Past-paper walk-through

Structure of nucleic acids and replication of DNA ▪ 6.1

eXercise

Questions in this set

- 9700/11 N25 Q23 ▪ 1 mark
- 9700/11 N25 Q24 ▪ 1 mark
- 9700/12 N25 Q24 ▪ 1 mark
- 9700/13 N25 Q25 ▪ 1 mark
- 9700/14 N25 Q22 ▪ 1 mark
- 9700/23 N25 Q4 ▪ 6 marks
- 9700/24 N25 Q3 ▪ 10 marks

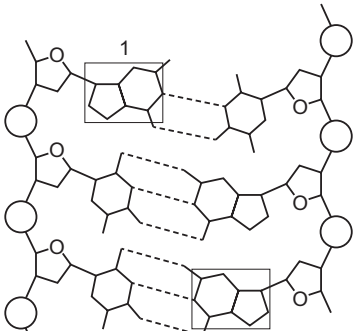
Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 23

9700/11 N25 ▪ Q23 ▪ 1 mark

23 The diagram shows a section of DNA. Two of the bases in this section are labelled 1 and 2.



Question 23

\ 2

Which row correctly identifies the bases 1 and 2?

	base 1	base 2
A	purine	adenine
B	purine	guanine
C	pyrimidine	adenine
D	pyrimidine	guanine

Solution 23

Answer: **B**

Why

- Purines (adenine and guanine) have two rings; pyrimidines (thymine and cytosine) have one.
- Count the rings drawn for each labelled base to sort purine from pyrimidine.
- Then use the hydrogen bonds: A–T has two and G–C has three.

Question 24

9700/11 N25 ▪ Q24 ▪ 1 mark

24 Which row describes the role of the enzymes DNA polymerase and DNA ligase?

	DNA polymerase	DNA ligase
A	adds nucleotides in a 5′ to 3′ direction	joins sections of DNA together on the lagging strand
B	adds nucleotides in a 3′ to 5′ direction	joins sections of DNA together on the leading strand
C	adds nucleotides in a 3′ to 5′ direction	joins sections of DNA together on the lagging strand
D	adds nucleotides in a 5′ to 3′ direction	joins sections of DNA together on the leading strand

Question 24

Solution 24

Answer: **A**

Why

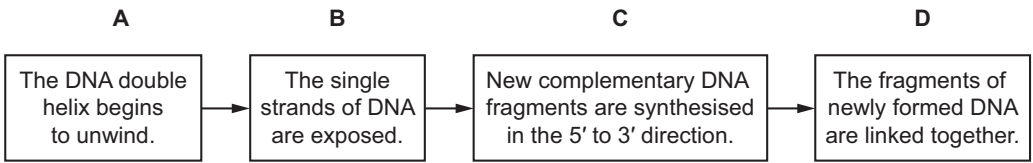
- DNA polymerase can only add nucleotides to a free $3'$ end, so it works $5'$ to $3'$.
- That forces the lagging strand to be made in short Okazaki fragments.
- DNA ligase then joins those fragments together.

Question 24

9700/12 N25 ▪ Q24 ▪ 1 mark

24 The flow diagram shows some of the stages in the replication of a lagging strand of DNA.

Which stage of DNA replication uses the enzyme DNA ligase?



Solution 24

Answer: **D**

Why

- DNA ligase joins fragments together, so it acts last on the lagging strand.
- The fragments are made first, each $5'$ to $3'$.
- Ligase then seals the gaps between them into a continuous strand.

Question 25

9700/13 N25 ▪ Q25 ▪ 1 mark

25 Which statements about complementary base pairing are correct?

1 It occurs during translation.

2 Purines and pyrimidines are the same size.

3 The base pairs are of equal length.

4 Uracil forms three hydrogen bonds with adenine.

A 1 and 2 **B** 1 and 3 **C** 2 and 3 **D** 3 and 4

Solution 25

Answer: **B**

Why

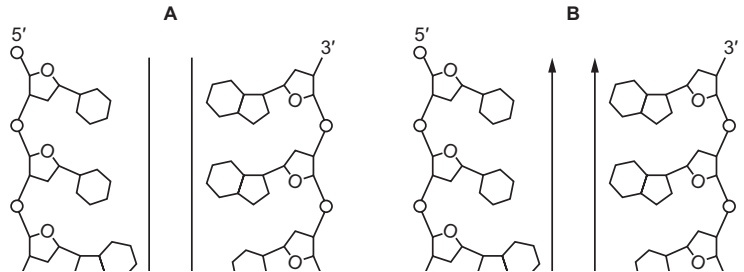
- Complementary base pairing happens in transcription and translation, so statement 1 is right.
- A purine is larger than a pyrimidine, so statement 2 is wrong.
- Every pair is one purine with one pyrimidine, which is why all base pairs are the same length – statement 3 is right.

