

BIOLOGY

Paper 2 Structured Questions

Candidates answer on the Question Paper. No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Name, Class and Index number in the spaces at the top of this page.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs. Do not use staples, paper clips, glue or correction fluid.

Answer all questions in the spaces provided on the Question Paper.

The use of an approved scientific calculator is expected, where appropriate. You may lose marks if you do not show your working or if you do not use appropriate units.

The number of marks is given in brackets [] at the end of each question or part question.



This document consists of 29 printed pages and 2 blank pages.

9744/02

2 hours

23 August 2023

Answer all questions.

1 The cell surface membranes of different cells have a similar basic structure, but the proportions of the various molecules present vary between membranes and even between the inner and outer layers of a membrane.



Fig. 1.2 shows an organelle which contains an extensive network of internal membranes.





- (b) With reference to Fig. 1.1, suggest if molecule B will be found in the internal membranes found within the organelle shown in Fig. 1.2. Explain your answer.
 - 1. Yes, molecule B will be found;
 - 2. E.g. of channel proteins embedded in thylakoid membrane: ATP synthase allow protons to diffuse down the electrochemical potential gradient / other channel proteins that allow diffusion/movement of molecules etc.; **R! proton pump**[2]

[Total: 8]

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2 One mechanism for bacterial resistance to antibiotics is through the action of efflux pumps, which are proteins found on the bacterial cell surface membrane. Table 2.1 shows the intracellular concentrations of an antibiotic in two strains of bacteria, after exposure to the antibiotic for 24 hours.

Table 2.1					
strain of bacteria	intracellular concentration of antibiotic / mg L ⁻¹				
antibiotic-resistant	0.008				
antibiotic-susceptible	0.125				

- (a) Explain why antibiotics do not harm the human cells when used to treat humans. Generally, certain antibiotics target the :
 - 1. peptidoglycan cell wall, which is absent in human cells;
 - 2. <u>70S ribosomes</u>, but the ribosomes in human cells are mainly 80S;
 - 3. bacterial <u>enzymes</u> involved in <u>DNA replication / transcription</u>, which have a <u>different 3D conformation</u> from that found in human cells;

AVP: antibiotics bind to a transport protein only found in bacterial cells to enter bacterial cells / transport protein absent in human cells;

- (b) Describe how the efflux pumps are held in position within the membrane.
 - Formation of <u>hydrophobic interactions</u> between <u>hydrophobic R groups of amino</u> <u>acid</u> residues of efflux pumps / proteins and <u>hydrophobic</u> <u>hydrocarbon tails/fatty</u> <u>acid</u> chains of <u>phospholipid</u> molecules / <u>hydrophobic core</u> of <u>phospholipid</u> bilayer;
 - 2. Formation of <u>ionic bonds/hydrogen bonds</u> between <u>charged/polar</u> <u>R groups of</u> <u>amino acid</u> residues and <u>phosphate groups</u> of <u>phospholipid</u> molecules;

......[2]

- (c) With reference to Table 2.1, explain how the presence of efflux pumps allow bacteria to be resistant to the antibiotic.
 - 1. * The antibiotic-resistant strain of bacteria had a <u>lower intracellular concentration</u> of antibiotic of <u>0.008 mgL⁻¹</u> after exposure to the antibiotic OR The antibiotic-resistant strain of bacteria had a <u>low intracellular concentration</u> of antibiotic of <u>0.008 mgL⁻¹</u> after exposure to the antibiotic compared to that of the antibiotic-susceptible strain which had a intracellular concentration of <u>0.125 mgL⁻¹</u>;
 - 2. The efflux pump is a carrier protein which actively transports the antibiotic;
 - 3. out of the bacteria, <u>against / regardless of the concentration gradient</u> of the antibiotic;
 - 4. with the expenditure / hydrolysis of ATP;
 - 5. The efflux pump changes its <u>3D conformation</u> to carry the antibiotic across the cell surface membrane;

* MP1 compulsory, max 4m

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(d) Some strains of this bacteria show resistance to the antibiotic while other strains are susceptible, even though they both belong to the same species.

Suggest explanations for this observation.

