Mark scheme - Nucleotides and Nucleic Acids

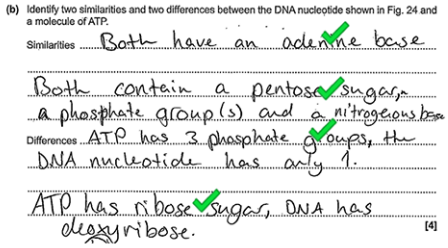
20		i	wbc do not have cell walls to break open ✓ wbc are, individual cells / not a tissue, so no separation needed ✓	1 max	
		ii	disrupts / breaks down / dissolves, phospholipid bilayer / membrane ✓	1	**ALLOW** remove bilayer / membrane
		iii	(named) protease ✓ break down, histones / proteins associated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

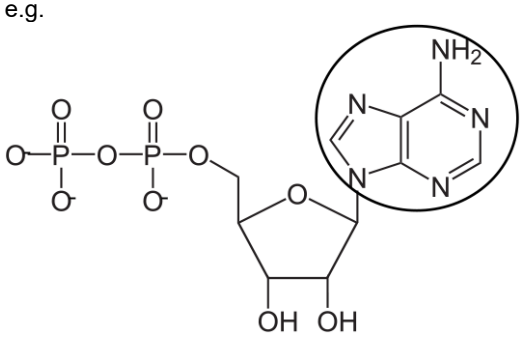
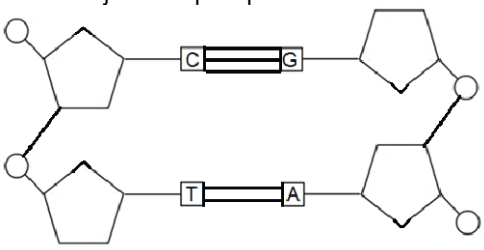
		iii	*idea that* pineapple juice contains DNA ✓ *idea that* pH might be too low ✓	1 (AO 3.4)	**IGNORE** references to incorrect protease **Examiner's Comments** Many candidates correctly made the link between pineapple juice and pineapple DNA. Responses that questioned the effectiveness of pineapple protease 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**	
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**	
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**	
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

					wrongly answered hydrolysis, with hydrogen given off.
		ii	water ✓	1	*If additional incorrect answer given, then 0 marks* **ACCEPT** H_2O (correct formula only) **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.
		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	**IGNORE** antiparallel 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**	

25			1 nucleotides joined by phosphodiester bonds ✓ 2 hydrogen bonds between, complementary / named bases ✓ 3 (polynucleotides) are anti parallel / described ✓ 4 AVP ✓	3 max (AO1.1)	**1 ALLOW** sugar phosphate backbone held with phosphodiester bonds e.g. sense / coding, strand is 5' to 3' antisense / nonsense / template, strand is 3' to 5'
			Total	**3**	
26			nucleotide ✓ phosphate ✓ pentose ✓ strands ✓	**4**	*If two or more words are given for each gap do not accept contradictory responses* **ALLOW** two **Examiner's Comments** The majority of candidates were able to gain at least one mark in **Q19(a)** and the gap fill in **Q19(b)** enabled the majority of candidates to show their knowledge about DNA structure gaining at least three out of the four marks available.
			Total	**4**	
27		i	phosphate ✓ deoxyribose ✓ guanine ✓	3(AO 1.1 2.1)	**IGNORE** PO_4 **DO NOT CREDIT** dioxyribose **DO NOT CREDIT** if any other sugar mentioned **IGNORE** G **DO NOT CREDIT** if any other base mentioned
		ii	phosphodiester ✓ condensation ✓	2(AO 1.1 2.1)	
			Total	**5**	
28			*both have:* a pentose (sugar) ✓ adenine (base) ✓ phosphodiester bond (between sugar and phosphate) ✓ an OH group on carbon 3 of the sugar ✓ phosphate (group) ✓ *ATP has:* two additional phosphates ✓	4 max	Mark first two similarities and first two differences **IGNORE** both have N, C, H, O, NO3− **DO NOT ALLOW** phosphate ion / molecule (but penalise only once) **ALLOW ORA** for DNA nucleotide

