WJEC EDUQAS AS BIOLOGY · COMPONENT 1

BIOLOGY



EXAM QUESTION PACK

1.5 NUCLEIC ACIDS

SCORE	PERCENTAGE
/74	%

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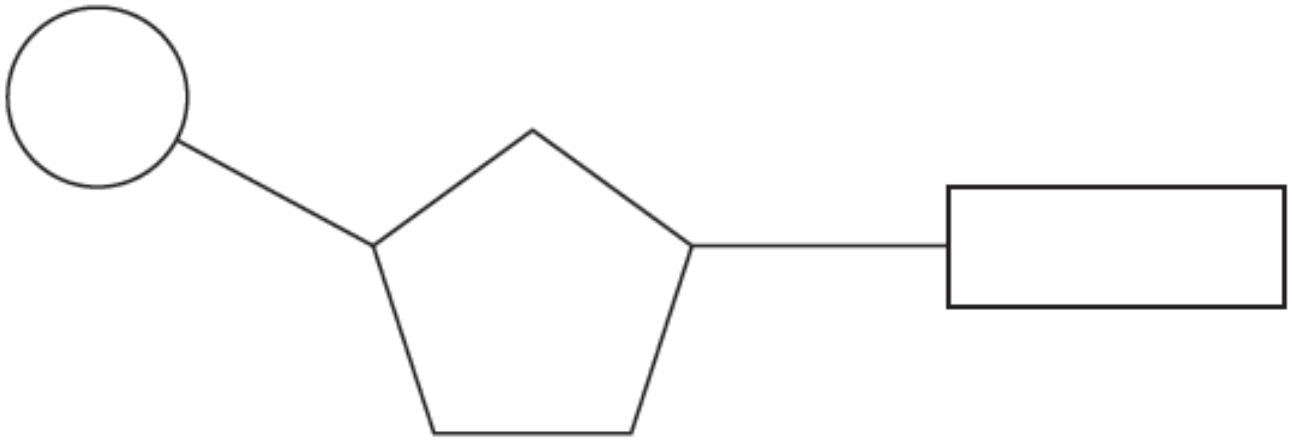
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1. The diagram below shows a simple nucleotide.



(a) On the diagram above, draw a circle around the component that contains nitrogen.

[1]

(b) Describe two differences between a DNA nucleotide and an RNA nucleotide.

[2]

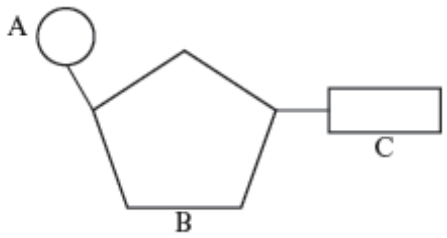
An experiment was carried out to determine the relative percentages of the bases in DNA from various organisms. The results are shown in the table below.

Source of DNA	Relative percentage of base in sample			
	Adenine	Guanine	Thymine	Cytosine
human	30.9	19.9	29.4	19.8
sea urchin	32.8	17.7	32.1	17.3
wheat	27.3	22.7	27.1	22.8

(c) DNA is a double stranded molecule. Explain how the data in the table supports the concept of complementary base pairing.

[2]

2. (a) The diagram below shows a unit which makes up nucleic acids.



(i) Name the structural unit shown.

[1]

. . . . . .

(ii) Name component A.

[1]

. . . . . .

(iii) Name component B in DNA and RNA.

[1]

DNA . . . . . .

RNA . . . . . .

(iv) Name the four components found in DNA, represented by C.

[2]

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(b) Describe how the structural units, drawn in part (a), are arranged in DNA molecules. [4]

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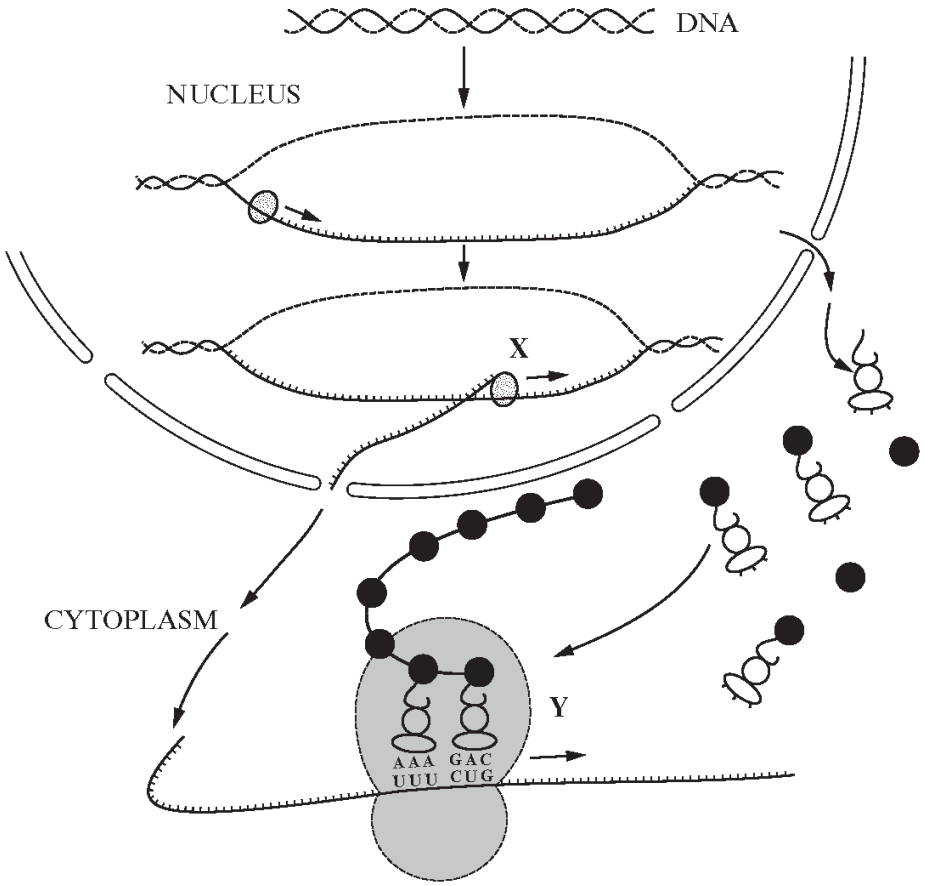
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(c) Describe the function of DNA molecules in cells. [1]

