DNA, RNA and Protein Synthesis (Topic 2): Edexcel SNAB A Level Biology Exam Questions by Topic

20 questions · 48 marks · about 58 minutes. Answer in the spaces, then check the mark schemes at the end.

Question 1 · AS Paper 1 · June 2017 · Q7(a) · 2 marks

7 DNA is a polymer made from monomers called nucleotides.

(a) Describe how nucleotides join together to form DNA.

(2)

Question 2 · AS Paper 1 · June 2019 · Q7(b)(ii) · 3 marks

(ii) Describe the differences between the structure of DNA and the structure of RNA.

(3)

Question 3 · information from earlier in the question

(b) Gene technology uses restriction enzymes and ligases.

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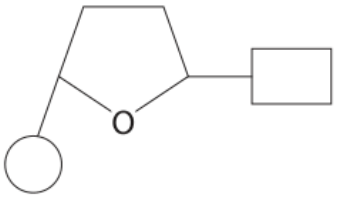
Question 3 · A level Paper 2 · June 2025 · Q9(b)(ii) · 3 marks

(ii) Determine the number of condensation reactions that occur when ligase joins a single gene to a bacterial plasmid.

(3)

Question 4 · AS Paper 1 · June 2023 · Q1(a)(i) · 2 marks

1 The diagram shows a DNA nucleotide.



(a) (i) Complete the diagram to show how a complementary pair of nucleotides would appear in a DNA molecule.

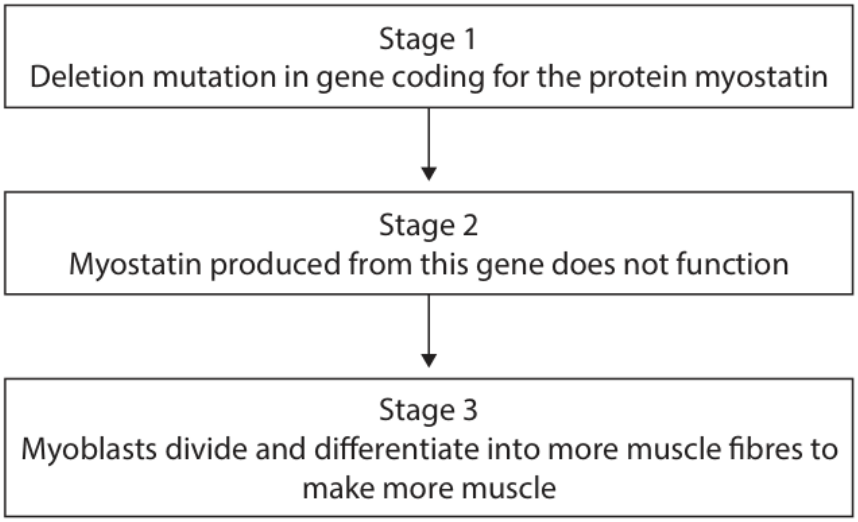
(2)

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Question 5 · information from earlier in the question

5 The Belgian Blue is a breed of cattle that contains a lot of muscle due to a mutation. The mutation affects cells called myoblasts.

The flow diagram shows some stages that lead to the production of excess muscle.



(a) The base sequence shows 21 bases in one DNA strand of part of the myostatin gene.

T	G	T	G	A	T	G	A	A	C	A	C	T	C	C	A	C	A	G	A	A

Question 5 · A level Paper 2 · June 2025 · Q5(a)(ii) · 3 marks

(ii) The bases shaded are deleted from one strand in the mutated gene (Stage 1).

T	G	T	G	A	T	G	A	A	C	A	C	T	C	C	A	C	A	G	A	A

The two strands of DNA are held together by hydrogen bonds.

There are two hydrogen bonds between adenine (A) and its complementary base and three between the other pair of bases.

Calculate the percentage reduction in the number of hydrogen bonds in this part of the myostatin gene due to the mutation.

Give your answer to one decimal place.

(3)

.....

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Question 6 · AS Paper 1 · June 2019 · Q7(b)(i) · 2 marks

(b) One function of DNA is to act as a template for the synthesis of messenger RNA (mRNA) during transcription.

(i) Describe how mRNA is synthesised at a template strand of DNA.

(2)

Question 7 · AS Paper 1 · June 2022 · Q1(b) · 3 marks

(b) Describe the role of mRNA in protein synthesis.

(3)

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Question 8 · AS Paper 1 · November 2021 · Q5(b)(iv) · 2 marks

(iv) Describe the role of the tRNA in the production of the protein part of a glycoprotein.

(2)

Question 9 · A level Paper 1 · June 2024 · Q8(a)(ii) · 3 marks

(ii) Describe the role of ribosomes in the synthesis of lactase.

