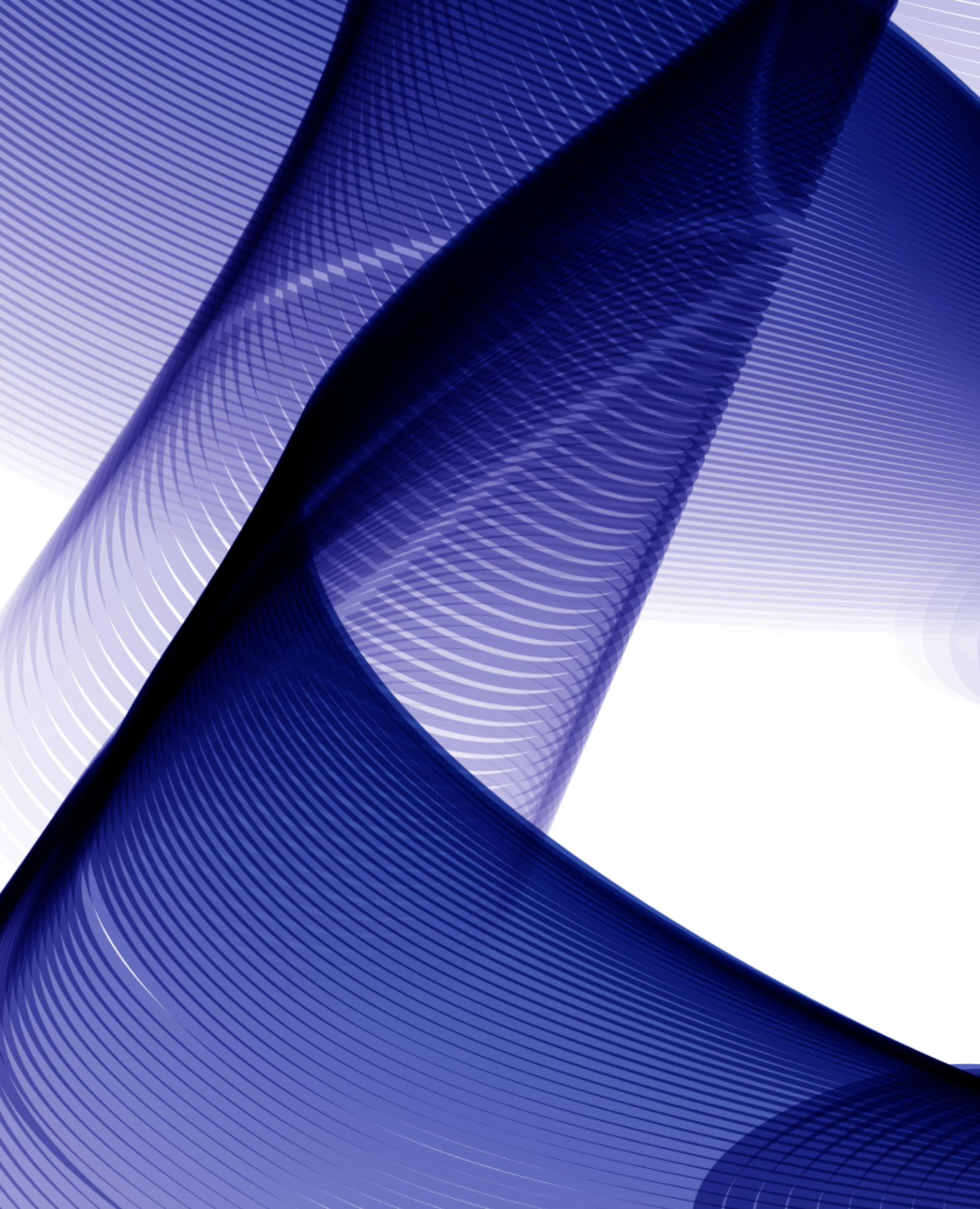
- ii) With reference to blood vessel structure, explain the pattern of the graph.

 _____ (2)

- iii) Interpret the decrease in velocity of blood flow with the function of blood capillaries and capillary beds.

 _____ (2)

Total: 20 marks



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