Question 22

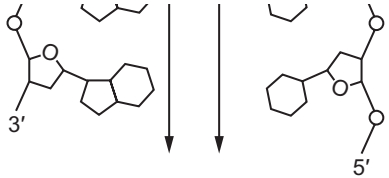
9700/14 N25 ▪ Q22 ▪ 1 mark

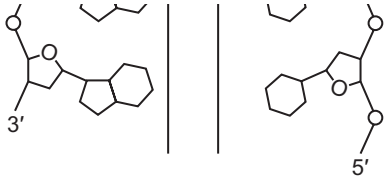
22 During DNA replication, the two original strands of a DNA molecule separate.

Which diagram shows the direction in which DNA polymerase moves along each of the original strands during DNA replication?

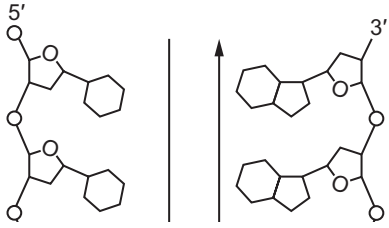


Question 22

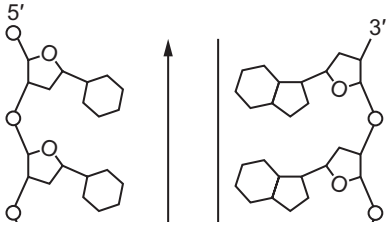




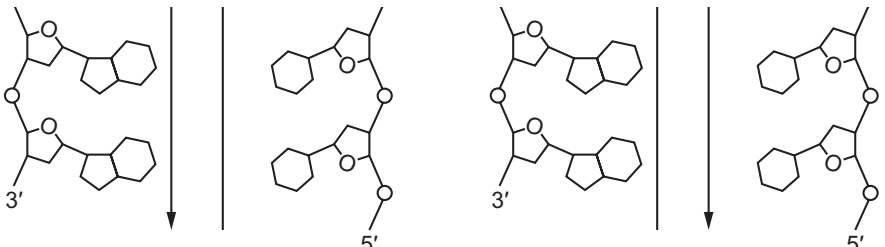
C



D



Question 22



Solution 22

Answer: **D**

Why

- DNA polymerase can only add nucleotides to a free $3'$ end.
- So it always moves along the template in the $3'$ to $5'$ direction, building the new strand $5'$ to $3'$.
- The two template strands are antiparallel, so the enzyme moves in opposite directions along them.

Question 4

9700/23 N25 ▪ Q4 ▪ 6 marks

4 **(a)** Fig. 4.1 shows a phosphorylated nucleotide which is one of the monomers that is used to synthesise DNA during replication.

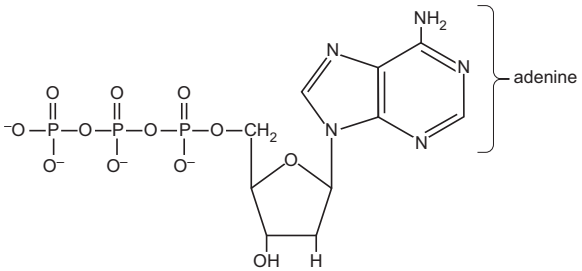


Fig. 4.1

Question 4

(i) State the meaning of monomers of DNA.

Question 4

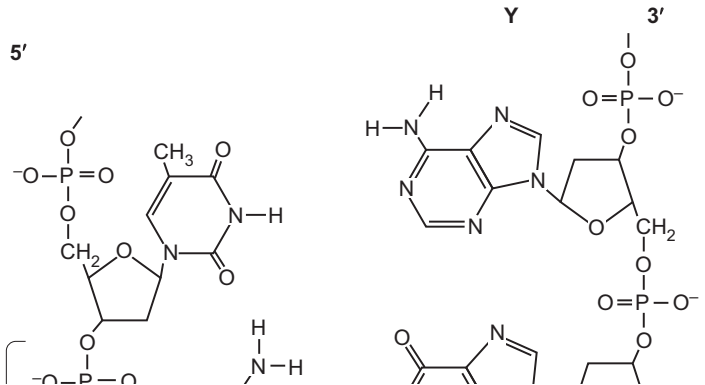
(ii) State how ATP differs in structure from the phosphorylated nucleotide shown in Fig. 4.1.