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3. The diagram represents stages of protein synthesis.



(a) (i) Give the name of the processes taking place at **X** and **Y**. [2]

X .....

Y .....

(ii) On the diagram label the following structures using clear lines and the letters given. [8]

M = messenger RNA
N = nuclear pore
O = RNA polymerase
P = codon
Q = ribosome
R = transfer RNA
S = three hydrogen bonds between complementary bases
T = template/sense strand of DNA

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(b) Transfer RNA (tRNA) molecules are very specific and will only carry one type of amino acid depending on three unpaired nitrogenous bases on the molecule (the anticodon). The table shows the type of tRNA molecules which combine with certain amino acids.

Amino acid	*anticodon*
glycine	CCU
cysteine	ACA
arginine	GCA
alanine	CGU

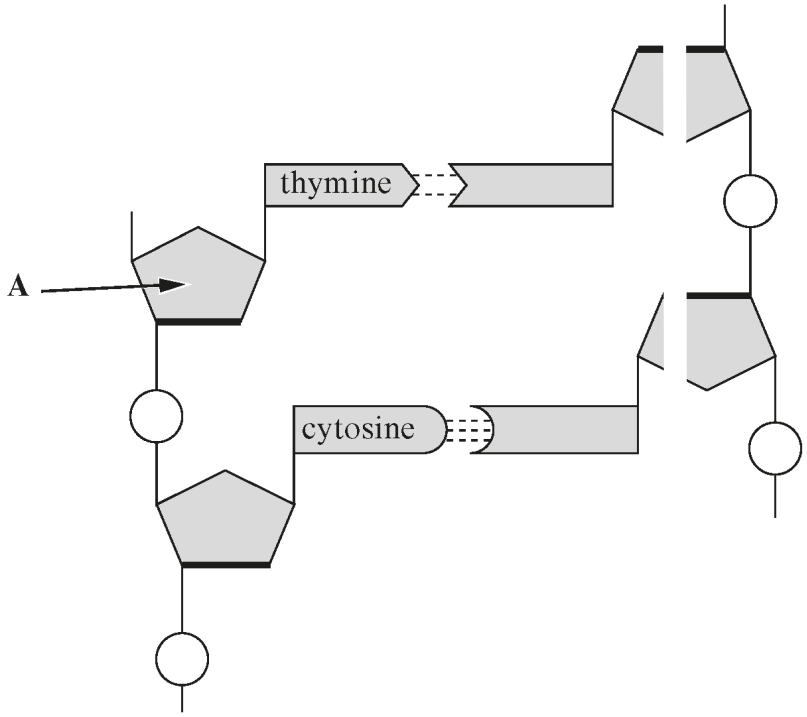
Using the information given, state the nucleotide sequence on the **DNA molecule** which codes for the following polypeptide. [2]

glycine-cysteine-arginine-alanine.

.....

(Total 12 marks)

4. The diagram represents the molecular structure of part of a D A molecule.



(a) Name part **A**. [1]

.....

(b) Part of a DNA molecule has the following sequence of b ses.

T-A-T-C-G

(i) In the table below write the letters for the sequence f bases of the complementary portion of DNA. [1]

DNA molecule	T	A	T	C	G
complementary DNA					

(ii) Biochemical analysis of a sample of DNA showed that 30% of the bases were guanine.
Calculate the percentage of the bases in the sample which would be adenine.
Show your working. [2]

Answer .....

(Total 4 marks)

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5. Meselson and Stahl investigated whether DNA replicated in a conservative or semiconservative way.

(a) What is meant by the term semiconservative replication? [2]

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(b) The bacterium *Escherichia coli* (E.coli) was cultured in a nutrient broth, containing the heavy isotope as a source of nitrogen ^{15}N instead of the normal ^{14}N. After several generations all of the DNA in all of the bacteria contained the heavy isotope ^{15}N. They were then washed and transferred to a ^{14}N medium and allowed to replicate. After each generation, bacteria were removed and ruptured to release the DNA. The DNA was then placed in a medium and spun in a centrifuge. The position of the DNA in the medium was then determined.

