Questions on Transport

Directions: The following questions are taken from previous IB Final Papers on Topic 6.2 (The Transport System). Answer all questions. This will serve as a study guide for the next quiz.

Due Date: Monday April 16
1. What is happening in the heart when the semi-lunar valves are closed?
   I. Blood is entering the aorta.
   II. Blood is entering the pulmonary artery.
   III. Blood is entering the ventricles.
   IV. The ventricles are contracting.
   A. I and II only
   B. I and III only
   C. III only
   D. III and IV only  
   (Total 1 mark)

2. Arterioles in the skin contain muscle fibres which contract. What is the function of these fibres?
   A. To move capillaries further from the skin when the body is too cold
   B. To reduce blood flow to the skin when the body is too cold
   C. To move capillaries closer to the skin when the body is too warm
   D. To increase blood flow to the skin when the body is too warm  
   (Total 1 mark)

3. Which of the following are functions of all mammalian arteries?
   I. To carry oxygenated blood
   II. To carry blood away from the heart
   III. To carry blood under high pressure
   A. I and III only
   B. I, II and III
   C. II and III only
   D. I and II only  
   (Total 1 mark)
4. What does the body use to control the heartbeat?
   I. Adrenalin
   II. Pacemaker
   III. Nerves from brain
   A. II and III only
   B. I and II only
   C. I, II and III
   D. I and III only
   (Total 1 mark)

5. Which of the following best describes the composition of human blood?
   A. Erythrocytes, leucocytes and platelets
   B. Erythrocytes, phagocytes and platelets
   C. Erythrocytes, lymphocytes and platelets
   D. Erythrocytes, antigens and platelets
   (Total 1 mark)
6. Marine mammals have a series of physiological responses to diving. This enables them to stay submerged for long periods in water colder than their body temperature. Collectively these responses are termed the diving reflex.

To investigate the diving reflex in humans, heart rate changes in ten healthy subjects were monitored during facial immersions in water ranging from 3°C to 37°C. The data for this experiment is shown below.

![Graph showing the effect of water temperature on heart rate](http://kesler.biology.rhodes.edu/sciJ/York.html)

(a) (i) State the effect of facial immersion on heart rate over the range of temperatures shown on the graph.

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(1)

(ii) Suggest one reason for the relationship between facial immersion and heart rate.

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(1)

(b) Outline the effect of the water temperature on heart rate.

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(1)
(c) Calculate the heart rate of a person immersed in water at a temperature of 15°C, if their heart rate before immersion was 70 beats per minute.

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(2)
(Total 5 marks)
7. One type of heart disease is diastolic heart failure (DHF). A study was carried out to see if DHF was related to abnormalities in the diastolic properties of the left ventricle. Two groups of patients, one with DHF and the other the control group with no symptoms of DHF, were assessed to compare:

- changes in left ventricular diastolic pressure and volume
- and stiffness of muscles leading to resistance of the left ventricle to stretch under increasing pressure.

Graph 1 shows the mean lowest pressure in the left ventricle during diastole after the opening of the atrio-ventricular valve. Graph 2 shows individual stiffness constants.

Graph 1

**Key:**
- ■ patients with DHF
- □ control group

Graph 2

(a) Identify the left ventricular diastolic volumes in patients and the control group that correspond to a pressure of 5 mm Hg.

Patients: ..........................................................................................................................

Control group: .................................................................................................................. (1)

(b) Compare the diastolic pressure-volume relationship of patients with DHF and the control group.

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(c) Distinguish between the stiffness constants in the two groups of patients.

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(d) (i) Suggest why in patients with DHF there is little or no increase in blood volume pumped out of the left ventricle with each contraction during exercise.

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(ii) Deduce how patients with DHF would respond to heavy exercise.
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(Total 6 marks)

8. Explain the oxygen dissociation curve for adult hemoglobin and how it is affected by the Bohr shift.
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(Total 6 marks)
9. Draw a labelled diagram of the heart showing all four chambers, associated blood vessels and valves.