- 1. Spontaneous <u>mutation</u> occurred only in some strains but not others, affecting gene(s) which confer resistance to the antibiotic;
- The gene(s)/allele(s)/sequence conferring resistance to the antibiotic may be found on plasmids instead of the bacterial chromosome;
- 3. which are not always distributed to daughter cells during <u>binary fission</u> / which are only passed from some cells to others through horizontal gene transfer;
- 4. the two strains are not sufficiently different genetically / morphologically / phylogenetically to be considered distinct species;

max 3m

......[3]

[Total: 11]



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3 Fig. 3.1 shows models of a haemoglobin molecule and part of a keratin molecule.



- (a) Outline the main structural differences between these two proteins, visible in Fig. 3.1.
 - Haemoglobin is a globular / spherical / rounded in structure while keratin is long / fibrous;
 - 2. Haemoglobin consists of <u>four</u> polypeptide chains / subunits / exists as a tetramer while keratin consists of <u>two</u> polypeptide chains / exists as a dimer;
 - 3. Haemoglobin has prosthetic / haem groups while keratin does not;
 - Haemoglobin does not have disulfide bonds while keratin has <u>disulfide</u> bonds between its polypeptide chains;
 - 5. Haemoglobin has a tertiary structure while keratin does not;
 -[3]
- (b) Describe the role of bonds in haemoglobin in increasing the efficiency of the loading and unloading of oxygen.
 - 1. The two polypeptide chains in each dimer are held together by <u>ionic bonds</u>, <u>hydrogen bonds and hydrophobic interactions (at least 2 bonds</u>) between R groups so as to form stable $\alpha\beta$ dimers:
 - 2. The two $\alpha\beta$ dimers are held together weakly by <u>hydrogen bonds</u> between R groups, resulting in the ability of the two dimers to move with respect to each other; [2]

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Unlike haemoglobin which circulates in the blood, myoglobin is the oxygen-binding protein located primarily in muscles. Myoglobin serves as a local oxygen reservoir that can temporarily provide oxygen when blood oxygen delivery is insufficient. This happens during periods of intense muscular activity when the concentration of oxygen drops below 20 mm Hg.



Fig. 3.3 shows the relationship between the concentration of oxygen and the percentage saturation of the two oxygen-binding proteins, haemoglobin and myoglobin.



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(c) (i) Identify the curves corresponding to haemoglobin and myoglobin.

C: myoglobin D: haemoglobin[1]

- (ii) With reference to Fig. 3.2 and Fig. 3.3, explain your answer to (c)(i).
 - 1. Haemoglobin consists of 4 polypeptide chains that can interact in a cooperative manner while myoglobin consists of 1 polypeptide chain/ 1 haem group and does not exhibit cooperativity i.e. idea of binding of one oxygen molecular to one of the subunits at low oxygen level increases the affinity of remaining subunits for oxygen;
 - leading to the sigmoidal shape of the curve / idea of sharper increase between 15mm Hg Oxygen to 35mm Hg Oxygen, while gradual increase between 0 – 15 mm Hg, and 35 to 100mm Hg;
 - 3. Myoglobin is a good oxygen storage molecule in muscle tissues / provides reserve oxygen that the cell needs during exercising;
 - At a O₂ concentration of <u>20 mm Hg</u>, myoglobin has a high percentage saturation of <u>84</u> (A! 82-85), compared to <u>20</u> (A! 20-25) for haemoglobin OR At a O2 concentration of <u>10 mm Hg</u>, myoglobin has a high percentage saturation of <u>60 (A! 60-62)</u>, compared to <u>3</u> (A! 3-5) for haemoglobin;

3

.....[4]

[Total: 10]

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(c) Protein T, not shown in Fig. 4.1, is normally involved in the initiation of translation.

The unfolded protein response (UPR) is a cellular stress response that is triggered by an accumulation of unfolded or misfolded proteins after a high rate of translation. During the UPR, a kinase known as PERK is activated and acts on protein T.

Suggest how the activation of PERK prevents the accumulation of unfolded or misfolded proteins.

- 1. *PERK phosphorylates/adds phosphate group to protein T and <u>activates/inactivates</u> it, which then leads to the following;
- 2. tRNA with UAC anticodon does not bind to the AUG start codon on mRNA / ribosome;
- 3. mRNA does not attach to the small ribosomal subunit;
- 4. large and small ribosomal subunits does not associate; *compulsory pt
-[2]

[Total: 8]



A Methodist Institution (Founded 1886) 5 SARS-CoV-2 is the virus responsible for the COVID-19 pandemic. It is a positive-sense single-stranded RNA enveloped virus which uses its viral spike glycoproteins to infect human cells bearing ACE2 receptors.