(3)

Question 10 · AS Paper 1 · June 2022 · Q1(a)(i) · 1 mark

1 (a) The diagram shows part of a mRNA base sequence.

A	U	G	C	U	A	G	G	C	A	C	G	U	A	U	A	C	G	G	G	C

(i) Give the sequence of the first **six** bases of the DNA that was transcribed to give this mRNA sequence.

(1)

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Question 11 · AS Paper 1 · June 2022 · Q1(a)(iii) · 1 mark

(iii) Give the maximum number of different tRNA molecules that would be needed to produce the polypeptide chain produced from this base sequence.

(1)

.....

Question 12 · A level Paper 2 · June 2024 · Q4(b)(i) · 2 marks

(b) Some mutations affect the phenotype of the organism.

(i) The DNA template strand is involved in the synthesis of mRNA.

The anticodons of the first four tRNA molecules that carry amino acids into a ribosome are shown.

UAC GGA UCG AAC

Determine why the sequence of bases in these anticodons is 83% the same as the sequence of bases on the DNA template strand.

(2)

.....

.....

.....

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Question 13 · AS Paper 1 · June 2016 · Q7(c) · 4 marks

(c) Mutations to DNA can affect the structure of proteins produced in the cell.

Removing one base from a DNA sequence will affect the primary structure of a protein.

Changing one base for another may not affect the primary structure of a protein.

Explain why these two types of mutation have different effects on protein structure.

(4)

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(ii) The table shows part of the gene that codes for the CFTR protein and the corresponding amino acid sequence. Each amino acid is represented by a single letter.

Part of the CFTR gene	ATTAAAGAAAATATCATCTTTGGTGTTTCCTAT									
Amino acid sequence	I	K	E	N	I	I	F	G	V	S	Y

Explain how the information in the table demonstrates the nature of the genetic code.

(3)

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Question 15 · A level Paper 1 · June 2018 · Q4(b) · 2 marks

(b) Several mutations of the leptin gene have been identified. All these mutations are frameshift mutations that result in shortened primary structures.

A frameshift mutation involves the insertion or removal of one or two nucleotides from a gene.

Describe how a frameshift mutation could result in the production of leptin with a variety of shorter primary structures.

(2)

Question 16 · AS Paper 1 · June 2016 · Q7(b)(i) · 1 mark

(b) A human gene is 27 000 base pairs long. In this section of double-stranded DNA there are 4050 nucleotides containing the base cytosine.

(i) State what is meant by the term gene.

(1)

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Question 17 · A level Paper 1 · June 2023 · Q3(b)(ii) · 4 marks

(ii) Describe how DNA is replicated.

(4)

Question 18 · AS Paper 1 · June 2024 · Q5(a)(i) · 2 marks

5 Scientists have investigated the functions of DNA polymerase.

(a) (i) Describe the function of DNA polymerase in producing a polynucleotide.

(2)

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Question 19 · A level Paper 2 · June 2023 · Q5(b)(i) · 3 marks

(b) Meselson and Stahl used *E. coli* to investigate the nature of DNA replication.

They initially grew an *E. coli* population in a medium containing heavy nitrogen (^{15}N) until all the bacteria had DNA containing heavy nitrogen.

They then transferred the bacteria into a medium containing light nitrogen (^{14}N).

The bacteria were sampled after the first replication and after the second replication.

(i) Complete the table to show the expected DNA after *E.coli* had been grown in ^{14}N, for two possible types of DNA replication.

(3)

Type of DNA replication	DNA before first replication	DNA after first replication in ^{14}N	DNA after second replication in ^{14}N
Conservative			
Semi-conservative			

Key

 = one strand of DNA containing heavy / ^{15}N

 = one strand of DNA containing light / ^{14}N

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Question 20 · A level Paper 2 · June 2023 · Q5(b)(ii) · 2 marks

(ii) This study enabled Meselson and Stahl to show that DNA replication was semi-conservative rather than conservative.

Explain what is meant by the term **semi-conservative DNA replication**.