(Total 5 marks)

10. Explain the relationship between the structure and functions of arteries, capillaries and veins.

(Total 9 marks)
11. Discuss the factors which affect the occurrence of coronary heart disease.

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(Total 4 marks)

12. Describe the mechanisms that control the heartbeat.

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(Total 4 marks)
13. Describe how carbon dioxide is carried by the blood.

(Total 4 marks)
14. Explain the events of the cardiac cycle.

(Total 7 marks)

15. Poor nutrition of a woman during pregnancy has been associated with a variety of metabolic disorders later in the life of her offspring.

During the second world war (WWII) the normally well-fed population of Holland suffered famine over a relatively short and precisely defined period. The data available from this period provided examples of fetuses that were affected by famine at specific periods during pregnancy.
Glucose tolerance was analysed in human adults 50–55 years of age who had suffered fetal famine during WWII (Figure 1). High glucose levels in blood plasma indicate poor glucose tolerance.

Figure 1: Glucose tolerance

![Graph showing glucose tolerance](image)

Period of exposure to famine


(a) (i) Identify the period of exposure to famine that produces the greatest decrease in glucose tolerance.

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(1)

(ii) Calculate the percentage change in plasma glucose concentration after exposure to famine from early to late pregnancy.

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(1)

(iii) Suggest a reason why glucose tolerance did not return to normal in people conceived after the famine.

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(1)
(b) Outline a possible cause of poor glucose tolerance.

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(1)

(c) Suggest how poor glucose tolerance could be related to the occurrence of coronary heart disease.

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(2)

(Total 6 marks)
1. C

2. B

3. C

4. C

5. A

6. (a) (i) immersing the face causes a lowering of the heart rate
   (ii) to reduce cardiac output;
        to preserve oxygen for brain / heart needs;
        slowing of metabolic rate;
        to reduce production of CO$_2$ / maintain blood pH
   1 max

   (b) the lower the temperature, the greater the suppression of heart rate / effect
   more pronounced at lower temperatures
   Numerical answers accepted.

   (c) at 15 °C, expect a 19% (± 1%) reduction in heart rate;
   therefore expect new heart rate of 56 / 57 beats per minute;
   2

7. (a) patients: 42 (±2) ml
    control group: 73 (±2) ml
    Both answers must be correct to receive [1].
(b) both show increase in ventricular pressure as volume increases / positive correlation;
    in DHF patients as diastolic volume increases diastolic pressure increases more rapidly than in the control group / the control group shows a gradual / almost linear increase while patients with DHF show very rapid / exponential increase in pressure;
    controls have relatively low pressure at large volumes whereas the DHF patients have higher pressure with a lower maximum volume;

(c) DHF patients all (but one) have stiffer left ventricles;
    control all have stiffness constant below 0.015 while patients with DHF all have stiffness constant above 0.014;
    DHF patients show wider range of stiffness;

(d) (i) stiff ventricle unable to stretch / increase in volume and fill optimally
    (ii) insufficient (oxygenated) blood would reach the tissues;
    heart rate increases due to increase carbon dioxide / decrease blood pH;
    cramp due to lactic acid build up;
    fatigue due to insufficient oxygenated blood reaching the tissues;

8. **Diagrams are acceptable provided they are adequately annotated.**
    initial uptake of one oxygen molecule by hemoglobin facilitates the further uptake
    of oxygen molecules / hemoglobin has an increasing affinity for oxygen / and vice versa;
    shows how the saturation of hemoglobin with oxygen varies with partial pressure of oxygen / dissociation curve for (oxy)hemoglobin is S / sigmoid-shaped;
    low partial pressure of oxygen corresponds to the situation in the tissue;
    when partial pressure of oxygen is low, oxygen released;
    high partial pressure of oxygen corresponds to the situation in the lungs;
    when partial pressure of oxygen is high, oxygen taken up by hemoglobin;
    Bohr effect occurs when there is lower pH / increased carbon dioxide / increased lactic acid;
    shifts the curve to the right;
    oxygen more readily releases to (respiring) tissue;
9. Award [1] for any two of the following clearly drawn and correctly labelled.
vena cava;
inferior and superior vena cava distinguished;
aorta;
pulmonary artery;
pulmonary vein;
left ventricle;
right ventricle;
left ventricle shown with thicker walls than right ventricle;
septum;
left atrium;
right atrium;
coronary artery;
two semi-lunar valves;
AV valves;
bicuspid and tricuspid valves distinguished;