(a) Compare the reproductive cycle of SARS-CoV-2 shown in Fig. 5.1 with that of the influenza virus.

Similarities (at least 1):

- 1. The viral glycoproteins on both viruses bind to the receptors on the cell surface membrane of the host cell;
- 2. In both, receptor-bound viruses are taken into the cell by receptor-mediated endocytosis;
- 3. Acidification / pumping of H+ into the endosome allows for;
- 4. Fusion of the viral envelope with the endosomal membrane is needed for release of viral genetic material into the cytoplasm;
- 5. Both viruses replicate their RNA genome using RNA-dependent RNA polymerase;
- 6. Both viruses use the host ribosomes to synthesise viral proteins through translation:
- 7. Both viruses use the host RER / GA for the modification / packaging / intracellular transport of viral proteins;

Differences (at least 1):

Basis of comparison	SARS-CoV-2	Influenza
8. Host receptor	Binds to host <u>ACE2</u>	Binds to host <u>sialic acid-</u>
	receptors	containing receptors;
9. genome used for	+ sense RNA used	<u>– sense RNA</u> has to be used as a
translation	directly for translation	template to synthesise the +
directly		sense RNA for translation;
10. Budding /	Budding / assembly to	budding / assembly to form viral
assembly	form viral particle occurs	particle occurs at the cell surface;
	at the cisternae of RER	
11. Method of	Released by exocytosis	Released by budding;
release		
12. Require	Does not require	Requires <u>neuraminidase</u> / cleave
additional	cleavage by additional	the sialic-acid containing
enzyme for	enzyme for release	receptors to release newly formed
release		viruses;
		At least 1 similarity and 1 difference

.....[4]

(b) Many different strains of SARS-CoV-2 have been detected since the start of the pandemic, a feature that is shared with the influenza virus.

Explain how new strains of the influenza virus may arise.

- 1. Antigenic drift may occur, which is caused by mutations that result in a gradual change in the haemagglutinin/neuraminidase antigen that attaches to receptors on host cells;
- 2. Mutations are caused by the error prone RNA replication / lack of proof reading of RNA dependent RNA polymerase (A! low fidelity);
- 3. Antigenic shift may occur, where the virus acquires a new genome segment through intracellular reassortment from an influenza virus capable of infecting other hosts, causing a major change in the haemagglutinin/neuraminidase antigen;
- which could occur when two different viral strains infect the same intermediate host cell, and the gene segments are randomly packaged into new virus particles;[3]

The polymerase chain reaction (PCR) test has been considered the most accurate test for diagnosing an infection by SARS-CoV-2.

To conduct the PCR test, viral RNA is first extracted from the patient's biological sample, then reverse transcribed to form complementary DNA (cDNA). The cDNA is then amplified through PCR, and the presence of significant quantities of amplified DNA indicates a positive test result.

- (c) Explain the basis for the high accuracy of the PCR test.
 - 1. <u>Forward and reverse primers</u> used in PCR <u>complementary</u> base pairs only to; <u>R! RNA primers</u>
 - 2. <u>specific</u> DNA sequences that flanks the viral gene sequence; allowing the viral sequences to be amplified

Another method used for diagnosis is the antigen rapid test (ART), which can be done without the need for analysis in a laboratory and can yield results within minutes.

Scientists evaluated the effectiveness of ART in diagnosing COVID-19 in 500 patients, where the presence of SARS-CoV-2 in the patients were then confirmed by PCR testing. The results are shown in Table 5.1.

	Table 5.1	
	result by	PCR
Tesult by ART	positive	negative
positive	111	3
negative	9	377

The sensitivity of a diagnostic test is defined as its ability to detect a disease when a patient is confirmed to be infected.

The specificity of a diagnostic test is its ability to correctly indicate the absence of disease when a patient is confirmed as not infected.

Both measures of sensitivity and specificity are calculated as percentages.

(d) Calculate the sensitivity and specificity of the ART method, showing your workings in the space provided.