(i) Name the part of the DNA molecule which contained the ^{15}N. [1]

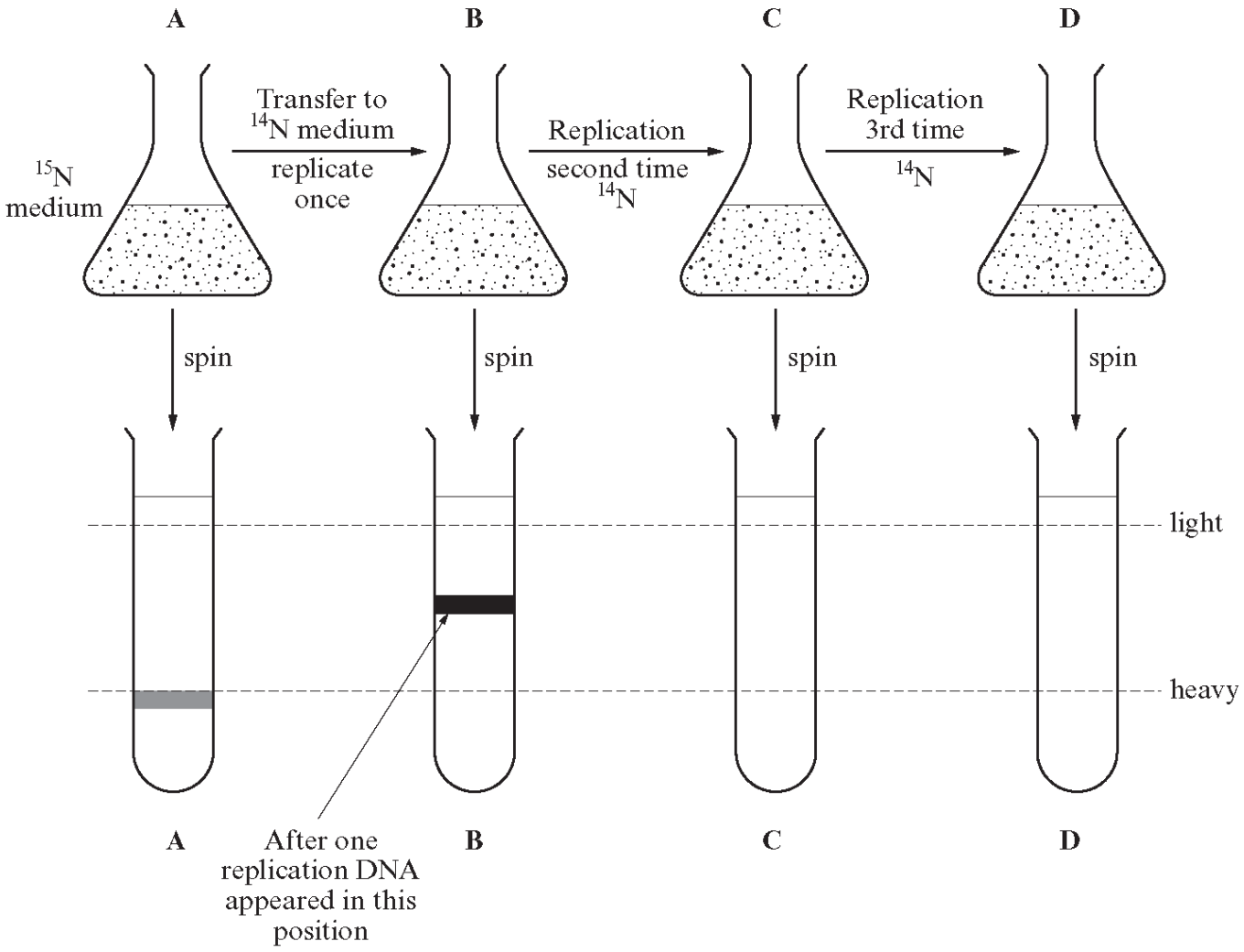
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(ii) If they wanted to show the relative position of DNA from different samples of bacteria, suggest **two** variables which would need to be controlled in the centrifugation process. [2]

1. .....

2. .....

(c) The diagram represents the results which they obtained.



(i) Explain why the results in tubes **A** and **B** support semiconservative replication. [3]

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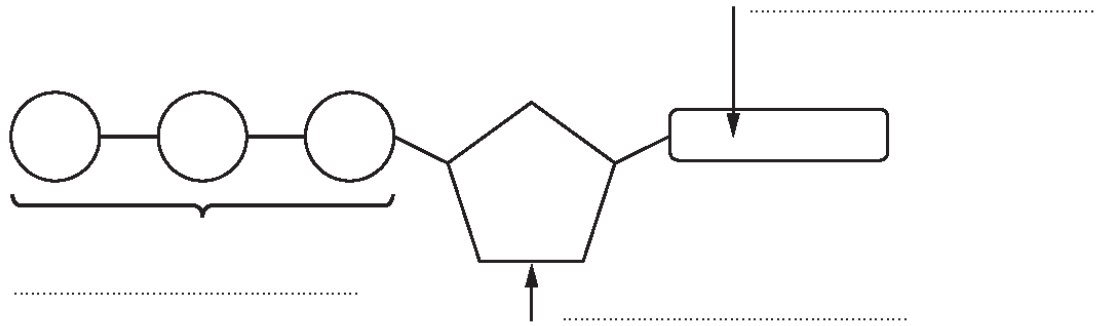
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(ii) Complete diagrams **C** and **D** to show the pattern and relative proportions of DNA you would expect. [2]

