

Interactive Example Candidate Responses

Paper 2 (May/June 2016), Question 6

Cambridge International AS & A Level

Biology 9700

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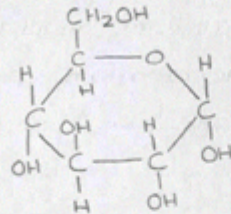
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6 One of the enzymes involved in glycogen synthesis is glycogen synthase. The monomer of the glycogen polymer is α -glucose.

(a) (i) Draw the ring form of α -glucose in the space provided.



[2]

(ii) Glycogen synthase catalyses the formation of a covalent bond between two α -glucose molecules during glycogen synthesis.

Name the type of bond formed.

.....glycosidic bond.....[1]

(iii) Glycogen branching enzyme is another enzyme that is required for glycogen synthesis.

Suggest why glycogen branching enzyme is needed in addition to glycogen synthase.

Enzymes are specific and their active sites are complementary to only one type of substrate and bond formation. Glycogen synthase is specific to forming 1,4- α -glycosidic bonds and forming glycogen branching enzyme is specific to 1,6- α -glycosidic bonds. [1]

(b) The gene coding for glycogen synthase in muscle cells is known as *GYS1*.

(i) Explain what is meant by a *gene*.

a specific length of nucleotides on the DNA molecule that codes for a specific order of amino acids i.e. a specific polypeptide chain or protein. [2]

Your
Mark

6(a)(i)

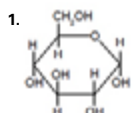
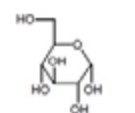
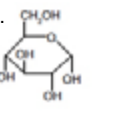
6(a)(ii)

6(a)(iii)

6(b)(i)

6(b)(ii)

6(c)

| Q6 | Mark scheme |
|----------|--|
| (a)(i) | <p>1.  2.  3. </p> <p>two marks for correct drawing of ring structure ;; all atoms shown or one of diagrams 1–3 above</p> <p>one mark if, inconsistent / incomplete, drawing: diagram 1 – one missing H from any of carbons 2–6 (OH groups and rest of drawing must be correct) diagrams 2 and 3 – adding the H to one of carbons 1–5 (OH groups and rest of drawing must be correct) [2]</p> |
| (a)(ii) | glycosidic ; A glucosidic [1] |
| (a)(iii) | to form / has, (glycosidic α) 1–6, bonds / links (to make branches) ; ref. to different shaped / specific / complementary, active site required to form bonds (for branching) ; [max 1] |
| (b)(i) | <p>treat as neutral unit of inheritance sequence of, nucleotides / bases ; section / length / part, of DNA (molecule) ; codes for a polypeptide ; A protein for polypeptide A enzyme A information to produce a polypeptide A codes / information, for sequence of amino acids / primary structure (of a, polypeptide / protein) R genetic code for a polypeptide [max 2]</p> |
| (b)(ii) | <p>1 (in DNA / gene) altered, sequence / AW, of, nucleotides / bases ; 1 DNA sequence 2 base substitution or base / nucleotide, replaces another, base / nucleotide ; A example must be in context of, DNA / gene 3 (mRNA synthesised) during transcription ; 4 (mutation leads to) altered / AW, mRNA / messenger RNA ; 5 (only) one (mRNA) codon changed / a different codon ; A one DNA, triplet / codon, changed 1 ref. to codons changed 6 tRNA, with / has, a different anticodon ; 7 (tRNA) brings, a different / a changed / the incorrect, amino acid, during translation / to the ribosome ; 8 codon-anticodon, binding / complementary / AW ; A matches R amino acid with anticodon</p> |
| (c) | <p>nucleolus ; R if other cell structures given mitochondrion ; R if other cell structures given rough endoplasmic reticulum or Golgi (body / apparatus / complex) ; [3] [Total: 12]</p> |

(ii) There are a number of known mutations for *GYS1*.

Outline how a mutation in *GYS1* can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid.

A base on the sense strand in the gene is substituted e.g. A. The triplet code is altered. is replaced by G. When transcription occurs, the mRNA strand formed by complementary base pairing contains the incorrect codon (specific to altered triplet code). mRNA leaves nucleus and binds to ribosome during translation. tRNAs enter ribosome in twos and amino acid joins chain however at incorrect codon, incorrect anticodon binds to it, so different amino acid added to chain. In this way, primary structure of protein changed. [3]

(c) Table 6.1 shows three functions of cell structures that are involved in the synthesis of glycogen synthase.

Complete Table 6.1 by naming the cell structure that carries out the function listed.

