Challenging Topic 2 Questions

Name: __________________________

Class: __________________________

Date: __________________________

Time: 76 minutes

Marks: 73 marks

Comments:
Q1.

The heart pumps blood to the lungs and to the cells of the body.

(a) Name the blood vessel that transports blood from the body to the right atrium.

___________________________________________________________________

(b) The aorta transports blood from the heart to the body.

In a person at rest:
• blood travels at a mean speed of 10 cm/s in the aorta
• blood travels at a mean speed of 0.5 mm/s in the capillaries
• the speed of blood decreases at a rate of 0.4 cm/s² as blood travels from the aorta to the capillaries.

Calculate the time it takes for blood to travel from the aorta to the capillaries.

Assume that the speed of blood decreases at a constant rate.

Use the equation:

\[
\text{rate of decrease in speed} = \frac{\text{change in speed}}{\text{time}}
\]

Give your answer to 2 significant figures.

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___________________________________________________________________

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Time = ____________________ s

(4)

(c) Describe the route taken by oxygenated blood from the lungs to the body cells.

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___________________________________________________________________
The digestive system and the breathing system both contain specialised exchange surfaces.

- In the digestive system, digested food is absorbed into the bloodstream in structures called villi.
- In the breathing system, gases are absorbed into the bloodstream in the alveoli.

The diagram below shows the structure of villi and alveoli.

Explain how the villi and the alveoli are adapted to absorb molecules into the bloodstream.

Q2.

The diagram below shows the human digestive system.
(a) Label the stomach and pancreas on the diagram.

(b) Many people suffer from stomach ulcers caused by a species of bacteria called *Helicobacter pylori*.

The stomach is lined with a protective lining of mucus.

*Helicobacter pylori* are acid-tolerant bacteria which can damage this mucus lining.

Suggest how an infection with *Helicobacter pylori* might result in a stomach ulcer developing.

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___________________________________________________________________
___________________________________________________________________

(2)

(c) *Helicobacter pylori* can also cause stomach cancer.

Describe how a person infected with *Helicobacter pylori* could also develop liver cancer.

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___________________________________________________________________
(d) Gluten is a form of protein found in some grains.

Describe the test you would use to find out if protein is present in food.

(e) Coeliac disease is a disease of the digestive system.

It damages the lining of the small intestine when foods that contain gluten are eaten.

When people with coeliac disease eat foods that contain gluten:
1. their immune system forms antibodies to gluten
2. these antibodies attack the lining of the small intestine
3. this causes inflammation in the intestines and damages the villi.

Symptoms of coeliac disease include poor growth.

Suggest why a person with coeliac disease might have this symptom.

Q3.

Fresh milk is a mixture of compounds including lipid, protein and about 5% lactose sugar.
Lactose must be digested by the enzyme lactase, before the products can be absorbed. Lactase can be added to fresh milk to pre-digest the lactose. This makes ‘lactose-free’ milk, which is suitable for people who do not produce enough lactase of their own.

A student investigated the effect of changing pH and temperature on the digestion of lactose in milk.

The results are shown in Tables 1 and 2.

<table>
<thead>
<tr>
<th>pH</th>
<th>Time taken to digest lactose in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.0</td>
<td>20</td>
</tr>
<tr>
<td>5.0</td>
<td>18</td>
</tr>
<tr>
<td>6.0</td>
<td>13</td>
</tr>
<tr>
<td>7.0</td>
<td>7</td>
</tr>
<tr>
<td>8.0</td>
<td>5</td>
</tr>
<tr>
<td>9.0</td>
<td>6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Temperature in °C</th>
<th>Time taken to digest lactose in minutes</th>
</tr>
</thead>
<tbody>
<tr>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>30</td>
<td>14</td>
</tr>
<tr>
<td>35</td>
<td>11</td>
</tr>
<tr>
<td>40</td>
<td>6</td>
</tr>
<tr>
<td>45</td>
<td>29</td>
</tr>
<tr>
<td>50</td>
<td>No digestion</td>
</tr>
</tbody>
</table>

(a) The label on a carton of lactose-free milk states:

‘Lactase is normally produced in the stomach of mammals.’

The results in Table 1 suggest that this statement is not true. Explain how.

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(b) Explain, as fully as you can, the results shown in Table 2.

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___________________________________________________________________
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Page 6 of 21
(c) Bile is produced in the liver and is released into the small intestine.
Bile helps the digestion of lipid in the milk.
Describe how.

Q4.
Amylase is an enzyme found in the human body.
Amylase breaks down starch into sugars.
(a) Where is amylase produced in the human body?
Tick one box.

