Nucleotides and Nucleic Acids

Total mark – 19

Question: 1

20. DNA can be extracted from a culture of white blood cells and precipitated using the following procedure:

1. Mix a culture of white blood cells with a detergent.
2. Add salt.
3. Add an enzyme.
4. Place in a water bath at 40 °C.
5. Filter the culture.
6. Gently pour ice-cold ethanol onto the filtrate.

i. Suggest why the cells do not need to be crushed before adding detergent.

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[1]

ii. Explain why the detergent is used in step 1.

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[1]

iii. Suggest the type of enzyme that should be used in step 3 and explain why.

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[2]

20		i	wbc do not have cell walls to break open ✓ wbc are, individual cells / not a tissue, so no separation needed ✓	1 max	
		ii	disrupts / breaks down / dissolves, phospholipid bilayer / membrane ✓	1	**ALLOW** remove bilayer / membrane
		iii	(named) protease ✓ break down, histones / proteins associated with DNA ✓	2	**ALLOW** hydrolytic
			Total	**4**	

Question: 2

21. A group of students tried to purify some DNA from leek cells using the following method. They decided that exact volumes were not necessary.

1. Grind a leek leaf to a fine pulp using a pestle and mortar.

2. Add salt and cold water and mix again for at least 10 s.

3. Add protease enzyme and mix again for at least 10 s.

4. Filter the liquid into a test tube and stand for at least 10 min.

5. Tilt the test tube and gently pour in ice-cold ethanol.

6. A white layer of DNA forms between the sample and the ethanol.

7. Extract the white layer carefully using a glass rod.

i. State the purpose of step **1**.

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[1]

ii. Suggest why a protease enzyme added in step **3** is needed to purify DNA.

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[1]

iii. The students considered using pineapple juice as a source of protease enzyme.

Suggest why this would **not** be an appropriate source of protease when attempting to produce a pure sample of leek DNA.

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[1]

iv. State one important step that the students had left out of their method.

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[1]

v. Name the process described in step **6**.

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[1]

21		i	break / AW, cell walls ✓	1 (AO 1.2)	**IGNORE** membranes **Examiner's Comments** A number of candidates achieved this mark. Many discussed increasing surface area or breaking cell membranes or breaking open nuclei, which didn't score any marks.
		ii	breaks down / digests / removes, proteins associated with DNA / histones ✓	1 (AO 2.7)	**DO NOT CREDIT** proteins in DNA **Examiner's Comments** Mainly higher ability candidates gained a mark in this question. Most referred to non-specific proteins and some responses even referred to DNA as a protein, which were not credited.

		iii	*idea that* pineapple juice contains DNA ✓ *idea that* pH might be too low ✓	1 (AO 3.4)	**IGNORE** references to incorrect protease **Examiner's Comments** Many candidates correctly made the link between pineapple juice and pineapple DNA. Responses that questioned the effectiveness of pineapple protease were not credited. Not were those that suggested pineapple juice would stain the DNA.
		iv	(add) detergent / washing-up liquid ✓	1 (AO 2.7)	**DO NOT CREDIT** in the context of washing **IGNORE** lipase **Examiner's Comments** A few candidates omitted this question, while many candidates suggested heating or safety precautions, which were not credited.
		v	precipitation ✓	1 (AO 2.7)	**Mark first suggestion only**
			Total	**0**	

Question: 3

22. A group of students attempted to extract and purify DNA from a plant in Upper End Meadow.

The students used the following steps:

1. Mix the plant sample with detergent.
2. Add salt.
3. Add protease enzyme.
4. Spool the DNA precipitate onto a glass rod.

Suggest whether this method would successfully extract and purify DNA. Justify your conclusion.