			deoxyribose replaced by ribose ✓ an OH group on carbon 2 of the, sugar / ribose		**DO NOT ALLOW** 'ATP has ribose' without comparison **Examiner's Comments** This question differentiated well. Candidates needed to recall the structure of ATP and compare that to the nucleotide shown in figure 24. Many candidates accurately identified two similarities and two differences. The most commonly stated similarities 'contain adenine' and 'contain phosphate'. Other similarities were given by more able candidates such as 'contain pentose sugars'. The most commonly stated differences were 'ATP contains three phosphates against one in the nucleotide' and 'ribose compared to deoxyribose'. Very few candidates went into further detail to describe the difference between ribose and deoxyribose. A few candidates lost credit as they did not make a clear comparison under the 'differences' section. The least able candidates appeared to have little concept that ATP is quite similar in structure to a nucleotide. **Exemplar 5**  (b) Identify two similarities and two differences between the DNA nucleotide shown in Fig. 24 and a molecule of ATP. Similarities Both have an adenine base Both contain a pentose sugar, a phosphate group(s) and a nitrogenous base Differences ATP has 3 phosphate groups, the DNA nucleotide has only 1. ATP has ribose sugar, DNA has deoxyribose. [4]
			Total	**4**	
29			*three from* adenine / A pairs with thymine / T **and** cytosine / C pairs with guanine / G (1) (because of) hydrogen bonding (1) *idea that* purine can only bind with pyrimidine because they are different sizes (1) *idea that* if one base is known it can pair with only one other base (1)	3	**ALLOW** 2 H bonds between A and T and 3 H bonds between C and G.
			Total	**3**	

30		i	circle around the two nitrogen containing rings ✓	1	e.g. 
		ii	ADP has 2 phosphates **whereas** DNA nucleotide (with adenine) has 1 phosphate ✓ ADP has ribose **whereas** DNA (nucleotide with adenine) has deoxyribose ✓ **or** ADP has OH on carbon 2 of sugar **whereas** DNA (nucleotide with adenine) has no OH on carbon 2 of sugar ✓	2	Note: a clear comparison between ADP and DNA nucleotide must be made
		iii	condensation ✓	1	**ALLOW** phosphorylation
			Total	**4**	
31			bond drawn between phosphate and carbon 3 of sugar **and** labelled phosphodiester bond ✓ two bonds drawn between bases T & A **and** three bonds between C & G **and** labelled hydrogen bonds ✓	2	**ACCEPT** just one phosphodiester bond drawn 
			Total	**2**	
32		i	adenine ✓	1 (AO2.1)	**DO NOT ALLOW** adenosine **IGNORE** nitrogenous base / purine
		ii	hydrolysis ✓	1 (AO2.1)	**IGNORE** dephosphorylation
		iii	because ATP is , broken down / hydrolysed (to ADP) ✓ ATP is constantly recycled ✓	max 2 (AO2.1)	**ALLOW** ATP is unstable **ALLOW** constant interconversion of ATP and ADP (+Pi)

			ATP used to provide energy for , (named) metabolic reactions / processes ✓ ATP is , not stored long term / used immediately ✓		**ALLOW** ATP produced is coupled to metabolic reactions **IGNORE** used for respiration unqualified **ALLOW** ATP is used as fast as it is produced
			Total	**4**	
33		i	deoxyribose ✓	1	**Examiner's Comments** Many candidates correctly identified the circled component as deoxyribose sugar. Pentose sugar or ribose were common responses that were not credited a mark.
		ii	phosphodiester ✓	1	**Examiner's Comments** The majority of candidates correctly named the bond as a phosphodiester bond. Weaker candidates gave other names that they could recall such as 'hydrogen bond' or 'covalent bond' which were not given credit.
			Total	**2**	
34		i	164 706 ✓✓	2	Correct answer with no working = **2 marks** If the answer is incorrect, look for a working mark: **either** (incorrect rounding) **ALLOW** 1 mark for seeing 164 705 **or** 164 705.88 **or** 164 705.9 anywhere **or** **ALLOW** 1 mark for any ref to 56 ÷ 34 (e.g. 5.6 ÷ 0.34 or 5600 ÷ 34) **Examiner's Comments** Most candidates recognised that the number of kB would be obtained by dividing the length of DNA by the length of a kB to arrive at the number of kB in the length of DNA. However, they were not confident converting units of cm and micrometres to standard form, and also