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Sensitivity = 111 / 120 x 100% = 92.5%; Specificity = 377 / 380 x 100% = 99.2%;

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[Total: 11]

Examiner Use Gene expression can be controlled at the transcriptional level. An investigation was carried out to find out the effect of an enhancer sequence on the transcription of a gene. Fig. 6.1 summarises the results of the investigation, with five different experiments, (a) to (e): (a) shows the gene without an enhancer, while (b) to (e) shows the gene under the influence of the enhancer at different arrangements. (a) Basal transcription Ρ Gene (b) Stimulated transcription F Ρ Gene (c) Stimulated transcription Ρ Е Gene (d) Stimulated transcription Ρ Gene E



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- (a) Describe the function of the enhancer.
 - 1. Enhancer sequence allows <u>activator</u> molecules to bind;
 - increasing the rate of formation of the <u>transcription initiation complex</u>/ increasing the affinity of the general transcription factors and RNA polymerase for the <u>promoter</u>;
 - resulting in an increase in the rate of transcription, hence producing more mRNA per unit time;

.....[3]

- (b) Explain how the enhancer is able to perform its function in the new location shown in Fig. 6.1(c).
 - 1. As the location is at a further distance away from the promoter, <u>DNA-bending</u> <u>protein</u> causes DNA to bend, which brings the bound activators closer to the promoter;
 - This results in the recruitment of <u>mediator proteins</u>, which facilitates a <u>higher rate</u> (higher than basal) of binding of general transcription factors and the RNA polymerase, to the promoter;
 -[2]
- (c) With reference to Fig. 6.1(d) and 6.1(e), describe the relationship between the activity of the enhancer and its arrangements.

Enhancers are able to function:

- 1. regardless of the position / downstream of target genes;
- 2. regardless of orientation / in the opposite orientation/inverted/reversed;

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Specificity protein 1, Sp1, was found to stimulate transcription of a gene. It was discovered that Sp1 binds specifically to GC box sequences found within the gene. In order to study Sp1 further, the method shown in Fig. 6.2 was used to obtain and purify Sp1.



Fig. 6.2

- (d) With reference to Fig. 6.2, suggest how the method purifies Sp1.
 - 1. Binding site of Sp1 is complementary to GC box sequences on the DNA bound to the agarose bead;
 - 2. Sp1 will remain bound in the column of beads while other proteins flow through;
 - 3. Buffer with a high salt concentration then breaks the weak hydrogen / ionic bonds between the binding site of Sp1 and DNA to release the Sp1 protein;
 - [3]

[Total: 10]

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7 A recombinant frequency of 1% indicates a distance of 1 centimorgan (cM) between two genes on a chromosome. Recombinant frequency can be calculated using the equation:

> Number of recombinant offspring 100% Recombinant frequency = Y Number of total offspring

In tomato plants, the two genes controlling the height of plant and the type of leaf are on the same homologous pair of chromosomes. They are located 12 cM apart on chromosome 1. The allele D, for a tall plant, is dominant to the allele d, for a dwarf plant. The allele M, for normal leaves, is dominant to the allele **m**, for mottled leaves.

Pure-breeding tall tomato plants with mottled leaves are crossed with pure-breeding dwarf plants with normal leaves. All the F1 tomato plants are tall with normal leaves. The F1 tomato plants then undergo a test cross, which gives 250 offspring. There are equal numbers between the two parental phenotypes and equal numbers between the recombinant phenotypes.

State the genotype of both plants from the parental generation. (a)



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Table 7.1

	1.52	2.05	2.39	2.14	1.84	1.65	1.91	2.34	1.04	2.95	
	1.72	2.28	2.32	2.00	2.11	1.66	1.74	1.97	2.21	1.43]
	2.08	1.76	2.68	1.91	2.07	1.85	2.19	2.14	1.99	1.57	
	2.06	2.45	1.82	1.11	2.68	1.86	2.19	1.56	2.78	1.23	
	2.83	2.01	2.44	2.04	2.63	1.90	2.21	1.37	2.57	2.54	
(c) S 1 2 3	State and . * <u>Conti</u> 2. An un plants 3. Height	explain t <u>nuous</u> v broken ; t is cont	he type variation range c	of genet ; of <mark>grade</mark> y <mark>many</mark>	ic variati <mark>d / not</mark> / severa	on show discrete	n in the pheno ge numb	height of types o per of ge	[,] tomato bserved nes (po	plants. I in the Iygenes	tomato s);
4 5	. Effect . <u>Enviro</u>	of gene onment	s is <u>add</u> has a la	l <u>itive;</u> rge effe	ct on the	e pheno	type;				
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Table 7.1 shows the height of 50 tomato plants measured in metres, to the nearest cm.