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[3]

22			*YES reasons why it **would**, work / be successful: **2 max*** **Y1** detergent, breaks / disrupts, (cell) membrane(s) / nuclear envelope OR detergent, releases contents of, cell / nucleus ✓ **Y2** salt, helps DNA, shed water / precipitate ✓ **Y3** protease breaks down, histones / proteins around DNA / proteins attached to DNA ✓ *NO reasons why it would **not**, work / be successful: **2 max*** **N1** cell walls not broken by,	3 max	**IGNORE** additional unlikely ideas throughout e.g. detergent breaks cell wall, salt disrupts membranes. **ALLOW** protease separates DNA from, protein / chromatin **ALLOW** ORA for N1-N4, e.g. action, should be / ought to be / needs to be, done to... e.g. **N1** *'plant should be crushed to break cell walls'* **N3 ALLOW** as reason *'to separate DNA from, solution / water / aqueous phase'*

			abrasion / grinding / blender ✓ **N2** no RNAase added to remove RNA (from DNA / chromatin) ✓ **N3** no, alcohol / ethanol, added to, precipitate DNA ✓ **N4** temperature not low to reduce, enzyme activity / DNA break down ✓		**Examiner's Comments** Knowledge of the reasons for each step in a procedure to purify DNA was poor. Candidates may have been put off by the commands to suggest and justify. Essentially candidates needed to argue yes for the correct steps listed which they could explain the point of, and no for the extra steps that they realised had been omitted. **Misconception** Many candidates thought that a crushing stage would be needed to break cell membranes instead of cell walls. Conversely, many candidates thought the detergent would break cell walls instead of cell membranes. Many candidates thought that protease would break down DNA instead of its associated proteins such as histones. There was misunderstanding of the roles of salt and ethanol to precipitate the DNA (separate it from the aqueous solution).
			Total	**3**	

Question: 4

23. A student tried to extract some DNA from a crushed banana at home. DNA dissolves in water but the student realised that they needed to add something to break open the nuclear envelope to release the DNA.

Suggest a suitable substance the student could use to release the DNA, **and** explain why it should work.

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[2]

23			detergent (1) works as an emulsifier / attracts phospholipid molecules and water molecules (1) it will break up the plasma / nuclear membranes (1)	2	
			Total	**2**	

Question: 5

24. A DNA molecule contains polynucleotide strands.

i. Individual nucleotides are joined together to make a polynucleotide strand.

What type of chemical reaction takes place when two nucleotides in a single polynucleotide strand are joined together?

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[1]

ii. Name the chemical released when the bond is formed between the two nucleotides.

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[1]

iii. A DNA molecule contains two polynucleotide chains.

Describe how these two chains are held together.

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[3]

24		i	condensation ✓	1	*If additional incorrect answer given, then 0 marks* **ACCEPT** esterification **Examiner's Comments** Most candidates identified the correct reaction involved and stated that the chemical released was water. Esterification also gained credit for some candidates. A minority of candidates
		ii	water ✓	1	**Examiner's Comments** Most candidates identified the correct reaction involved and stated that the chemical released was water. Esterification also gained credit for some candidates. A minority of candidates wrongly answered hydrolysis, with hydrogen given off.
					IGNORE antiparallel

			iii	1 phosphodiester bonds in, backbone / described ✓ 2 hydrogen / H, bonds / bonding (between chains / bases) ✓ 3 purine to pyrimidine / A to T **and** C to G ✓ 4 ref to correct number of bonds between base pairs (A-T & C-G) ✓	max 3	1 **ACCEPT** covalent bond in backbone 2 **DO NOT CREDIT** if other bond mentioned to connect between the two chains **DO NOT CREDIT** H^+ bonds **IGNORE** strength of bond 3 **DO NOT CREDIT** thiamine / cysteine / adenosine **Note:** 'Two bonds between A and T and three bonds between C and G' **= 2 marks (mp 3 and mp 4)** 'Two hydrogen bonds between A and T and three hydrogen bonds between C and G' **= 3 marks (mp 2, mp 3 and mp 4)** **Examiner's Comments** Generally this was a well answered question with candidates recalling correctly the base pairs and the relevant number of hydrogen bonds between the pairs. Fewer candidates were able to describe the correct location of the phosphodiester bond in the sugar-phosphate backbone. A few candidates were unsure of DNA structure, incorrectly identifying them as polypeptides and then going on to list the bonds found in protein structure.
				Total	**5**	