(2)

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Mark schemes

Question 1 · AS Paper 1 · June 2017 · Q7(a) · 2 marks

Question Number	Answer
7 (a)	A description which includes two of the following: • condensation reaction (1) • phosphodiester bonds (1) • DNA polymerase (1)

Additional Guidance	Mark
Must be in context of forming a DNA strand ALLOW hydrogen bonding between bases (in context of double strand) ALLOW bonds forming between phosphate and deoxyribose	**(2)**

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Question 2 · AS Paper 1 · June 2019 · Q7(b)(ii) · 3 marks

Question Number	Answer
7(b)(ii)	A description which includes reference to the following: • DNA is double stranded whereas RNA is single stranded (1) • DNA contains deoxyribose whereas RNA contains ribose (1) • DNA contains {thymine / T} whereas RNA contains {uracil / U} (1)

Additional Guidance	Mark
	(3)

Question 3 · A level Paper 2 · June 2025 · Q9(b)(ii) · 3 marks

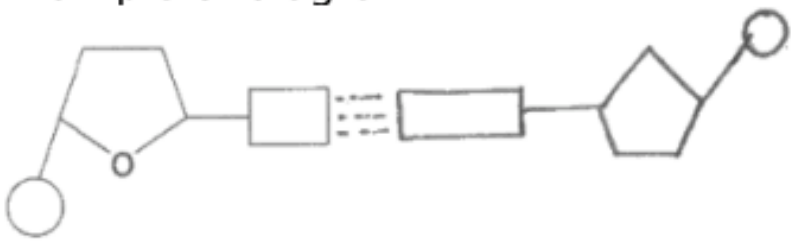
Question Number	Answer
9 (b)(ii)	An explanation that makes reference to three of the following: • four (1) • phosphodiester bonds (1) • two per DNA strand (1) • (and) DNA is double-stranded (1)

Additional Guidance	Mark
ALLOW each end of gene/plasmid/DNA would need two bonds	(3)

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Question 4 · AS Paper 1 · June 2023 · Q1(a)(i) · 2 marks

Question Number	Answer
1 (a)(i)	An answer that makes reference to the following: • inverted DNA nucleotide (1) • {2 / 3} hydrogen bonds (1)

Additional Guidance	Mark
Example of diagram:  **(2)**	

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Question 5 · A level Paper 2 · June 2025 · Q5(a)(ii) · 3 marks

Question Number	Answer
5 (a)(ii)	An answer that makes reference to the following: • total number of hydrogen bonds in this part of the gene (1) • number of hydrogen bonds in { deleted part of gene / remaining part of gene } (1) • correct percentage change calculated and given to one decimal place (1)

Additional Guidance	Mark
<u>Example of calculation</u> (12 x 2) + (9 x 3) = 24 + 27 = 51 (6 x 2) + (5 x 3) = 12 + 15 = 27 OR (6 x 2) + (4 x 3) = 12 + 12 = 24 (24÷51) x 100 = 47.1% OR (27÷51) x 100 = 52.9% Correct answer with no working gains full marks	**(3)**

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Question 6 · AS Paper 1 · June 2019 · Q7(b)(i) · 2 marks

Question Number	Answer
7(b)(i)	A description which makes reference to two of the following: • (RNA) nucleotides align with complementary bases (on DNA) (1) • RNA nucleotides joined together by {RNA polymerase / phosphodiester bonds} (1)

Additional Guidance	Mark
ALLOW correct description of base pairing (A-U / C-G)	(2)

Question 7 · AS Paper 1 · June 2022 · Q1(b) · 3 marks

Question Number	Answer	Additional Guidance	Mark
1(b)	A description that makes reference to three of the following: • (mRNA) carries the genetic code for a protein / copy of {part of the template DNA strand / gene / allele} (1) • mRNA {binds / attaches} to ribosome (1) • complementary anticodon (on tRNA) will bind to codon (on mRNA) (1) • sequence of {bases / codons (on mRNA)} determines the sequence of amino acids (1)	ALLOW (mRNA) carries part of the genetic code {out of the nucleus/ to the ribosome} ALLOW mRNA is translated at the ribosome	(3)

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Question 8 · AS Paper 1 · November 2021 · Q5(b)(iv) · 2 marks

Question Number	Answer
5 (b)(iv)	A description that makes reference to two of the following: • each tRNA brings a specific amino acid (to the ribosome) (1) • the tRNA with the complementary anticodon binds to the mRNA codon (1) • tRNA bonds to ribosome (1)

Additional Guidance	Mark
ALLOW tRNA anticodons are complementary to mRNA codons	**(2)**

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Question 9 · A level Paper 1 · June 2024 · Q8(a)(ii) · 3 marks

Question Number	Answer
8(a)(ii)	A description that makes reference to three of the following • the ribosomes receive mRNA (from the nucleus) / mRNA binds to the ribosome (1) • (at the ribosome) an anticodon on tRNA pairs with the (complementary) codon on the mRNA (1) • ribosome moves along the mRNA (1) • peptide bonds form between the amino acids (held at the ribosome) (1)

Additional guidance	Mark
ALLOW ribosome is the site of mRNA translation ALLOW mRNA moves along the ribosome	(3)