Liver and pancreas
Liver and stomach
Salivary glands and pancreas
Salivary glands and stomach

(b) Enzymes speed up chemical reactions.
Explain how amylase breaks down starch.
(c) One sugar in the body is glucose.
   Glucose is used for respiration.
   Give one other use for glucose in the body.

(d) A student investigated the effect of temperature on the activity of human amylase.

   This is the method used.
   1. Put 2 cm$^3$ of 1% starch solution into a boiling tube.
   2. Put 2 cm$^3$ of amylase solution into a second boiling tube.
   3. Put both boiling tubes into a water bath at 20 °C.
   4. After 5 minutes, mix the amylase and the starch together in one boiling tube.
   5. After 30 seconds, add a drop of the starch and amylase mixture to a drop of iodine solution in one well of a spotting tile.
   6. Repeat step 5 until the iodine solution no longer changes colour.
   7. Repeat steps 1 – 6 at 40 °C and at 60 °C and at 80 °C

   Why did the student leave the starch and amylase solutions in the water bath for 5 minutes in step 3?

(e) The temperature of the human body is 37 °C

   The diagram below shows the results of the investigation at 20 °C and at 80 °C
   Complete the diagram to show the results you would expect at 40 °C and at 60 °C
   You should write a tick or a cross in each well of the spotting tile.
There are different ways to investigate the breakdown of starch by amylase.

One other method is to measure the concentration of starch present in the solution every 30 seconds.

Why is this method better than the method the student used?
___________________________________________________________________
___________________________________________________________________
___________________________________________________________________

A colorimeter can be used to measure the concentration of starch present in the solution every 30 seconds.

A colorimeter measures the amount of light that cannot pass through a solution.

This is known as absorbance.

Below shows a graph of absorbance against concentration of starch.
(g) The absorbance of the solution at 40 °C was 0.56 arbitrary units after 30 seconds.
What was the concentration of starch in this solution?

Concentration of starch = ____________________
(1)

(h) The concentration of starch in the solution at 20 °C after 1 minute is different from the concentration at 40 °C after 1 minute.

Explain why.

___________________________________________________________________
___________________________________________________________________
___________________________________________________________________
(2)
(i) Predict the absorbance for the solution at 80 °C after 30 seconds.

Give a reason for your answer.

Absorbance = ______________________ arbitrary units

Reason ____________________________________________________________
_________________________________________________________________
_________________________________________________________________
_________________________________________________________________
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(3)
(Total 16 marks)

Q5.

Figure 1 shows a model representing the human breathing system.

The different parts of the model represent different parts of the human breathing system.

(a) (i) Which part of the human breathing system does the flexible rubber sheet represent?

________________________________________________________________________

(1)

(ii) Explain why the balloons inflate when the flexible rubber sheet is pulled down.

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________________________________________________________________________
________________________________________________________________________

Page 11 of 21
(b)  

(i) During breathing, oxygen moves into the blood.

Explain how oxygen moves into the blood.

(ii) **Figure 2** shows a fish head and gill.

![Figure 2](image)

Fish absorb oxygen from the water. Oxygen is absorbed through the gills of the fish.

Explain one way in which the gills are adapted for rapid absorption of oxygen.

Q6.

During exercise, the heart beats faster and with greater force.

The ‘heart rate’ is the number of times the heart beats each minute. The volume of blood that travels out of the heart each time the heart beats is called the ‘stroke volume’.

In an investigation, **Person 1** and **Person 2** ran as fast as they could for 1 minute. Scientists measured the heart rates and stroke volumes of **Person 1** and **Person 2** at rest, during the exercise and after the exercise.
The graph below shows the scientists’ results.

(a) The ‘cardiac output’ is the volume of blood sent from the heart to the muscles each minute.

Cardiac output = Heart rate × Stroke volume

At the end of the exercise, Person 1’s cardiac output = 160 × 77 = 12 320 cm³ per minute.

Use information from the figure above to complete the following calculation of Person 2’s cardiac output at the end of the exercise.

At the end of the exercise:

Person 2’s heart rate = _____________ beats per minute

Person 2’s stroke volume = _____________ cm³

Person 2’s cardiac output = _____________ cm³ per minute

(3)

(b) Person 2 had a much lower cardiac output than Person 1.

(i) Use information from the figure above to suggest the main reason for the lower cardiac output of Person 2.

____________________________________________________________________________________
____________________________________________________________________________________
(ii) **Person 1** was able to run much faster than **Person 2**.

Use information from the figure above and your own knowledge to explain why.

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(Total 9 marks)

**Q7.**

Explain how the human circulatory system is adapted to:

- supply oxygen to the tissues
- remove waste products from tissues.