					failed to state the answer to the nearest whole number.
		ii	28 ✓✓	2	Correct answer with no working = **2 marks** If answer incorrect, **ALLOW** 1 mark for seeing 100 − 44 or 50 − 22 **Examiner's Comments** The majority of candidates correctly scored maximum marks for this calculation, but the most common mistake that was presented was through poor arithmetic, e.g. 100 − 44 = 66.
			Total	**4**	
35			***Please refer to the marking instructions point 10 for guidance on how to mark this question.*** ***In summary:*** *Read through the whole answer. (Be prepared to recognise and credit unexpected approaches where they show relevance.)* *Using a 'best-fit' approach based on the science content of the answer, first decide which of the level descriptors,* ***Level 1****,* ***Level 2*** *or* ***Level 3****, best describes the overall quality of the answer.* *Then, award the higher or lower mark within the level, according to the* ***Communication Statement*** *(shown in italics):* • *award the higher mark where the Communication Statement has been met.* • *award the lower mark where aspects of the Communication Statement have been missed.*		

			• ***The science content determines the level.*** • ***The Communication Statement determines the mark within a level.***		
			Level 3 (5–6 marks) A comparison of all or most aspects of the two processes is included, with no significant errors. *There is a well-developed line of reasoning, which is clear and logically-structured and uses scientific terminology at an appropriate level. All the information presented is relevant and forms a continuous narrative.* **Level 2 (3–4 marks)** A description of some similarities and differences between the two processes is included, with only minor errors. *There is a line of reasoning presented with some structure and use of appropriate scientific language. The information presented is mostly relevant.* **Level 1 (1–2 marks)** A description of similarities or differences between the two processes is included, but with significant omissions or errors. *There is a logical structure to the answer. The explanation and use of scientific language, though basic, is clear.* **0 marks** No response or no response worthy of credit.	6	**Indicative scientific points may include:** *Similarities* • DNA unwinds and unzips • Helicase enzymes • Template DNA • Complementary base pairing • Hydrogen bonds • Free, activated nucleotides • Polymerase enzymes *Differences* • Only a small section of DNA (where the gene is located) unzips during transcription • Both strands act as templates in replication • RNA vs DNA free nucleotides • RNA vs DNA polymerase • Different helicase enzymes • Products are two new daughter strands of DNA in replication and one mRNA strand in transcription • mRNA leaves nucleus whereas the new DNA strand remains bound to the template strand

			Total	**6**	
36		i	2.8 x 10^3 ✓✓✓	3 (AO2.6)	**ALLOW** 2.777 x 10^3 or 2.778 x 10^3 or 2.78 x 103 **ALLOW** 2 marks for 2777 **ALLOW** max 2 marks for working Each line can be awarded 1 mark: 3000 000 000 / 50 = 60 000 000 (s^{-1}) 60 000 000 (s^{-1}) / 3600 (s) = 16 667 (h^{-1}) 16 667 / 6 (h) **OR** 3 000 000 000 ÷ 21600 (i.e. 6 x 60 x 60) = 138 889 138 889 ÷ 50 1.08 x 10^6 / 1080000 Each line can be awarded 2 marks: 3000000000 ÷ 1080000 (ie: 6 x 60 x 60 x 50) **OR** 3 x 10^9 ÷ 1.08 x 10^6
		ii	helicase ✓ <u>DNA</u> polymerase ✓ AVP ✓ e.g. (DNA) ligase (DNA) gyrase	2 max (AO1.2)	**ALLOW** 'helixase'
		iii	1 enzymes , are (biological) catalysts / speed up reactions ✓ 2 they lower the activation energy (so reactions can take place at, low / body, temperatures) ✓ 3 high temperatures (in living organisms), would denature, enzymes / proteins ✓	2 max (AO1.1)	**ALLOW** enzymes catalyse reactions **ALLOW** enzymes reduce time taken for reaction **<u>Examiner's Comments</u>** Where more complex calculations were required, such as in this question, the working of these calculations was often confused and difficult to follow. Candidates needed to calculate how many enzyme complexes were required to replicate the human genome in a set time. However, responses were often incomplete or