10. arteries carry blood away from the heart / to tissues;
arteries have thick walls to withstand high pressure / prevent bursting;
arteries have muscle fibres to generate the pulse / help pump blood / even out blood flow;
arteries have elastic fibres to help generate pulse / allow artery wall to stretch / recoil;
capillaries allow exchange of \( O_2 \), \( CO_2 \), nutrients / waste products from tissues / cells;
capillaries have a thin wall to allow (rapid) diffusion / movement in / out;
capillaries have pores / porous walls to allow phagocytes / tissue fluid to leave;
capillaries are narrow so can penetrate all parts of tissues / bigger total surface area;

veins carry blood back to the heart / from the tissues;
veins have thinner walls because the pressure is low / to allow them to be squeezed;
veins have fewer muscle / elastic fibres because there is no pulse / because pressure is low;
veins have valves to prevent backflow;
11. **Named factors and explanation.**
   - genetic – some people predisposed for high cholesterol levels / high blood pressure;
   - age – older people greater risk / less elasticity in arteries;
   - sex – males at greater risk than females;
   - smoking – constricts blood vessels / increases blood pressure / heart-rate / decreases oxygenation of heart muscle;
   - diet – increases fat / cholesterol / LDL in blood / leads to plaque formation in arteries;
   - exercise – lack of exercise increases risk;
   - obesity – increase in blood pressure / leads to plaque formation in arteries;
   - Accept any other factor correctly explained eg diabetes, atherosclerosis.
   *Do not award a mark for the name of a factor and simply that it leads to CHD.* [4]

12. **myogenic / initiated in heart muscle itself;**
   - SA node / pacemaker sends waves of excitation / impulse to atria;
   - stimulus to the AV node;
   - conducting fibres / bundle of His / Purkinje fibres conduct impulses to lower ventricles;
   - moderated by ANS / vagus nerve / parasympathetic; [4]

13. (a) **carbon dioxide is carried in three forms in the blood;**
   - carbon dioxide can be dissolved in the blood / plasma;
   - carried as dissociated carbonic acid / $H_2CO_3$, $H^+H_2CO_3$–;
   - carried as carbaminohemoglobin / bound to hemoglobin;
   - carbonic anhydrase found in red blood cells / erythrocytes;
   - carbonic anhydrase speeds up production of hydrogen carbonate / bicarbonate / $HCO_3$–;
   - chloride shift / movement of chloride ions into red blood cell / erythrocyte occurs to balance movement of hydrogen carbonate / bicarbonate / $HCO_3$– ion movement out; [4]
14. SA node fires (electrical) signal throughout walls of atria to begin cycle; causing atria to undergo systole; SA signal reaches atrioventricular node; which spreads signal throughout (Purkinje fibres); causing ventricles to undergo systole; atrioventricular valves slap shut; causing "lub" sound; after ventricles are emptied semilunar valves close; causing "dub" sound; atrioventricular valves open; ventricles begin diastole and start filling; all four chambers are in diastole and filling; when atria filled and ventricles 70% filled cycle has ended; 

Accept bicuspid and tricuspid valves as alternatives to atrioventricular valves.

15. (a) (i) late pregnancy
(ii) increase of 3.3%; (± 0.3)  
Do not deduct the mark if the denominator is 6.3.
(iii) mother with long-term effects of famine / affect child’s development / famine over but nutrition remains poor;
(b) no / little insulin / diabetes / tissues do not respond to insulin
(c) increased blood glucose could lead to obesity (which is a risk factor for CHD); increased blood glucose could be due to diabetes (which is a risk factor for CHD); genetic factors could relate both conditions; 2 max