(Total 10 marks)

6. The diagram below shows a molecule of ATP.

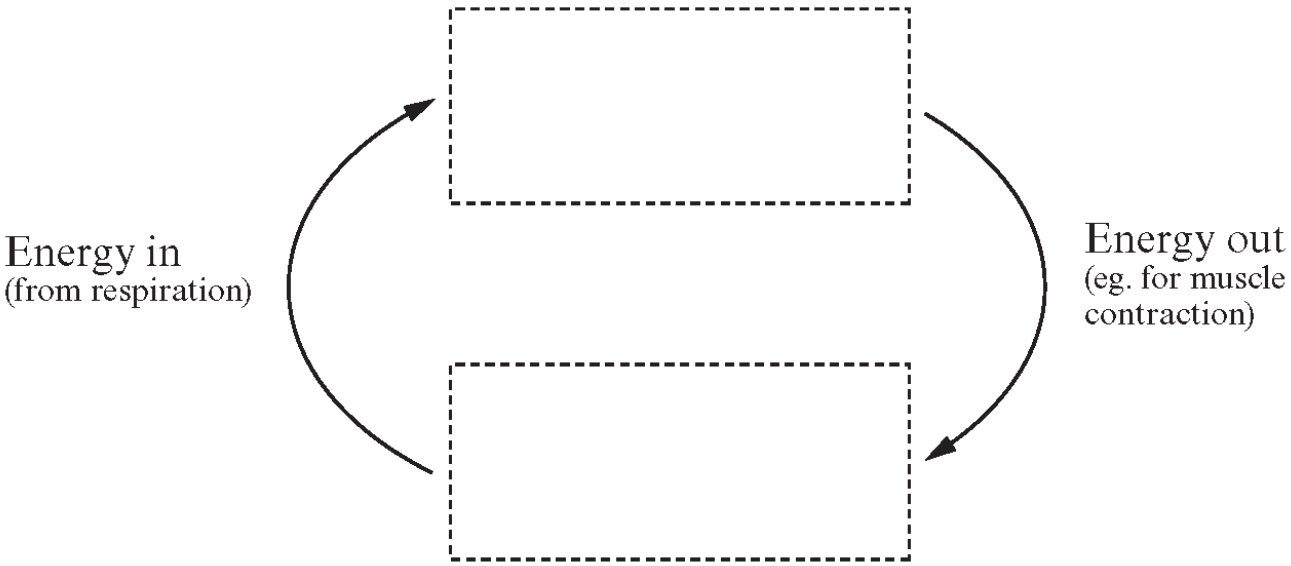


(a) (i) Label the component parts of the molecule. [2]

(ii) Give the full name of the molecule. [1]

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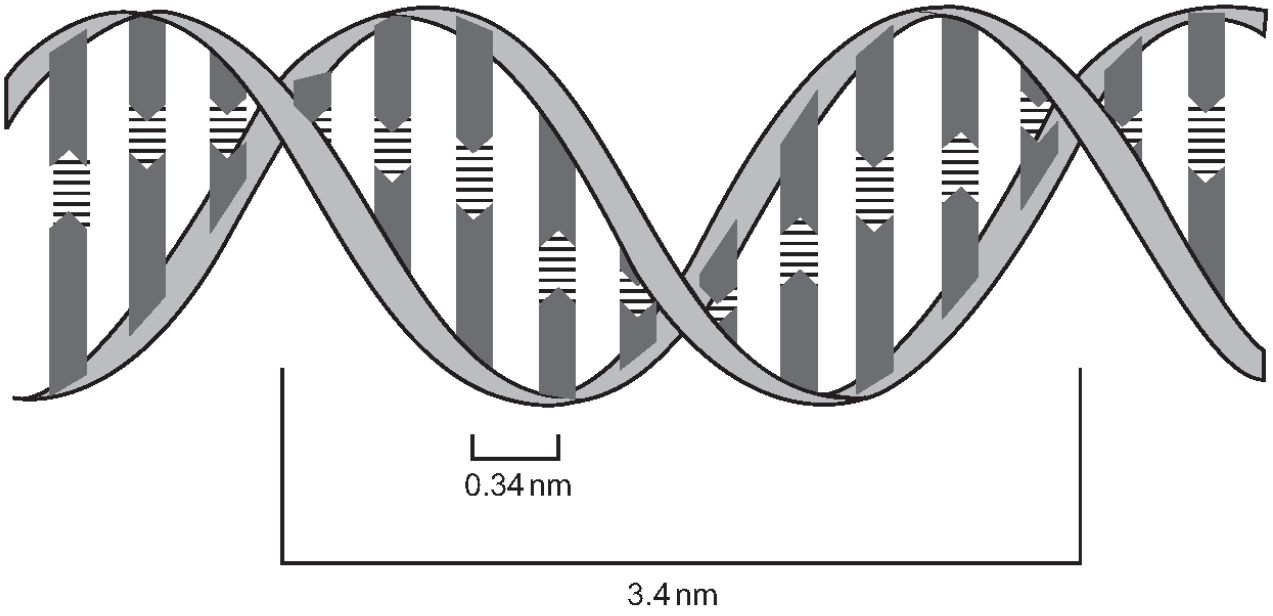
(b) (i) In the spaces indicated below, use drawings similar to the one above to show the changes that this molecule undergoes in cells. [1]



(ii) Apart from muscle contraction, name **one** *other* process in cells which requires energy. [1]

.....