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... [2]

8 Fig. 8.1 is an electron micrograph of a mitochondrion.



- (a) (i) On Fig. 8.1, clearly label and name the precise location where the Krebs cycle occurs. Indicate, label and name 'matrix' clearly; [1]
 - (ii) Explain the importance of structure **Q** to the function of the mitochondrion.
 - 1. Allows <u>electron carriers and ATP synthase</u> to be <u>embedded</u> for <u>chemiosmotic</u> <u>synthesis of ATP;</u>
 - 2. Increase <u>surface area</u> for more electron carriers and ATP synthase to be embedded for higher rate of chemiosmotic synthesis of ATP;
 - 3. Structure A is impermeable to protons, allowing for accumulation of protons / establish a proton gradient for chemiosmotic synthesis of ATP;

See "chemiosmotic synthesis of ATP" once for full marks

.....

(b) The metabolic activity of mammalian cells can be measured by the uptake of glucose into the cells.

With reference to named stages in aerobic respiration, explain why the uptake of glucose can be used to measure the metabolic activity of mammalian cells.

- 1. Glucose is a respiratory substrate and is broken down to <u>pyruvate</u> during <u>glycolysis; R! reduction</u>
- 2. (In the presence of oxygen,) pyruvate is oxidized to form <u>acetyl-coA</u> during <u>link</u> <u>reaction</u>, which is further oxidised during the <u>Krebs cycle</u>;
- producing <u>reduced NAD and reduced FAD</u> used in <u>oxidative phosphorylation</u> to synthesise ATP via chemiosmosis; <u>R! NADPH</u>

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In an investigation, the effects of environmental temperature on oxygen and carbon dioxide levels in the air around a cockroach were studied. Fig. 8.2 shows the experimental set-up consisting of a closed animal chamber, a heat lamp and three digital probes linked to a computer.



The set-up was allowed to equilibrate for 10 minutes. After 10 minutes, ice packs were wrapped around the sides of the animal chamber to decrease the temperature of the chamber. Measurements were collected using the digital probes for a further 20 minutes. The experiment was conducted once every day for the next six days with the same cockroach.



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- 22
- (c) (i) With reference to Fig. 8.3, comment on the results of this investigation.
 - When the temperature is constant at <u>30°C</u> for the first 10 minutes, the levels of CO₂ increase from <u>0.04 %</u> to <u>0.07%</u> / increase <u>by 0.03%</u> AND the levels of O₂ decrease from <u>22.5% (A! 22%)</u> to <u>17.5% (A! 18%) / decrease by 4% or 5%;</u>
 - 2. When temperature decreases from <u>30°C to 10°C</u>, the levels of CO₂ increase gradually from <u>0.07%</u> to <u>0.09% / increase by 0.02%</u> and the levels of O₂ decrease gradually from <u>17.5% (A! 18%)</u> to <u>15.5%</u> (A! 16%) / <u>decrease by 2%;</u>
 - 3. shows that as temperature decreases, rate of cellular respiration decreases;
 - shows that oxygen is used during respiration and carbon dioxide is produced during respiration;
 -[3]
 - (ii) Identify one variable which should be kept constant and explain how it could affect the validity of the results if it is not controlled.
 - 1. Make sure that the experiment is conducted at the same time of day;
 - 2. due to cockroaches being more active at different times, therefore could increase aerobic respiration;

OR

- 3. Feed the cockroach the same amount of glucose/food each day;
- 4. to ensure the same initial glucose levels, which could affect cellular respiration;

OR

- 5. Ensure that the environment the cockroach is kept in between experiments is the same;
- so that other factors such as external temperature do not affect the cellular respiration rate before the experiment;

.....

[Total: 12]

[2]

Junin Callege A Methodist Institution (Founded 1886) **9** A species of zooplankton, *Daphnia dentifera*, feeds on phytoplankton. An increase in nitrogen compounds dissolved in the lakes will cause the phytoplankton populations to increase.

The yeast *Metschnikowia bicuspidata* is a parasite of *D. dentifera*. Biologists monitored the infections of *D. dentifera* population in a lake in Indiana, USA.

Fig. 9.1 shows the relationship between nitrogen levels dissolved in the water and the number of individuals infected in the *D. dentifera* population.