Table 6.1

| function | name of cell structure |
|---|------------------------------|
| assembles ribosomes for polypeptide synthesis | rough endoplasmic reticulum. |
| synthesises ATP to provide a supply of energy for transcription of <i>GYS1</i> | mitochondria |
| folds and modifies synthesised polypeptide to produce functioning glycogen synthase | golgi apparatus |

[3]

[Total: 12]

Your
Mark

6(a)(i)

6(a)(ii)

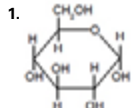
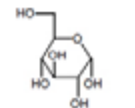
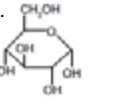
6(a)(iii)

6(b)(i)

6(b)(ii)

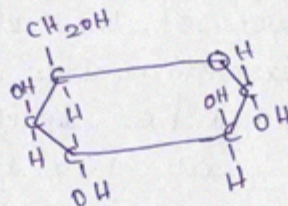
6(c)

Q6 Mark scheme

| | |
|----------|--|
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- 6 One of the enzymes involved in glycogen synthesis is glycogen synthase. The monomer of the glycogen polymer is α -glucose.

(a) (i) Draw the ring form of α -glucose in the space provided.



[2]

- (ii) Glycogen synthase catalyses the formation of a covalent bond between two α -glucose molecules during glycogen synthesis.

Name the type of bond formed.

glycosidic bond [1]

- (iii) Glycogen branching enzyme is another enzyme that is required for glycogen synthesis.

Suggest why glycogen branching enzyme is needed in addition to glycogen synthase.

To catalyst the reaction and faster the reaction by reducing the activation energy needed for the reaction. [1]

- (b) The gene coding for glycogen synthase in muscle cells is known as GYS1.

(i) Explain what is meant by a gene.

gene is a section in DNA that codes for a specific amino acid sequence to produce a specific protein that is needed for cell metabolism and exhibit different traits or characters. [2]

Your
Mark

6(a)(i)

6(a)(ii)

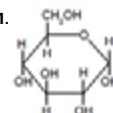
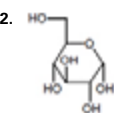
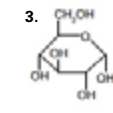
6(a)(iii)

6(b)(i)

6(b)(ii)

6(c)

Q6 Mark scheme

| | |
|----------|--|
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| (a)(iii) | to form / has, (glycosidic a) 1–6, bonds / links (to make branches) ; ref. to different shaped / specific / complementary, active site required to form bonds (for branching) ; [max 1] |
| (b)(i) | <p>treat as neutral unit of inheritance sequence of, nucleotides / bases ; section / length / part, of DNA (molecule) ; codes for a polypeptide ; A protein for polypeptide A enzyme A information to produce a polypeptide A codes / information, for sequence of amino acids / primary structure (of a, polypeptide / protein) R genetic code for a polypeptide [max 2]</p> |
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| (c) | <p>nucleolus ; R if other cell structures given mitochondrion ; R if other cell structures given rough endoplasmic reticulum or Golgi (body / apparatus / complex) ; [3] [Total: 12]</p> |

(ii) There are a number of known mutations for *GYS1*.

Outline how a mutation in *GYS1* can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid.

when there is a change in order of nucleotides in a gene, & when it is used in translation that mutated gene will produce a different amino acid instead of a normal amino acid as there was different nucleotide causing a different amino acid chain giving a different protein as disrupting the function of the protein.

(c) Table 6.1 shows three functions of cell structures that are involved in the synthesis of glycogen synthase.

Complete Table 6.1 by naming the cell structure that carries out the function listed.

Table 6.1

| function | name of cell structure |
|---|------------------------|
| assembles ribosomes for polypeptide synthesis | nucleolus |
| synthesises ATP to provide a supply of energy for transcription of <i>GYS1</i> | mitochondria |
| folds and modifies synthesised polypeptide to produce functioning glycogen synthase | golgi apparatus |

[3]

[Total: 12]

Your
Mark

6(a)(i)

6(a)(ii)

6(a)(iii)

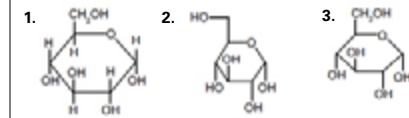
6(b)(i)

6(b)(ii)

6(c)

Q6 Mark scheme

(a)(i)



two marks for correct drawing of ring structure ;; all atoms shown or one of diagrams 1–3 above

one mark if, inconsistent / incomplete, drawing:

diagram 1 – one missing H from any of carbons 2–6 (OH groups and rest of drawing must be correct)

diagrams 2 and 3 – adding the H to one of carbons 1–5 (OH groups and rest of drawing must be correct)

[2]

(a)(ii)

glycosidic ; **A** glucosidic

[1]

(a)(iii)

to form / has, (glycosidic **a**) 1–6, bonds / links (to make branches) ; ref. to different shaped / specific / complementary, active site required to form bonds (for branching) ;

[max 1]

(b)(i)

treat as neutral unit of inheritance
sequence of, nucleotides / bases ;
section / length / part, of DNA (molecule) ;
codes for a polypeptide ; **A** protein for polypeptide **A** enzyme
A information to produce a polypeptide
A codes / information, for sequence of amino acids / primary structure (of a, polypeptide / protein)
R genetic code for a polypeptide

[max 2]

(b)(ii)