7. The diagram below shows the DNA structure proposed by Watson and Crick in 1953.



(a) If the double helix takes 3.4 nm to make one complete turn and base pairs are 0.34 nm apart, how many base pairs would you expect to find in five complete turns?
Show your working. [2]

Answer = ...

(b) Give a reason why the diagram **shown** above must be DNA rather than RNA. [1]

.....

.....

.....

.....

(c) The table below shows the bases guanine and cytosine as percentages of the total nucleotides present in three different micro-organisms.

Micro-organism	Base composition (%)	
	G	C
yeast	18.7	17.1
bacteria	36.0	35.7
virus	42.0	13.9

(i) Suggest which type of nucleic acid is present in the virus shown in the table. Explain your answer. [2]

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.....

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.....

(ii) State the type of base to which cytosine belongs. [1]

.....

6

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8. Protein synthesis involves two stages, transcription and translation. Different types of RNA are involved in each stage.

(a) The table below shows the percentages of the different types of RNA present in a rabbit body cell.

RNA	Percentage of total RNA
RNA present in nucleus	11.5
mRNA	3.5
rRNA	69.5
tRNA	15.5

(i) Name the organelle that would contain the greatest percentage of RNA. Explain your answer. [1]

.....

.....

.....

(ii) The total mass of RNA in a typical rabbit cell contains about 50000000000 nucleotides.

Calculate the approximate number of nucleotides contained in the tRNA of a typical rabbit cell. **Give your answer in standard form to two significant figures.** [3]

Number of nucleotides in tRNA = ...

(iii) Explain why there would be large numbers of different mRNA molecules in a rabbit cell but only a maximum of 64 different tRNA molecules. [3]

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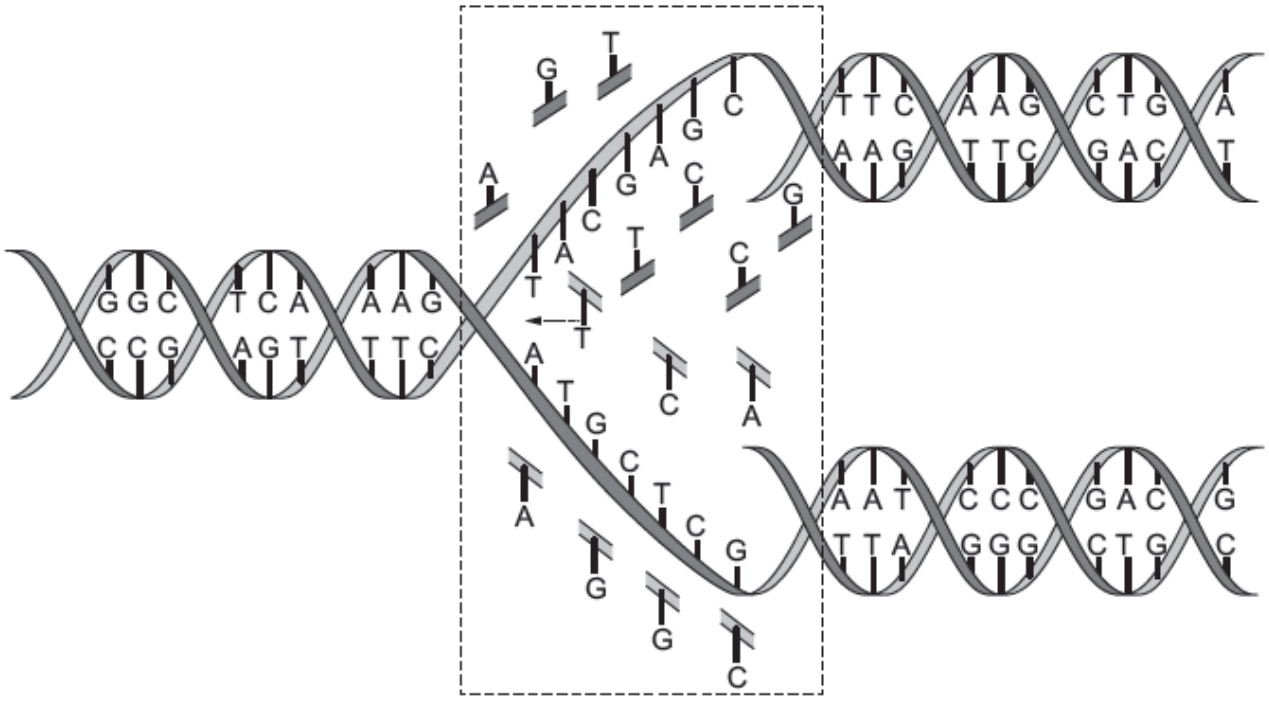
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9. The diagram below illustrates replication of DNA in cells.



(a) (i) Describe the sequence of events shown within the dotted rectangle in the diagram above.

[3]

(ii) What is the role of DNA polymerase in the process?

[1]

(b) Explain why the process is referred to as 'semi conservative'.