					there were bits of working arranged haphazardly around the page. **OCR support** The Biology mathematical skills handbook provides support with teaching mathematical skills and is available here: https:/www.ocr.org.uk/Images/294471-biology-mathematical-skills-handbook.pdf.
			Total	**7**	
37	a	i	(new DNA molecule comprises) one, original / old / parent, strand and one new strand ✓ each strand (of DNA molecule) acts as a template strand (for a new double helix) ✓	**1 max**	**DO NOT ACCEPT** 'DNA strand' instead of 'DNA molecule' **Examiner's Comments** Most candidates gave a perfect answer referring to the DNA molecule comprising one original or parental strand and one new strand. The most common mistake was referring to just having an old strand. As in previous years, many candidates found it difficult to express their answer in a creditworthy manner e.g. 'each strand contains one old strand and one new', 'half of the DNA is replaced with new DNA', 'half of the original strand is used to make the new one'. Most of these answers show a lack of understanding of the difference between a DNA strand and a DNA molecule. Some candidates used logic with the term 'semi-conservative' and wrote about 'half the DNA staying the same', without appreciating this process compared with dispersive replication.
		ii	**E1** (DNA) helicase ✓	**4 max**	**Mark the first 2 enzymes mentioned** **NOTE only award the function mark when linked to the correct enzyme** **IGNORE** ligase

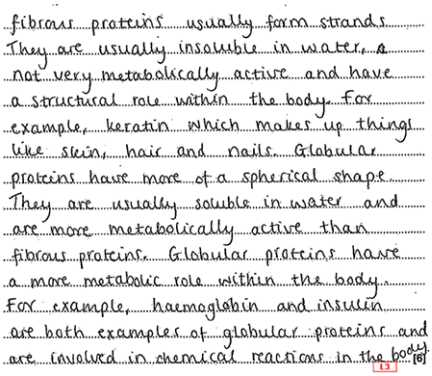
			F1 unzips the DNA molecule / breaks hydrogen bonds (between complementary bases) / separates the (2) strands ✓ **E2** DNA polymerase ✓ **F2** forms phosphodiester bonds / joins (adjacent) nucleotides / forms sugar-phosphate backbone ✓ ***Also creditworthy*** **E3** gyrase ✓ **F3 unwinds / uncoils,** the DNA ✓		**F1 IGNORE** unwinds the DNA molecule **E2 DO NOT ACCEPT** RNA polymerase **F2 DO NOT ACCEPT** forms H bonds **ACCEPT** checks for errors (in nucleotide sequence) **Examiner's Comments** Most candidates named two enzymes, commonly helicase and DNA polymerase. A few candidates described helicase as unzipping one strand, rather than separating the strands, but most correctly described its action. The most common misconception was describing DNA polymerase as pairing up free nucleotides with the template strand, and joining or reforming hydrogen bonds. Candidates should appreciate that hydrogen bonds occur due to complementary bases pairing and then DNA polymerase joins the nucleotides 'vertically', forming the sugar-phosphate backbone with phosphodiester bonds between the adjacent nucleotides. A few candidates did not specify 'DNA' polymerase or stated RNA polymerase. Some candidates attempted to write about DNA ligase and this illustrates the importance of reading the question properly. A very few candidates suggested random enzymes such as protease.
	b		*tube with generation 1* shows (new) DNA / band**,** contains**,** light nitrogen / N^{14} **,** **and,** heavy nitrogen / N^{15} ✓ *tube with generation 2*	**2 max**	Marks can be awarded from suitably labelled / annotated diagrams **ACCEPT** shows that (new) DNA is a hybrid