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(Total 6 marks)
Mark schemes

Q1.

(a) vena cava 1

(b) 0.5 mm = 0.05 cm 1

\[
\text{time} = \frac{10.00 - 0.05}{0.4} = 24.875 \\
\text{allow alternative correct substitution}
\]

25 (s) 1

an answer of 25 (s) scores 4 marks
allow 24 for 3 marks (no conversion of mm to cm)
allow 23.8 / 23.75 for 2 marks (no conversion of mm to cm and incorrect sf) 1

(c) (blood) travels through (the) pulmonary vein 1
(blood) enters left atrium 1
(blood) enters (the) left ventricle 1
(blood) leaves the heart via / through (the) aorta 1
allow blood travels through arterioles
allow blood (travels round the body and) reaches the cells / tissues via / in capillaries 1
ignore ref to valves / systole / diastole throughout

(d) Level 3 (5-6 marks):
Relevant points (reasons / causes) are identified, given in detail and logically linked to form a clear account.

Level 2 (3-4 marks):
Relevant points (reasons/causes) are identified, and there are attempts at logical linking. The resulting account is not fully clear.

Level 1 (1-2 marks):
Points are identified and stated simply, but their relevance is not clear and there is no attempt at logical linking.

No relevant content (0 marks)

Indicative content

S = structural  F = functional
• (S) both have a large surface area
• (S) villi have many microvilli
• (S) alveolar walls are not flat / are folded
• (F) to maximise diffusion (of gases) / absorption of (food) molecules
• (S) both have many capillaries / good blood supply / capillaries near the surface
• (F) to maintain concentration / diffusion gradient
• (S) both have thin walls / walls that are one cell thick / one cell thick surface
• (F) to provide a short diffusion distance (for molecules to travel)
• (S) villi have many mitochondria
• (F) to provide energy for active transport (of food molecules)
• (S) cells of the villi have microvilli / more projections
• (F) to further increase the surface area / increase the number of proteins in the membrane / to allow more active transport to take place

Q2.
(a) stomach and pancreas correctly labelled

(b) bacteria not killed (by stomach acid / HCl) and so they damage mucus lining
so acid / HCl damages stomach tissue / causes an ulcer
allow bacteria infect stomach tissue

(c) if the cancer is malignant
(cancer) cells can spread to other organs
via the blood forming a secondary tumour
do not award marking points 2 or 3 without marking point 1

(d) add Biuret reagent to food sample
allow sodium / potassium hydroxide (solution) + copper sulfate(solution)
mauve / purple colour shows protein present

(e) damaged villi reduce surface area for absorption (of food molecules)
(therefore) fewer amino acids and glucose absorbed
with less glucose transfer of energy from respiration is reduced
and fewer amino acids available to build new proteins

Q3.

(a) stomach is acidic / has low pH
   allow any pH below 7
   ignore stomach is not alkaline

lactase works best / well in alkali / high pH / neutral / non-acidic conditions
   allow any pH of 7 and above
   accept works slowly in acid conditions
   allow figures from table with a comparison
   ignore reference to temperature

(b) any three from:
   • (below 40(°C)) increase in temperature increases rate / speed of reaction
   • reference to molecules moving faster / colliding faster / harder / more collisions
   • enzyme optimum / works best at 40°C
     allow value(s) in range 36 – 44
     ignore body temperature unless qualified
   • high temperatures (above 40°C) / 45°C / 50°C enzyme denatured
     allow synonyms for denaturation, but do not allow ‘killed’
     denaturation at high and low temperature does not gain this mark
     ignore references to time / pH

(c) any two from:
   • acid neutralised or conditions made neutral / alkali
     accept bile is alkaline
   • (allow) emulsification / greater surface area (of lipid / fat)
     allow description of emulsification eg fat broken down / broken up into droplets
     do not accept idea of chemical breakdown
   • lipase / enzymes (in small intestine) work more effectively / better
     allow better for enzymes
     ignore reference to other named enzymes
Q4.