Question 10 · AS Paper 1 · June 2022 · Q1(a)(i) · 1 mark

Question Number	Answer	Mark
1(a)(i)	T A C G A T ALLOW as words: thymine, adenine, cytosine, guanine, adenine, thymine	(1)

Question 11 · AS Paper 1 · June 2022 · Q1(a)(iii) · 1 mark

Question Number	Answer	Additional Guidance	Mark
1(a)(iii)	5 / five		(1)

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Question 12 · A level Paper 2 · June 2024 · Q4(b)(i) · 2 marks

Question Number	Answer
4(b)(i)	An answer that makes reference to the following: • (only) U replaced by T (1) • (so the other) 10 bases out of 12 are the same (1)

Additional Guidance	Mark
ALLOW DNA does not have uracil ALLOW (10 ÷ 12) x 100 = 83% OR {uracil / two} bases are different which makes up 17% of the bases	**2**

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Question 13 · AS Paper 1 · June 2016 · Q7(c) · 4 marks

Question Number	Answer
7 (c)	An explanation that makes reference to four of the following: • deletion could affect every codon (on the mRNA) / substitution will only affect one codon (1) • deletion more likely to affect the position of { stop codon / start codon } (1) • deletion results in a different sequence of amino acids / substitution may not affect the sequence of amino acids (1) • substitution may code for the same amino acid (1) • (same amino acid) due to the degenerate nature of the genetic code (1)

Additional Guidance	Mark
Allow reference to 'frame shift'	(4)

Question 14 · A level Paper 1 · June 2017 · Q2(c)(ii) · 3 marks

Question Number	Answer
2(c)(ii)	An explanation that makes reference to the following: • (triplet code) is shown by three bases coding for an amino acid (1) • non-overlapping code e.g. ATT codes for amino acid I and then AAA code for amino acid K (1) • degenerate code as both ATT and ATC code for amino acid I (1)

Additional Guidance	Mark
	3

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Question 15 · A level Paper 1 · June 2018 · Q4(b) · 2 marks

Question Number	Answer
4(b)	A description that makes reference to two of the following: • (adding or removing one or two nucleotides) changes the triplet code (1) • introducing a new {start / stop} codon (1) • coding for a shorter sequence of amino acids (1)

Additional Guidance	Mark
ALLOW different codons produced (1) ALLOW one amino acid shorter	**(2)**

Question 16 · AS Paper 1 · June 2016 · Q7(b)(i) · 1 mark

Question Number	Answer	Additional Guidance	Mark
7(b)(i)	sequence of **{** bases / nucleotides **}** in DNA coding for a **{**polypeptide / protein**}**		**(1)**

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Question 17 · A level Paper 1 · June 2023 · Q3(b)(ii) · 4 marks

Question Number	Answer
3(b)(ii)	A description that makes reference to four of the following • hydrogen bonds between the {bases/ strands} are broken / the double helix {unwinds/unzips} (1) • (unzipping brought about by) (DNA) helicase (1) • (DNA) nucleotides (line up) along each DNA strand (1) • (by) complementary base pairing (1) • (adjacent nucleotides) joined by DNA polymerase (1)

Additional guidance	Mark
ALLOW DNA {unwinds / unzips} ALLOW A pairs with T and C pairs with G	(4)

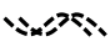
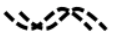
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Question 18 · AS Paper 1 · June 2024 · Q5(a)(i) · 2 marks

Question Number	Answer
5(a)(i)	A description that makes reference to two of the following: • (catalyses) condensation reactions (1) • to {join / bond} DNA (mono)nucleotides together (1) • forming phosphodiester bonds (between phosphate group and deoxyribose sugar) (1)

Additional Guidance	Mark
ALLOW nucleotides unqualified reject RNA nucleotides ignore hydrogen bonds	(2)

Question 19 · A level Paper 2 · June 2023 · Q5(b)(i) · 3 marks

Question Number	Answer	Additional Guidance	Mark
5(b)(i)	Conservative: 1 x  and 3 x  (1) Semi-conservative – 1st replication:  and  (1) Semi-conservative – 2nd replication: 2 x  and 2 x  (1)		[3]

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Question 20 · A level Paper 2 · June 2023 · Q5(b)(ii) · 2 marks

Question Number	Answer
5(b)(ii)	An explanation that makes reference to two of the following: • doubling of the DNA (1) • with each original DNA strand acting as a template (onto which a new strand is formed) (1) • (so) (each double-stranded) DNA formed contains one original strand of DNA and one new strand of DNA (1)

Additional Guidance	Mark
ALLOW marks for annotated diagram ALLOW two double helices formed ALLOW reference to {template / sense and antisense} strands from original DNA	**[2]**

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