1 (in DNA / gene) altered, sequence / AW, of, nucleotides / bases ;
1 DNA sequence
2 base substitution or base / nucleotide, replaces another, base / nucleotide ;
A example must be in context of, DNA / gene
3 (mRNA synthesised) during transcription ;
4 (mutation leads to) altered / AW, mRNA / messenger RNA ;
5 (only) one (mRNA) codon changed / a different codon ;
A one DNA, triplet / codon, changed 1 ref. to codons changed
6 tRNA, with / has, a different anticodon ;
7 (tRNA) brings, a different / a changed / the incorrect, amino acid, during translation / to the ribosome ;
8 codon-anticodon, binding / complementary / AW ; **A** matches
R amino acid with anticodon

(c)

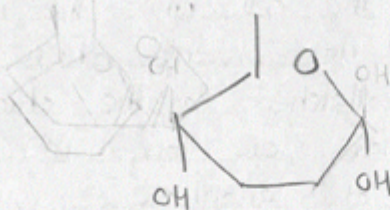
nucleolus ; **R** if other cell structures given
mitochondrion ; **R** if other cell structures given
rough endoplasmic reticulum or Golgi (body / apparatus / complex) ;

[3]

[Total: 12]

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(a) (i) Draw the ring form of α -glucose in the space provided.



[2]

(ii) Glycogen synthase catalyses the formation of a covalent bond between two α -glucose molecules during glycogen synthesis.

Name the type of bond formed.

Glycosidic Bond

[1]

(iii) Glycogen branching enzyme is another enzyme that is required for glycogen synthesis.

Suggest why glycogen branching enzyme is needed in addition to glycogen synthase.

This is necessary as the glycogen needs to have a compact shape for storage

[1]

(b) The gene coding for glycogen synthase in muscle cells is known as *GYS1*.

(i) Explain what is meant by a *gene*.

A gene is the component of DNA that has the coding for different proteins and amino acids. There are numerous genes present in the DNA

[2]

Your
Mark

6(a)(i)

6(a)(ii)

6(a)(iii)

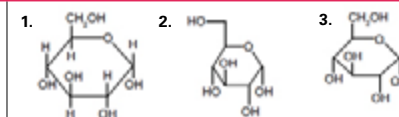
6(b)(i)

6(b)(ii)

6(c)

Q6 Mark scheme

(a)(i)



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diagrams 2 and 3 – adding the H to one of carbons 1–5 (OH groups and rest of drawing must be correct)

[2]

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glycosidic ; **A** glucosidic

[1]

(a)(iii)

to form / has, (glycosidic α) 1–6, bonds / links (to make branches) ;
ref. to different shaped / specific / complementary, active site required to form bonds (for branching) ;

[max 1]

(b)(i)

treat as neutral unit of inheritance
sequence of, nucleotides / bases ;
section / length / part, of DNA (molecule) ;
codes for a polypeptide ; **A** protein for polypeptide **A** enzyme

A information to produce a polypeptide

A codes / information, for sequence of amino acids / primary structure (of a, polypeptide / protein)

R genetic code for a polypeptide

[max 2]

(b)(ii)

1 (in DNA / gene) altered, sequence / AW, of, nucleotides / bases ;
I DNA sequence

2 base substitution or base / nucleotide, replaces another, base / nucleotide ;

A example must be in context of, DNA / gene

3 (mRNA synthesised) during transcription ;

4 (mutation leads to) altered / AW, mRNA / messenger RNA ;

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8 codon-anticodon, binding / complementary / AW ; **A** matches

R amino acid with anticodon

(c)

nucleolus ; **R** if other cell structures given
mitochondrion ; **R** if other cell structures given
rough endoplasmic reticulum or Golgi (body / apparatus / complex) ;

[3]

[Total: 12]

(ii) There are a number of known mutations for GYS1.

Outline how a mutation in GYS1 can lead to the formation of an altered polypeptide where one amino acid is replaced by a different amino acid.

As the gene has mutated, the base sequence of the mRNA will be altered, and it will have different coding. When it enters cytoplasm, the tRNA and amino acid specific to the altered gene will arrive at the ribosome, hence different polypeptide is formed. [3]

(c) Table 6.1 shows three functions of cell structures that are involved in the synthesis of glycogen synthase.

Complete Table 6.1 by naming the cell structure that carries out the function listed.

Table 6.1

| function | name of cell structure |
|---|-----------------------------|
| assembles ribosomes for polypeptide synthesis | Rough Endoplasmic Reticulum |
| synthesises ATP to provide a supply of energy for transcription of GYS1 | Mitochondria |
| folds and modifies synthesised polypeptide to produce functioning glycogen synthase | Golgi Apparatus |

[3]

[Total: 12]

Your
Mark

6(a)(i)

6(a)(ii)

6(a)(iii)

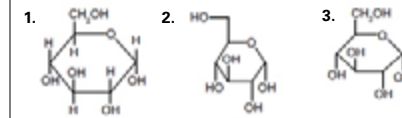
6(b)(i)

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6(c)

Q6 Mark scheme

(a)(i)



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to form bonds (for branching) ; [max 1]

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sequence of, nucleotides / bases ;
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A information to produce a polypeptide
A codes / information, for sequence of amino acids / primary
structure (of a, polypeptide / protein)
R genetic code for a polypeptide [max 2]

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nucleolus ; **R** if other cell structures given
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[Total: 12]

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