			(new) DNA / band, made from only, light nitrogen / N^{14} ✓ so a, light / N^{14} , strand of DNA must be a, template / parent strand, for the new molecule ✓ *tube with generation 10* (highest band gets thicker because) more of the DNA is made from only, light nitrogen / N^{14} ✓		***Could be credited in context of generation 10 instead (but only award once)*** **Examiner's Comments** This question was answered poorly. Only a few candidates could apply the information given in the stem, or were already familiar with the experiment, to correctly describe the banding pattern.
			Total	**7**	
38		i	(involves) DNA polymerase (1) sugar-phosphate backbone (re)forms / condensation reaction between phosphate and sugar (1)	3	
		i	DNA winds into double helix (1)		**ALLOW** higher level answers e.g. role of DNA ligase in joining sugar-phosphate backbone lagging strand filled in with Okazaki fragments.
		ii	(new molecule consists of) one old strand and one new strand (1)	1	
			Total	**4**	
39		i	**1** gene / DNA, copied / transcribed, to (m)RNA ✓ **2** (*idea that* RNA goes to / translation is at) ribosome(s) / RER ✓ **3** DNA, is too large to / cannot / is not able to, leave nucleus /	2 max	**Read all and mark as prose** **ALLOW** used as a template to create / AW, for 'copied to' **ALLOW** RNA, copies / takes a copy of, gene / DNA **DO NOT ALLOW** replicated for 'copied' **ALLOW ORA** 'RNA, is small enough to / can / is able to' or just 'RNA leaves nucleus' **ALLOW** nuclear membrane for 'nuclear envelope' **DO NOT ALLOW** leave the cell for 'leave

			cross nuclear envelope / fit through nuclear pores ✓		nucleus' **Examiner's Comments** As a recall question this was done well, particularly with respect to the sizes of molecules being able or unable to leave the nucleus via nuclear pores, and ribosome being the site of translation. Some candidates confused translation with transcription. **Misconception** Some candidates misuse language in describing transcription. Correct: • DNA is transcribed into mRNA. *(Note passive tense)* • mRNA is a transcript of the DNA. • mRNA is a copy of the DNA. Incorrect: • mRNA transcribes the DNA. *(Active tense)* • mRNA copies the DNA. *(RNA polymerase does this)*. • DNA is converted into mRNA.
		ii	90 252 **or** 90 255 **or** 90 258 ✓ ✓	2	**Correct final answer gets 2 marks**, even if no working is shown. Wrong final answer (which may include a 90 252 stage in the working) = **ALLOW 1 mark for seeing any of these:** 327 × 92 × 3 **OR** 30 084 **OR** 981 **Examiner's Comments** Most candidates multiplied the number of amino acids in pepsin (327) by the number of times bigger that titin is compared to pepsin (92). These candidates gained 1 mark for arriving at the figure 30 084. Only a minority of candidates

					understood that the question information was about the number of amino acids in a polypeptide while the question was asking for the number of bases in the equivalent DNA. Some of those who realised the distinction divided by the number of bases that code for one amino acid in error. The correct process was multiplying by 3 due to the logic that every amino acid in a polypeptide is coded for by 3 bases on DNA. Candidates who followed a different route could calculate the number of bases in DNA coding for pepsin and then multiply by 92, or could add 3 or 6 bases to their final answer for a stop and/or start codon.
		iii	For answers marked by levels of response: Read through the whole answer from start to finish, concentrating on features that make it a stronger or weaker answer using the indicative scientific content as guidance. The indicative scientific content indicates the expected parameters for candidates' answers, but be prepared to recognise and credit unexpected approaches where they show relevance. Using a 'best-fit' approach based on the science content of the answer, first decide which set of level descriptors, Level 1, Level 2 or Level 3, best describes the overall quality of the answer using the guidelines described in the level descriptors in the mark scheme. Once the level is located, award the higher or lower mark. **The higher mark** should be awarded where the level descriptor has been evidenced and all aspects of the communication statement (in italics) have been met.	6 max	*Communication may be via bullet points, a table of comparisons, labelled diagrams or prose.* Indicative scientific points may include the following: FIBROUS PROTEINS **Properties:** • insoluble • elongated / long / rods / filaments / ropes / strands • strong / tough • flexible IGNORE size refs / compact / coiled / bond types / hard Functions: Look for the general category or for a named protein or glycoprotein example with supporting detail. Related categories and examples are paired or grouped together: • for structure • collagen in, bone / cartilage / connective tissue / tendons / ligaments / skin / blood vessels • fibrin + role described • for protection • keratin in, skin / hair / nails • to give, elasticity / elastic properties