[2]

10. There are 2 types of nucleic acid: DNA and RNA.

(a) Complete the table below to describe **three** differences between the structure of DNA and RNA. [3]

DNA	RNA

(b) A sample of DNA was analysed, 23% of the nucleotides contained guanine. Calculate the percentage of nucleotides which contained adenine. Show your working. [2]

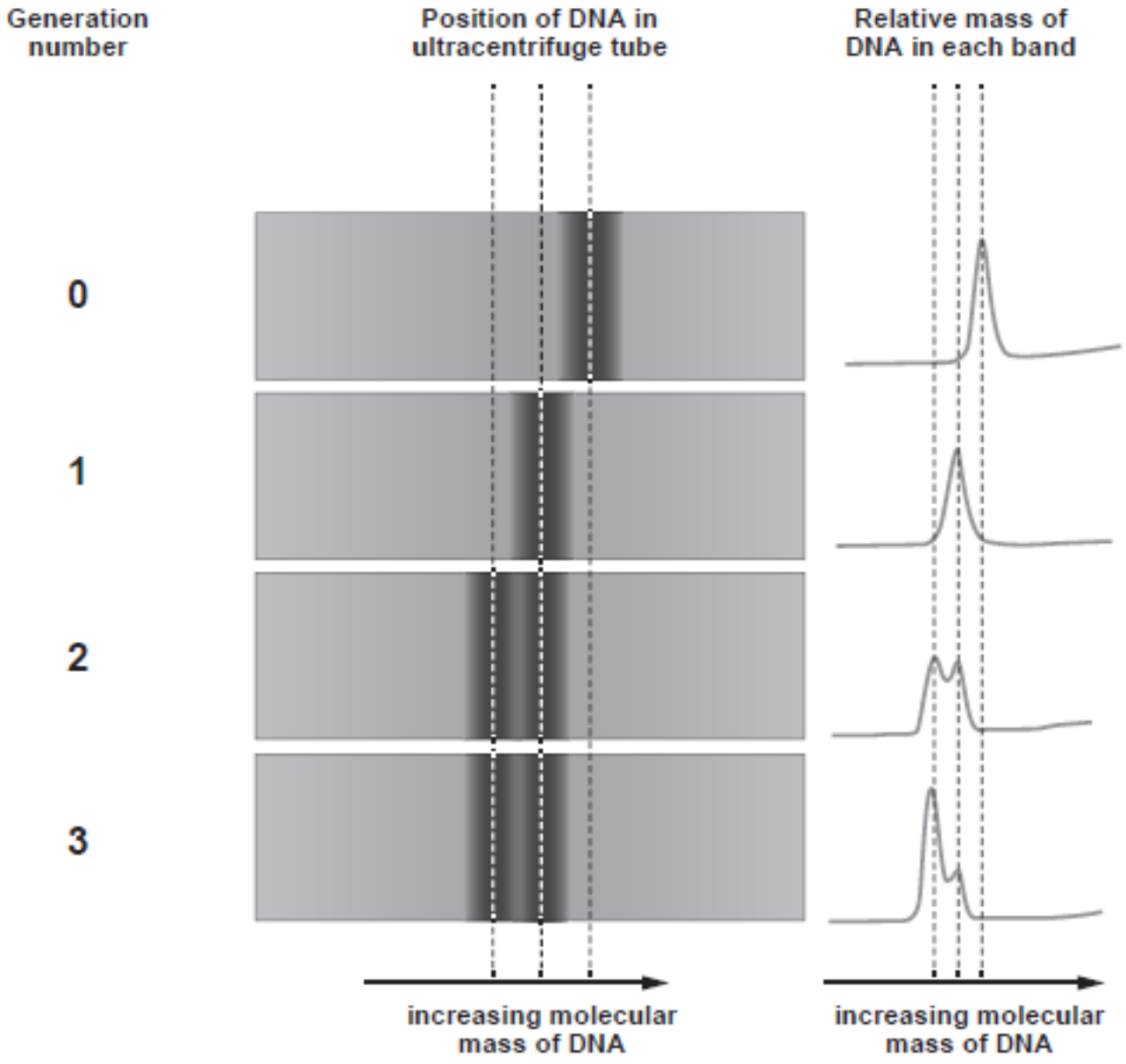
(Total 5 marks)

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11.

In 1958, Matthew Meselson and Franklin Stahl conducted a series of experiments that demonstrated that DNA replication is semi-conservative.

The images below show some of their results.

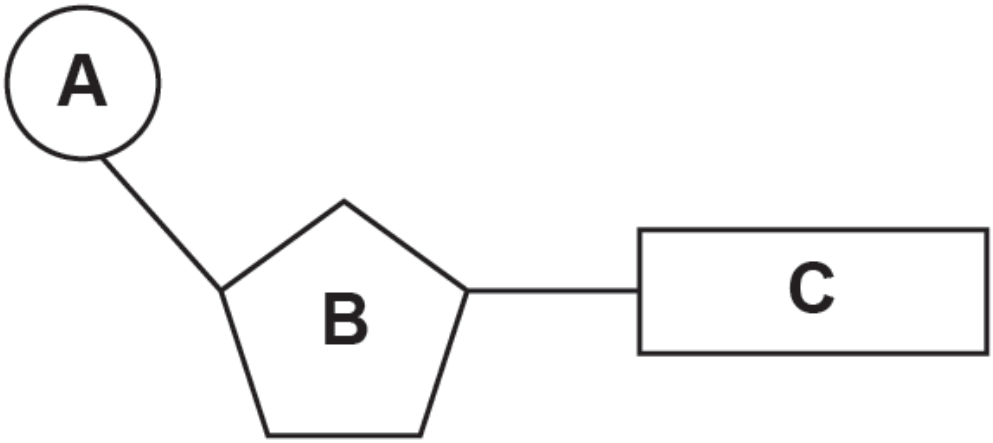


Other theories of DNA replication included:

- conservative replication, in which the original DNA is retained as a double stranded molecule; and
- dispersive replication, where the original DNA is split into many fragments which are then dispersed throughout the replicated molecules.