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- (ii) Biologists predicted that there would be fewer infected individuals in the *D. dentifera* population over many generations. Describe the evolutionary process that supports this prediction.
 - 1. <u>Genetic variation</u> in terms of resistance to yeast parasite present in the population;
 - 2. <u>Selection pressure</u> is the infection by the yeast parasite;
 - 3. *D. dentifera* with greater resistance to the yeast parasite are selected for / have selective advantage;
 - These individuals have <u>higher reproductive success/more likely to survive and</u> <u>reproduce</u> and <u>pass on</u> <u>allele</u> coding for resistance to yeast parasite to their offspring;
 - 5. <u>Over time/many generations</u>, there is an increase in the <u>frequency of allele</u> coding for increased resistance to parasite in the <u>gene pool</u>;

[4] *D. dentifera* is a member of the crustacean group. Table 9.1 shows part of the amino acid sequence of ATP synthase from four different species of crustaceans.

Species		Amino acio	l sequence	
P. monodon	KSFKEILAGK	YDDLPEAAFY	MQGSIEDVVA	KAEQLAAQAS
M. japonicus	KSFKEILAGK	YDDLPEAAFY	MQGSIEDVVE	KAEQLAAQAS
L. vannamei	RSFKEILAGK	YDDLPEAPFY	MQGSIEDVIE	KAEQLAAQPS
P. leniusculus	ASFKEILAGK	YDHLPKLPST	CRGDIQDVLE	KAEQLATQGS

Table 9.1

- (b) Explain what the data indicate about the relationships between *P. monodon* and the other three crustaceans.
 - 1. *P. monodon* is most closely related / share most recent common ancestor to *M. japonicus* as there is only a difference of <u>1</u> amino acid in the sequence;
 - 2. *P. monodon* is most distantly related / share least recent common ancestor to *P. leniusculus* as there is a difference of <u>15</u> amino acids in the sequence;
 - 3. *L. vannamei* is more closely related / shares more recent common ancestor to *P. monodon* compared to *P. leniusculus* as there is a difference of <u>5</u> amino acids in the sequence;

.....[3]

[Total: 10]

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10 Colostrum is a form of milk. Colostrum is produced by mammals to feed their newborn babies for a few days after birth.

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I able I	U. I	5110W51	.wo	classes of	antibu	ules III	numan	anui		colostium.

	Table 10.1	AT ALL			
aloop of optibody	antibody concentration/ mg cm ⁻³				
class of antibody	human colostrum	bovine colostrum			
IgA	17.4	3.9			
IgG	0.4	47.6			

- (a) With reference to Table 10.1, compare the antibody composition of human colostrum with that of bovine colostrum.
 - 1. (similarity) Both human colostrum and bovine colostrum have lgG and lgA;
 - 2. Human colostrum has a higher concentration of IgA, <u>17.4 mg cm⁻³ compared to</u> bovine at <u>3.9 mg cm⁻³</u>; A! 13.5 mg cm⁻³ more
 - 3. Human colostrum has a lower concentration of IgG, <u>0.4 mg cm⁻³ compared to bovine</u> <u>at 47.6 mg cm⁻³</u>; A! 47.2 mg cm⁻³ lesser
 - 4. Human colostrum has less total antibody compared to bovine, <u>17.8 mg cm⁻³</u> <u>compared to 51.5 mg cm⁻³</u> in bovine; A! vice versa for all
- (b) Vaccines are able to stimulate the production of antibodies in human. [2]

Outline the benefits and risks of vaccination. Benefits (at least 1):

in.

- 1. Allows possible eradication of disease;
- 2. reduced suffering / cost of treatment;
- 3. prevention of death / immunity from the disease;
- 4. long-term disabilities reduced; e.g. sterility from mumps / congenital defects from rubella;
- 5. prevent epidemics / spread of infections;
- 6. confers immunological memory / immunity OR production of memory cells to the pathogen in vaccinated individuals; R! antibodies (as its in preamble)
- 7. <u>Herd immunity</u> conferred as the vaccination of a significant portion of a population provides a measure of protection for individuals who have not developed immunity; Risks (at least 1):
- 8. People may contract disease from vaccine due to possible risk of pathogen to revert to virulence / virulent form;
- 9. hence may cause serious infections in immunocompromised / immunodeficient individuals;

10. vaccination may cause rare adverse/allergic reactions/anaphylaxis in some individuals e.g. allergic reaction to egg proteins as a consequence of viral vaccines produced in eggs;

.....[3] [Total: 5]

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11 Pollen grains present in peat bogs and lake sediment may provide evidence of climate change.

In an investigation, the age of the sediment in a lake was determined. The lake sediment was also analysed for the abundance of pollen grains belong to four types of plant.