			The lower mark should be awarded where the level descriptor has been evidenced but aspects of the communication statement (in italics) are missing. **In summary:** • **The science content determines the level.** • **The communication statement determines the mark within a level.** **Level 3 (5–6 marks)** A detailed comparison of the properties **and** functions of fibrous **and** globular proteins. *There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.* **Level 2 (3–4 marks)** A comparison of the properties **and/or** functions of fibrous **and** globular proteins. *There is a line of reasoning presented with some structure. The information presented is in the most-part relevant and supported by some evidence.* **Level 1 (1−2 marks)** A limited comparison of the properties **or** functions of fibrous **and** globular proteins. *A basic structure and some relevant information is provided, although a clear line of reasoning may not be present. The information is supported by limited evidence and the relationship to the evidence may*		• elastin in, (named) blood vessels / alveoli / cartilage • for, contraction / mechanical movement • actin / myosin, in muscle • microtubules in, cilia / flagella / spindle / cytoskeleton GLOBULAR PROTEINS Properties: • soluble • spherical / ball-shaped • have, 3D / tertiary / 3o, shape / structure • specific / complementary (to another molecule) • ref. conjugated / contain prosthetic group • temperature / pH, sensitive • hydrophilic on outside IGNORE size refs, compact, round, bond types Functions: Look for the general functional category name or description, or a named protein or glycoprotein example with some supporting detail. • enzymes / metabolic role / to catalyse reaction(s) / to lower activation energy • named enzyme + its specific role described • hormones / receptors / for cell signalling • named hormone / insulin + role described • opsonin / antitoxin / agglutinin + role described • fibrinogen in blood clotting • to transport substances across cell membranes • carrier / channel / pump + role described • to transport substances in blood • haemoglobin + role described e.g. carry oxygen • to, package / organise DNA

			not be clear. **0 marks** No response or no response worthy of credit.		**Examiner's Comments** Candidates generally had plenty to say and almost all attempted to fulfil the command word compare by making reference to both fibrous and globular proteins. Level 3 answers fully answered the question brief by providing science content covering at least one property of a fibrous protein and one property of a globular protein and at least one function of each type of protein. The word 'property' was confused by some candidates with structure and this resulted in irrelevant material about levels of protein structure and bonding within proteins. Properties may be physical or chemical and relate to aspects like the solubility, strength, flexibility, shape and stability (for example at different temperatures) of molecules. Exemplar 1  fibrous proteins usually form strands. They are usually insoluble in water, & not very metabolically active and have a structural role within the body. For example, keratin which makes up things like skin, hair and nails. Globular proteins have more of a spherical shape. They are usually soluble in water and are more metabolically active than fibrous proteins. Globular proteins have a more metabolic role within the body. For example, haemoglobin and insulin are both examples of globular proteins and are involved in chemical reactions in the body. [6] Exemplar 1 is a level 3 answer that is contained within the line space, answers all aspects of the question and contains an appropriate level of science content. There is a well-developed line of reasoning, a clear and logical structure and all the material is relevant and substantiated by fact, so the communication statement for 6 marks is met.
		iv	**EITHER** **1** 9300 / 9700 ✓ **2** deaths year^{-1} or deaths per year or deaths / year ✓ **OR** **3** 9.3 / 9.7 ✓ **4** thousand deaths year $^{-1}$ or thousand deaths per year or thousand deaths / year ✓	2	Correct answer to 2 s.f. **with** correct matching units = **2 marks** **ALLOW** mark for unit even if no or wrong figure given **ALLOW** minus sign with number or 'fewer' with unit **ALLOW** from AIDS / of AIDS in unit **ALLOW** mp 3 so long as the **word thousand** appears afterwards or in the units (even if the