Using your own knowledge of Meselson and Stahl's experiments, explain how their experiment and the results shown in the image supported the theory of semi-conservative replication. Predict how the results would have differed if the other theories had been correct. Explain your answer. [9 QER]

12. The diagram below shows a component of **DNA**.



Name the parts **A**, **B** and **C**.

[3]

A . . . . . .

B . . . . . .

C . . . . . .

(b) Describe how a polymer of DNA would be different from a polymer of RNA.

[2]

13. ATP is regarded as a universal energy currency as it is used in all organisms for cellular processes.

(a) Draw a simple, fully labelled diagram of ATP. [2]

1.

Question		Marking details	Marks Available
1	*(a)*	Base clearly circled;	1
	(b)	(The pentose in) RNA is ribose and in DNA is deoxyribose; the base thymine is only found in DNA and the base uracil is found in RNA; NOT: ref. helix/strands/uracil and thymine unqualified	2
	(c)	Adenine with thymine and cytosine with guanine; Appropriate use of {data/ratios} for {human/sea urchin/wheat}; Need data on both A T and C G NOT 'they are the same' or reference to ratio the same in all organisms	2
		Question 1 total	**[5]**

2. (a)

(i)

Nucleotide; 1

(ii)

Phosphate / phosphoric acid / PO4 / PO3-;

NOT phosphorus / P; 1

(iii)

Deoxyribose in DNA and ribose in RNA (both); 1

(iv)

Adenine, Thymine, Cytosine, Guanine (1 if 1 error). 2

(b)

Any 4

Pairing described A-T and C-G (both needed);

Backbone / Chains / polynucleotide formed by alternating sugar phosphate groups;

two chains connected / joined by base pairs;

hydrogen bonding;

two chains (twisted) to form a helix / double helix;

NOT alpha helix.

4

Accept labelled diagram.

(c)

{forming template / code / instructions} for {protein synthesis / mRNA / amino acid sequence / primary structure of protein / transcription} (accept Replication in dividing cells) /

NOT genetic material alone.

1

Question total 10

3.

(a) (i)	X transcription;	
	Y translation;	**2**
(ii)	8 marks on diagram S- to line between anticodon/codon; T – to solid line not dotted line; R not if just labelled to black circle	**8**
(b)	CCT ACA GCA CGT	
	All correct 2 marks	
	2/3 correct 1 mark	

4.

(a) deoxyribose/ pentose/ 5 C sugar **1**

(b) (i) A-T-A-G-C **1**

(ii) Guanine pairs with cytosine/ G pairs with C = 60%/ G+ C = 60%; **2**

A+T= 40%

A= 20% (any two)

Correct answer = 2 marks

(Total 4 marks)

5.	**(a)**	Each strand of DNA used as a template to make a new DNA strand;	
		New DNA (mols) made of an old/original strand linked to a new strand; (not: if ref. to new DNA strand)	**2**
	(b) (i)	nitrogenous bases/organic bases/purines and pyrimidine bases/ all four named (not: bases/letters only/nucleotide)	**1**
	(ii)	spin (at same) speed;	
		(Same) time;	
		(Same) density/concentration of gel; (Same) temperature (not: pH/ref. volume or mass)	
			Max 2
	(c) (i)	Tube A all heavy/N^{15};	
		Tube B DNA mixture of heavy and light (so intermediate position)/ $N^{15} + N^{14}$;	
		DNA in B must be made from one strand of heavy and one light;	
		If conservative would get two bands in light and heavy position.	
			Max 3
	(ii)	C intermediate and light equal amounts; (touching dotted lines)	
		D intermediate and light more light than intermediate e.g. shown as thicker or wider line;	

6.	(a) (i)	phosphate; pentose/ribose; adenine (all correct for 2; 1 error = 1) (not: adenosine/nitrogenous base)	**2**
	(ii)	adenosine triphosphate (not: triose phosphate/ATP)	**1**
	(b) (i)	ATP drawn as in part a in upper box; ADP two Ps attached + 1P not attached in lower box.	**1**
	(ii)	protein synthesis/biosynthesis/active transport/nerve conduction/cell division/avp (not: metabolism/growth/movement)	**1**
			Total 5 marks

7.

Question			Marking details	Marks Available
7	*(a)*		(3.4/0.34)x5 or 3.4 x 5/0.34 = 50 Correct Answer = 2 marks correct calculation, incorrect answer = 1 mark Wrong unit = 1 mark only	2
	(b)		Any **one** from: double {stranded / polynucleotide chains} / not single stranded; helical; NOT alpha helix antiparallel strands;	max1
	(c)	(i)	RNA; NOT mRNA, tRNA, rRNA The percentages of G and C are not equal and so there is no (complementary) base pairing;	2
		(ii)	Pyrimidine;	1
			Question 7 total	**[6]**

8.