(a) salivary glands and pancreas

(b) starch / substrate fits into active site (of enzyme)

shape of active site is unique / complementary to substrate

_or_
substrate is specific to active site / enzyme

_allow enzyme has a high specificity for substrate_

bonds (within starch / substrate
_or_
between sugar molecules) are broken

(c) converted to new carbohydrates / glycogen / named organic compound (e.g. protein / fat)

(d) to allow (the starch and amylase / solutions) to equilibrate (to the temperature of the water bath)
_or_
to get the starch and amylase / solutions to the same temperature / 20 °C
_or_
to get the starch and amylase / solutions to the (same) temperature of the water bath

(e) 40 °C
all wells contain a symbol
_and_
must contain at least two crossed (×) wells at the end

_allow final three wells crossed (×)_

60 °C
all wells contain a symbol
_and_
must have fewer crossed (×) wells at the end than at 40 °C

_allow all wells ticked (√) for either mp do not allow a crossed well followed by a ticked well_

(f) more accurate

_allow (so) closer to (the) true value_

_because_ it is a quantitative measure

_allow (it's) an actual value as opposed to an opinion_
_or_
less / not subjective
(g) 0.07 (%)  
(h) starch is broken down less quickly (at 20 °C)  
   allow converse  
   because, at 20 °C, substrates / enzymes / molecules have less (kinetic) energy  
(i) 1.08 (arbitrary units)  
   at 80 °C, enzyme / amylase has denatured  
   allow description of denaturation  
   do not allow enzyme is killed  
   so starch is not broken down (at all)  
   allow the concentration of starch is still 0.5%

Q5.  
(a) (i) diaphragm  
   accept phonetic spelling  
   (ii) (because) the volume (inside the jar) increases  
   maximum two marks if no reference to correct part of model  
   (causing) the pressure to decrease  
   (and) air enters the balloon  
   allow oxygen  
(b) (i) (so it moves by) diffusion  
   do not allow osmosis or active transport  
   from a high concentration (of oxygen) to a low concentration  
   allow down its / oxygen concentration gradient from the air  
   or to the blood  
   or (because) there is a high(er) concentration (of oxygen) in the air or there  
   is a low(er) concentration of oxygen in the blood  
   ignore reference to amount of oxygen  
(ii) many gill filaments
must be in the correct pairs to gain 2 marks

(give a) large surface / area
    do not allow surface area to volume ratio
    or
    thin
    (so) short diffusion pathway
    or
    good blood supply
    (to) maintain the concentration gradient
    or
    water continually flows over them / continually ventilated
    (to) maintain the concentration gradient

Q6.
(a) 5624

allow 2 marks for:
• correct HR = 148 and correct SV = 38 plus wrong answer / no answer
  or
• only one value correct and ecf for answer

allow 1 mark for:
• incorrect values and ecf for answer
  or
• only one value correct

(b) (i) Person 2 has low(er) stroke volume / SV / described
    eg Person 2 pumps out smaller volume each beat
    do not allow Person 2 has lower heart rate

(ii) Person 1 sends more blood (to muscles / body / lungs)

(which) supplies (more) oxygen

(and) supplies (more) glucose

(faster rate of) respiration or transfers (more) energy for use
    ignore aerobic / anaerobic
    allow (more) energy release
    allow aerobic respiration transfers / releases more energy
    (than anaerobic)
    do not allow makes (more) energy

removes (more) CO2 / lactic acid / heat
    allow less oxygen debt
or less lactic acid made
or (more) muscle contraction / less muscle fatigue

if no other mark awarded,
allow person 1 is fitter (than person 2) for max 1 mark

Q7.

Level 3 (5–6 marks):
A detailed and coherent explanation is provided with most of the relevant content, which demonstrates a comprehensive understanding of the human circulatory system. The response makes logical links between content points.

Level 2 (3–4 marks):
The response is mostly relevant and with some logical explanation. Gives a broad understanding of the human circulatory system. The response makes some logical links between the content points.

Level 1 (1–2 marks):
Simple descriptions are made of the roles of some of the following: heart function, gas exchange, named blood vessels, named blood cells. The response demonstrates limited logical linking of points.

0 marks:
No relevant content.

Indicative content
- dual / double circulatory system which means that it has higher blood pressure and a greater flow of blood to the tissues
- heart made of specialised (cardiac) muscle cells which have long protein filaments that can slide past each other to shorten the cell to bring about contraction for pumping blood
- heart pumps blood to lungs in pulmonary artery so that oxygen can diffuse into blood from air in alveoli
- blood returns to heart via pulmonary vein where muscles pump blood to the body via aorta
- oxygen carried by specialised cells / RBCs which contain haemoglobin to bind oxygen and have no nucleus so there is more space available to carry oxygen
- arteries carry oxygenated blood to tissues where capillaries deliver oxygen to cells for respiration and energy release
- thin walls allow for easy diffusion to cells
- large surface area of capillaries to maximise exchange
- waste products removed eg CO₂ diffuse from cells into the blood plasma
- blood goes back to the heart in veins which have valves to prevent backflow
- cardiac output can vary according to demand / is affected by adrenaline

accept annotated diagrams

[9]