Question 4

(iii) State the process occurring in all cells that results in the production of ATP.

Question 4

(b) Fig. 4.2 shows a short length of a DNA molecule. One of the strands of the DNA molecule is labelled **Y**.



Question 4

Question 4

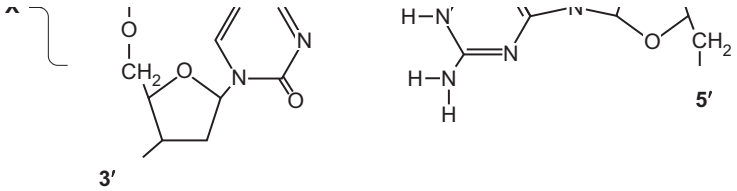


Fig. 4.2

(i) Complete Fig. 4.2 by drawing dotted lines to represent all the hydrogen bonds between the two strands of the DNA molecule. [2]

(ii) State the name of the bond **X**.

Question 4

[Total: 6]

Solution 4

(a)(i)

Mark scheme

- repeating, units / sub-units / molecules / nucleotides (used to make a, polymer / polynucleotide / strand (of DNA)) ;
- 1

Solution 4

(a)(ii)

Mark scheme

- any one from:
- (pentose / sugar is) ribose (not deoxyribose) ; C2
- on the, pentose / sugar, is -OH not -H ;
- 1

Solution 4

(a)(iii)

Mark scheme

- respiration ;
- 1

Solution 4

(b)(i)

Mark scheme

- two hydrogen bonds drawn correctly between A and T ;
- three hydrogen bonds drawn correctly between C and G ;
- for positioning of H bonds on C-G, A from either H on amine group on C to link with oxygen on G
- if no marks gained but A-T has two lines and C-G has three lines between bases award 1 mark
- 2

Solution 4

(b)(ii)

Mark scheme

- phosphodiester ;
- 1
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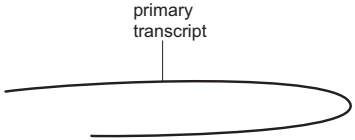
Question 3

9700/24 N25 ▪ Q3 ▪ 10 marks

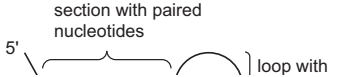
3 Small interfering RNA (siRNA) is a short length of double-stranded RNA (dsRNA), approximately 21 to 25 nucleotides long. siRNA helps to regulate protein synthesis in cells.

(a) Fig. 3.1 is an outline summary of one way in which a primary transcript can be processed to produce a molecule of siRNA. The transcript does **not** code for a sequence of amino acids.

step 1: a primary transcript is synthesised from one strand of DNA



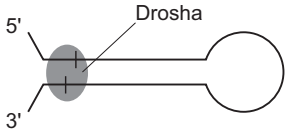
step 2: the primary transcript loops and a section of the RNA becomes



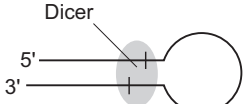
Question 3

a section of the RNA becomes double stranded

step 3: the enzyme Drosha attaches and cleaves (cuts) the RNA to produce a shorter length



step 4: in the cytoplasm, the enzyme Dicer attaches and cleaves the RNA



Question 3

Question 3

and has 2 unpaired nucleotides at each 3' end, is produced

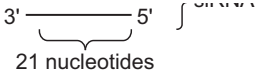


Fig. 3.1

(i) In **step 2** in Fig. 3.1, the single-stranded primary transcript loops and forms a section where dsRNA is present.

Explain how it is possible for the double-stranded section of RNA to be held together in **step 2** and maintained this way in **steps 3**, **4** and **5**.

Question 3

(ii) After **step 3**, the shorter dsRNA produced by the action of Drosha is transported to the cytoplasm, where it is cleaved further by Dicer to produce ds siRNA.

Suggest why two different enzymes, Drosha and Dicer, are needed to cut dsRNA into shorter lengths.

Question 3

(b) From 2018, siRNA has been used as a therapeutic drug to treat a number of diseases.

The presence of molecules of siRNA in the cytoplasm can result in the cleavage of messenger RNA (mRNA) molecules coding for a protein involved in the disease. This prevents the synthesis of the protein.

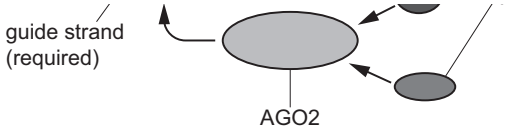
Describe the differences between a molecule of mRNA and a molecule of siRNA, such as the siRNA shown in **step 5** in Fig. 3.1.

