Exam Papers Practice

2.5 Nucleic Acids: Structure & DNA Replication

Mark Schemes

Course	DP IB Biology
Section	2. Molecular Biology
Topic	2.5 Nucleic Acids: Structure & DNA Replication
Difficulty	Medium

To be used by all students preparing for DP IB Biology SL
Students of other boards may also find this useful

1

The correct answer is **B** because:

- There is a total of 19 base pairs per chain (this is stated in the question).
- 19 total bases - 8 T - 3 G - 4 C = **4 A bases**
- In any one piece of DNA:
    - The amount of adenine = amount of thymine
    - The amount of cytosine = the amount of guanine

Remember that the bases are complementary, so the no. of A on strand 1 = the no. of T on strand 2 and no. of C on strand 1 = no. of G on strand 2
Thus, on strand 1 there would be:

- **4 thymine** that bond with the 4 adenine on strand 2
- **4 guanine** that bond with the 4 cytosine on strand 2
- **3 cytosine** that bond with the 3 guanine on strand 2

	Number of nucleotide bases			
	A	**T**	**G**	**C**
Strand 1	8	4	4	3
Strand 2	4	8	3	4

2

The correct answer is **A**. Whilst thin-layer chromatography has been widely used in DNA analysis since Crick and Watsons' era, it did not form a significant part of the discovery of DNA's structure.

B is incorrect because Rosalind Franklin, working in a separate research institution, specialised in this technique and fed a lot of data into Crick and Watsons' work.

C was exactly the technique used painstakingly by Crick and Watson to model the DNA molecule.

D was a vital part of their work, and indeed of any rigorous scientific research. Other scientists that contributed to the the discovery of the double helix structure of DNA include Rosalind Franklin, Maurice Wilkins, Linus Pauling and Erwin Chargaff.

3

The correct answer is **A** because in every nucleotide there is one **phosphate group**, one **pentose sugar,** and one **base**. Therefore, there would be an equal ratio of pentose sugars to phosphates (1:1).

Thymine and **adenine** are **complementary bases** and therefore they will appear in equal numbers in a DNA molecule.

B is incorrect because each nucleotide contains one pentose and one phosphate so their ratio in the overall polymer must also be 1:1.

C and **D** are both incorrect because the sugars in DNA are pentose (5-carbon) not hexose, which are 6-carbon. Both statements also claim inaccurate information about ratios of bases because T does not base pair with C and G does not base pair with A.

4

The correct answer is **D**. The orientation of the whole nucleotide (including sugar, phosphate and base) is flipped on the sense strand versus the antisense strand. Therefore, the DNA code runs in opposite directions on the two strands.

A is incorrect because all the sugars in DNA are deoxyribose; ribose sugars feature in RNA.

B and **C** are incorrect because they only state that **part** of the nucleotides on the opposite strand are inverted, when in fact the whole chain of nucleotides inverts.

5

The correct answer is **C** because a nucleotide angle of 36 degrees would mean that 10 base pairs would equal one whole turn of 360°.

A. $\frac{360^\circ}{5} = 72^\circ$ [too large]

B. $\frac{360^\circ}{8} = 45^\circ$ [too large]

C. $\frac{360^\circ}{10} = 36^\circ$ [correct] [1 mark]

D. $\frac{360^\circ}{12} = 30^\circ$ [too small]

6

The correct answer is **C** because even though Crick and Watson hypothesised about semi-conservative replication, which made sense after their discovery of DNA's structure, Meselson and Stahl were the first scientists to provide unequivocal proof of the hypothesis.

Statement I is incorrect because DNA polymerase always works in the 5' to 3' direction (the opposite direction to statement I).

Statement II is incorrect because helicase works first to unwind and unzip the DNA before DNA polymerase can start synthesising a new strand.

7

The correct answer is **C** because:

- The circle shapes depict **phosphate groups** (**Z**).
- The pentagon shapes depict **ribose sugars** (**Y**).
- Adenine is already shown; **X** has a complementary shape to adenine and is therefore
- **W** is therefore **guanine** and the other unlabelled base is cytosine.

8

The correct answer is **D** because there are no glycosidic bonds within DNA's structure. Glycosidic bonds tend to be found mainly within carbohydrate molecules (disaccharides and polysaccharides).

A takes place when helicase unzips the original DNA prior to replication.

B occurs when DNA polymerase 'captures' a free nucleotide and holds it briefly in position to be attached to the growing strand.

C takes place as new covalent bonds between sugars and phosphates form, linking nucleotides together in the growing strand.

9

The correct answer is **C** because the complementary bases pairs are adenine with thymine and cytosine with guanine.The ratios of **complementary base** pairs should be equal:

- **Thymine** in human liver = 10% so **W (Adenine) = 10%**
- Guanine in mouse bone marrow = 26% so **X (Cytosine) = 26%**
- Cytosine in sunflower leaf = 39% so **Y (Guanine) = 39%**
- Adenine in human liver = 30% so **Z (Thymine) = 30%**

These values are **percentages** and therefore each row must **add to 100**!

10

The correct answer is **C**.

The mistakes are:

1. In the final base pair, cytosine (C) and guanine are **complementary**; however, adenine (A) is shown to pair with guanine.
2. On the whole of the right strand: the **phosphates** are bound on the wrong side of the deoxyribose sugars. Phosphate always binds to the opposite side to the base.
3. The strands should run in **antiparallel** directions (one goes 3' to 5' and the other 5' to 3').