					unit is wrong in another respect) **DO NOT ALLOW** '*9.3 1000 deaths per year*' for mp3 (but gets mp 4) **Examiner's Comments** Candidates often achieved one of the two marks available but few successfully worked through all the processes involved in arriving at an answer with appropriate units for the rate of decrease over three years. One error was for candidates to calculate not a rate (over time) but a percentage decrease. A breakdown of how to tackle this question is listed in the 'Assessment for Learning' box. This, together with sections from the three tutorial sheets listed under OCR support, could form the basis of a step-by-step worksheet on solving the problem set in this question. Additional questions could be devised using this graph to calculate rates of increase or decrease in the numbers of new diagnoses or those living with an AIDS diagnosis for different time periods.  **AfL** 1. Select the dash-dot line for deaths and read to the nearest half-square of the grid where values for 1995 and 1998 intercept the y axis. 2. Check the left-hand y axis label to see that these figures represent thousands. 3. Subtract one away from the other to find the difference. 4. Divide this answer by the time between the two values on the x axis, 3 years. 5. Give the answer to two significant figures. 6. Determine the units.  **OCR support**

					Tutorial sheets and quizzes are available to support the teaching of the skills listed in the specification for Maths for Biology. Three areas cover key skills needed to successfully answer this question: http:/www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m3-graphs/ (calculating a rate from a graph with time on the *x* axis) http:/www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m0-arithmetic-and-numerical-computation/ (introduction to significant figures) http:/www.ocr.org.uk/qualifications/by-subject/biology-related/maths-for-biology/m0-arithmetic-and-numerical-computation/ (using and choosing units)
		v	*(answers must relate to **data** on graph)* **1** decrease in new diagnoses, from 1992 / already / began before 1995 ✓ **2** peak / plateau, in deaths, from 1994 / already / began before 1995 ✓ **3** no change in / same, (rate of) increase in people living with AIDS, before / after, 1995 ✓	2 max	**ALLOW** when, saquinavir / drug / medicine, was introduced for '1995' in mps **1**, **2** and **3** **ALLOW** new diagnoses decrease at same time as deaths **ALLOW** from / since / after, 1993 (instead of 1992) **Examiner's Comments** As specified in the question, candidates had to make use of data from the graph in their answer. Ideas from their own knowledge like improved education or increased precautions against transmission of HIV did not therefore score. Strong responses did not just look at 1995 to judge whether the introduction of a drug had an effect (pre-supposing that a change would begin from this point), but instead drew conclusions from ongoing trends that pre-dated 1995. These showed that new diagnoses were already falling, deaths had already peaked and the number living with AIDS experienced no change in its rate of increase.
			Total	**14**	
40		i	3 bases / triplet, code for 1 (specific) amino acid ✓	2 max	

			sequence of, bases / triplets, determines the sequence of, amino acids / primary structure ✓ (code) non-overlapping ✓ AVP ✓		e.g. more than one codon codes for an amino acid / degenerate code is, universal / similar in eukaryotes and prokaryotes
		ii	mechanical strength (to cells) ✓ cell, support / stability / maintains shape ✓ movement of (named), molecules / vesicles / organelles within cell **OR** holding organelles in position ✓ formation / movement, of, cilia / flagella ✓ cell movement / endocytosis / exocytosis / phagocytosis / cytokinesis / described ✓	3 max	**IGNORE** strength unqualified **ALLOW** maintain internal organisation
		iii	movement of mRNA from nucleus to ribosome ✓ movement of polypeptides through the rER ✓ movement of vesicles from rER to Golgi ✓ movement of vesicles between cisternae of Golgi (cis to trans face) ✓ movement of secretory vesicles from Golgi to cell surface membrane✓	2 max	Note: this requires more detail than part ii
			Total	**7**	
41			C	1	**Examiner's Comments** Candidates found this difficult, many suggesting

					A or D. It is possible that they had misread the question and gave an option that was a correct statement about the genetic code rather than an incorrect one. Candidates should be encouraged to take care when reading questions rather than rushing into answering the question that they thought had been asked.
			Total	**1**	