Question 3

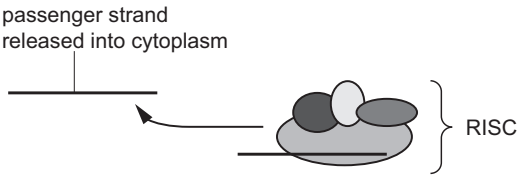
(c) Fig. 3.2 summarises how mRNA coding for a protein involved in disease can be targeted and cleaved by siRNA.

Question 3

siRNA and other proteins to form a complex known as RISC



passenger strand is separated from RISC



RISC uses guide strand to

Question 3

Question 3

for cleavage

Fig. 3.2

(i) With reference to Fig. 3.2, state why the passenger strand needs to be separated and released from the RISC.

Question 3

(ii) The aim of siRNA therapy is to prevent or decrease the synthesis of a protein involved in the disease being treated.

A target mRNA molecule can be cleaved in a different location by a RISC with a different siRNA.

Suggest how cleaving mRNA in different locations will have different effects on protein synthesis **and** explain how these different effects can result in a lack of functioning protein.

Question 3

[Total: 10]

Solution 3

(a)(i) Mark scheme

- if DNA or thymine stated within response, allow only H-bond mark (ecf)
- any two from:
- (paired section) contains, complementary nucleotides / complementary bases / base pairs ;
- adenine-uracil and guanine/cytosine ; A A/U and G/C
- (paired by) hydrogen / H, bonds ; I strong (bonds) ecf from mp1
- R if another bond also named
- I phosphodiester bonds between, adjacent / AW, nucleotides

Solution 3

- 2

Solution 3

(a)(ii) Mark scheme

- any two from:
- (enzyme / Drosha / Dicer) active site is specific (to site on dsRNA) ;
- can apply in context of specific shaped active site or active site specific to a particular location
- detail of different active sites of Drosha and Dicer ;
- site to be cleaved / AW, (only), fits into / can bind with / is complementary to (the specific) active site
- forms enzyme-substrate complex at a particular site

Solution 3

- Drosha and Dicer require different, conditions / cell locations, to function ;
- AVP ; e.g. suggestion that Dicer too large to enter nucleus
- Drosha exposed to degradation in cytoplasm
- 2
- 9700/24
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Solution 3

(b) Mark scheme

- any two from:
- mRNA is single-stranded and siRNA is double-stranded ;
- A polynucleotide / chain, for strand
- siRNA has paired and unpaired nucleotides
- or
- mRNA has, only unpaired nucleotides / no base pairing ;
- mRNA codes for a, sequence of amino acids / protein ; ora for siRNA
- mRNA has a longer sequence of nucleotides ;

Solution 3

- A mRNA, is longer / has more nucleotides
- AVP ; e.g. ref. to siRNA antiparallel / mRNA only 5' to 3'
- mRNA has no H bonds
- 2

Solution 3

(c)(i) Mark scheme

- any one from:
- RISC must, align with / attach to / form H bonds with, (target) mRNA ;
- (passenger strand needs to be, separated / released) to allow guide strand to, be exposed / bind to mRNA ; AW
- ora e.g. (otherwise) guide strand cannot bind to mRNA
- passenger strand prevents guide strand binding
- guide strand has complementary sequence to target sequence of mRNA ;
- ora passenger strand does not ….

Solution 3

- 1
- 9700/24
- October/November 2025

Solution 3

(c)(ii) Mark scheme

- allow protein for polypeptide
- points need the correct context of cleaved mRNA
- any three from:
- no protein formed
- 1 idea that mRNA may be degraded in cell before attaching to ribosome ;
- 2 mRNA may not (be able to) attach to ribosome so no, polypeptide formed / translation ;
- 3 cleaved mRNA results in loss of start, sequence / codon ;

Solution 3

- abnormal polypeptide formed
- 4 polypeptide chain is not released from ribosome ;
- A cleaved mRNA results in loss of stop codon
- 5 polypeptide chain degraded within cytoplasm / AW ;
- 6 cleaved mRNA results in short(er) (polypeptide) chain being produced ;
- 7 polypeptide does not, fold up / form correct tertiary structure / form correct 3D shape ; I tertiary structure changes
- 8,9 AVP ; e.g. (results in) different R-group interactions / change in number of bonds that can form
- active site / site of activity, changed / lost
- 3

Solution 3

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