Question				Marking details	S	Marks Available					
						AO1	AO2	AO3	Total	Maths	Prac
8	(a)	(i)		ribosome + rRNA is ribosomal RNA/constituent of ribosomes (1) OR Nucleolus + synthesis of RNA			1		1		
		(ii)		15.5/100 x 50 000 000 000 = 1 mark = 7 750 000 000 / 7.75 x 10^9 = 2 marks = 7.8 x 10^9 = 3 marks			3		3	3	
		(iii)		different mRNA for every {protein/polypeptide}/many different genes/one gene one polypeptide/OWTTE (1) ref to base triplet code hypothesis (in mRNA/DNA) giving {64/4^3} triplets (1) tRNA molecules have anticodons which have three bases (which are complementary to codons)/tRNA are specific to one amino acid(1)			3		3		
				Question 8 total		**0**	**7**	**0**	**7**	**3**	**0**

9.

Question			Marking details	Marks Available
9	(a)	(i)	DNA molecule unwinds; Unzips/ breaks hydrogen bonds/ strands separate; (free) {nucleotides } {join/align} with {complementary bases/ A to T/ C to G};	3
		(ii)	{To join the nucleotides together/ catalyses the addition of nucleotides} to form a {new strand/ backbone/ phosphodiester bonds};	1
	(b)		Each new DNA molecule has one {original/ template} strand; And one new strand which has been {made/ synthesised/ replicated};	2
			Question 9 Total	**[6]**

10. *(a)*

DNA	RNA
Double <u>stranded</u>	Single <u>stranded</u>
helical	Not helical
Deoxyribose/ $C_5H_{10}O_4$/ one less oxygen atom in pentose NOT deoxyribonucleic acid	Ribose/ $C_5H_{10}O_5$/ one more oxygen atom in pentose NOT ribonucleic acid
Contains thymine Not letters Can list all bases present	Contains uracil Not letters Can list all bases present
Only one type	3 types (mRNA, tRNA & rRNA)
(Relatively) long/ larger molecule	(relatively) short/ smaller molecule

Max 3

(b) 23% guanine therefore 23% cytosine;

(54% made up of adenine and thymine)

Adenine = 27(%);

Correct answer = 2 marks

2

11.

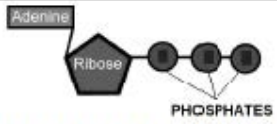
Question				Marking details	Marks Available					
					AO1	AO2	AO3	Total	Maths	Prac
11.				**Indicative content** • description of experiment including details of use of heavy and light isotopes of N and use of ultracentrifugation • explanation of how bands seen in centrifuge tube are formed giving details of heavy and light strands for each generation in terms of the heavy and light isotopes of N • the relative amounts of DNA in each band are explained conservative replication: • always some heavy DNA present • increasing mass of light DNA • no intermediate DNA • because original heavy DNA is not split Dispersive replication: • apart from G_0, all DNA would be intermediate in molecular mass • getting lighter between Go and G3 • because original heavy DNA split between all new molecules	2	2	5	9		
				7-9 marks • detailed description of experimental procedure and explanation of results • correct detailed explanation to reject conservative theory • correct detailed explanation to reject dispersive theory *The candidate constructs an articulate, integrated account, which shows sequential reasoning. The answer fully addresses the question with no irrelevant inclusions or significant omissions. The candidate uses scientific conventions and vocabulary appropriately and accurately.* **4-6 marks** • description of experimental procedure and explanation of results • correct explanation to reject conservative theory • correct explanation to reject dispersive theory OR • detailed description of experimental procedure and explanation of results • correct detailed explanation to reject either conservative theory or dispersive theory *The candidate constructs an account correctly linking some relevant points, such as those in the indicative content, showing some reasoning. The answer addresses the question with some omissions. The candidate usually uses scientific conventions and vocabulary appropriately and accurately.*						
				1-3 marks • some description of experimental procedure and/or explanation of results OR • correct explanation to reject conservative theory OR • correct explanation to reject dispersive theory *The candidate makes some relevant points, such as those in the indicative content, showing limited reasoning. The answer addresses the question with significant omissions. The candidate has limited use of scientific conventions and vocabulary.*						
				Question 11 total	**2**	**2**	**5**	**9**		

12.

Question		Marking details	Marks Available
12.	(a)	A – Phosphate; Accept phosphoric acid B – Deoxyribose; NOT pentose C – {Organic/nitrogerous} base; NOT named base (can be neutral)	3
	(b)	Uracil in RNA thymine in DNA; NOT U in RNA and T in DNA RNA is (usually) singe stranded, DNA is double stranced; DNA is longer molecule than RNA ; Sugar is ribose in RNA, deoxyribose in DNA;	Max 2

Question 12 Total [5]

13.

Question				Marking details	Marks available					
					AO1	AO2	AO3	Total	Maths	Prac
13	(a)			 Only one phosphate need be labelled. Pentagon shape with adenine and 3 phosphates coming off at correct points (1) Ignore shape of adenine Correct labels = ribose + adenine + phosphate (1) Accept adenosine if structures bracketed Reject pentose Reject base	2			2		
				Question 13 total	**2**	**0**	**0**	**2**	**0**	**0**