# Cellular Control (6.1.1): OCR A Level Biology Exam Questions by Topic

15 questions · 44 marks · about 53 minutes. Answer in the spaces, then check the mark schemes at the end.

**Question 1 · A level Paper 2 · June 2022 · Q22(a) · 5 marks**

**22** Body plan is important in multicellular organisms.

**(a)** Complete the following sentences about control of body plan using the most appropriate terms.

Body plan is under genetic and ..... control. Internal and external..... can influence the expression of genes that regulate the cell cycle. Such genes can promote or inhibit programmed cell death, known as ..... . During programmed cell death ..... digest the cell contents and the products are removed by ..... so that they do not damage the surrounding tissues.

**[5]**

**Question 2 · A level Paper 2 · June 2022 · Q22(b) · 1 mark**

**(b)** State the name of the type of gene responsible for controlling body plan in multicellular organisms.

..... **[1]**


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**Question 3 · A level Paper 2 · November 2020 · Q16(a) · 5 marks**

## SECTION B

Answer **all** the questions.

**16** The body plan of multicellular organisms is under genetic control.

**(a)** Complete the passage below using the most appropriate words from the list.

| | | | | |
|---|---|---|---|---|
| **analogous** | **archaea** | **development** | **DNA** | **domains** |
| **homeobox** | **homologous** | **homozygous** | **kingdoms** | **operon** |
| **phyla** | **plant** | **preserved** | **prokaryotes** | **regulator** |
| **ribosomes** | **transcription** | **translation** | | |

The development of body plan in eukaryotic organisms is controlled by ..... genes. These genes code for proteins that are able to bind to ..... and turn specific genes on and off and are known as ..... factors. These proteins contain a sequence of base pairs that varies little between species within the animal, ..... or fungus ..... .

**[5]**

**Question 4 · A level Paper 2 · November 2021 · Q16(c)(i) · 2 marks**

**(c)** DNA codes for proteins within the cell. Some regions of DNA are described as non-coding.

**(i)** Explain why some regions of DNA can be described as 'non-coding'.

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..... **[2]**


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**Question 5 · A level Paper 2 · November 2021 · Q16(c)(ii) · 1 mark**

**(ii)** Non-coding regions of DNA show more variation than coding regions. This makes non-coding regions useful in DNA profiling.

Suggest why non-coding regions of DNA show more variation.

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..... **[1]**

**Question 6 · A level Paper 3 · June 2025 · Q4(b) · 2 marks**

**(b)** Outline how gene expression is regulated within cells at the post-transcriptional level.

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..... **[2]**

**Question 7 · information from earlier in the question**

**(ii)** *E. coli* usually grows in conditions where the extracellular concentration of lactose is low. In such conditions lactose does not easily cross the bacterial cell surface membrane.

Suggest and explain why lactose is unable to cross membranes.

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..... **[2]**


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**Question 7 · A level Paper 2 · June 2017 · Q20(b)(iii) · 2 marks**

**(iii)** In order for lactose to enter the cytoplasm of *E. coli* a protein is required.

The *E. coli* living in the digestive system of young mammals are more likely to contain this protein than *E. coli* living in the digestive system of old mammals.

Suggest an explanation for this observation.

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..... **[2]**

**Question 8 · information from earlier in the question**

**(c)** The colour of onion bulbs is determined by two genes, **A/a** and **B/b**.

- **A** is a dominant allele and codes for the production of a red pigment.
- Onion bulbs that are homozygous for the recessive allele, **a**, produce no pigment and are white.
- **B** is a dominant allele that inhibits the expression of allele **A**.
- The recessive allele, **b**, allows the production of the red pigment.

A white onion plant was cross-pollinated with a red onion plant. All 15 offspring had the genotype **AaBb**.

**(i)** Identify the following:

The genotype of the white onion plant .....

The genotype of the red onion plant .....

The phenotype of the offspring .....

**[3]**


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**Question 8 · A level Paper 3 · June 2018 · Q1(c)(iii) · 2 marks**

**(iii)** Suggest how allele **B** inhibits the expression of allele **A**.

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..... **[2]**

Turn over


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**Question 9 · information from earlier in the question**

**6** β-thalassemia is an inherited blood disorder in which the β-globin chain of haemoglobin is changed or absent in a person's red blood cells.

Many different DNA mutations in the β-globin gene can cause β-thalassemia, including these two mutations:

mutation 1: **C G G ⟶ C T G**

mutation 2: **G T C ⟶ A T C**

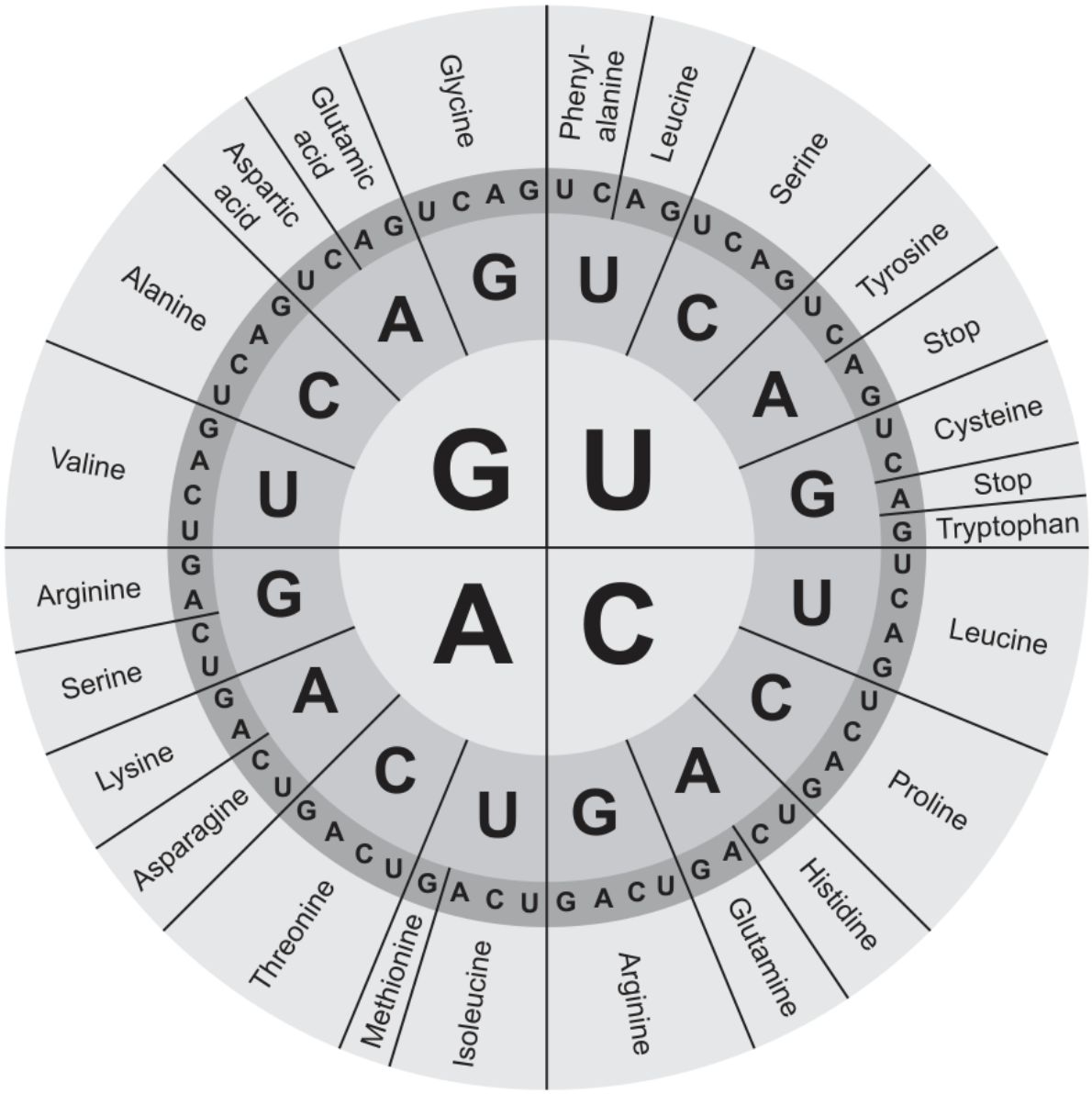
Each mutation occurs in a triplet in the template strand of DNA.

The transcribed mRNA is complementary to the template strand.

**(a)**

**(i)** The diagram on the opposite page is a representation of the genetic code. It shows the amino acid encoded by each mRNA codon.

The letters in the centre of the diagram represent the first base in each codon.




State the amino acids that are encoded by the original triplet and the mutated triplet in mutation 1.

Original amino acid .....


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**Question 9 · A level Paper 3 · June 2025 · Q6(a)(ii) · 1 mark**

**(ii)** State **and** explain the effect of mutation 2 on the structure of the β-chain of haemoglobin.

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..... **[1]**

**Question 10 · information from earlier in the question**

**(b)** Genes isolated from DNA can be used in gene therapy.

Cystic fibrosis (CF) is a disease that could be treated using gene therapy.

Healthy individuals have a gene that codes for a channel protein, called CFTR, found in the plasma membrane of a variety of cells, including those lining the airways of the lungs.

People suffering from CF have two copies of a recessive allele and so their cells do not synthesise the correct channel protein.

The allele that codes for the functioning CFTR protein can be inserted into the DNA of CF sufferers. The cells can then synthesise the correct CFTR protein and function as normal.

**(i)** The treatment of cystic fibrosis is described as **somatic** gene therapy. Another type of gene therapy is known as **germ-line** gene therapy.

Complete the table below to show **three** differences between somatic gene therapy and germ-line gene therapy.

| Somatic | Germ-line |
|---|---|
| | |
| | |
| | |

**[3]**


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**Question 10 · A level Paper 2 · June 2019 · Q17(b)(ii) · 2 marks**

**(ii)** Some attempts at gene therapy have resulted in changes to the functioning of other genes.

Explain how inserting a new gene into a chromosome could affect the functioning of other genes in that chromosome.

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..... **[2]**

**Question 11 · A level Paper 2 · June 2017 · Q19(b)(iv) · 1 mark**

**(iv)** One type of gene is known as a homeobox gene.

The base sequences of homeobox genes in humans and chimpanzees are almost identical.

What conclusions about the evolutionary relationship between humans and chimpanzees can be drawn from this piece of evidence?

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..... **[1]**

**Question 12 · A level Paper 2 · November 2020 · Q16(b)(i) · 2 marks**

**(b)** Investigations into the activity of genes that control body plan frequently use fruit flies and mice.

One reason fruit flies are used is that there are fewer public concerns about the ethics of using flies.

**(i)** Suggest **two other** reasons why fruit flies are chosen for research into genes controlling the development of body plan.

1 .....

.....

2 .....

.....

**[2]**


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**(b)** Sickle cell disease is a genetic disease that results from a substitution mutation in one of the genes that code for haemoglobin.

**Fig. 16.2** below shows part of the mRNA sequence that codes for normal haemoglobin and the corresponding sequence of amino acids.

| | | | | | |
|---|---|---|---|---|---|
| **mRNA** | ACU | CCU | GAG | GAG | AAG |
| **Amino acids** | 1 | 2 | glutamic acid | glutamic acid | lysine |

**Fig. 16.2**

**Fig. 16.3** is a representation of the genetic code.

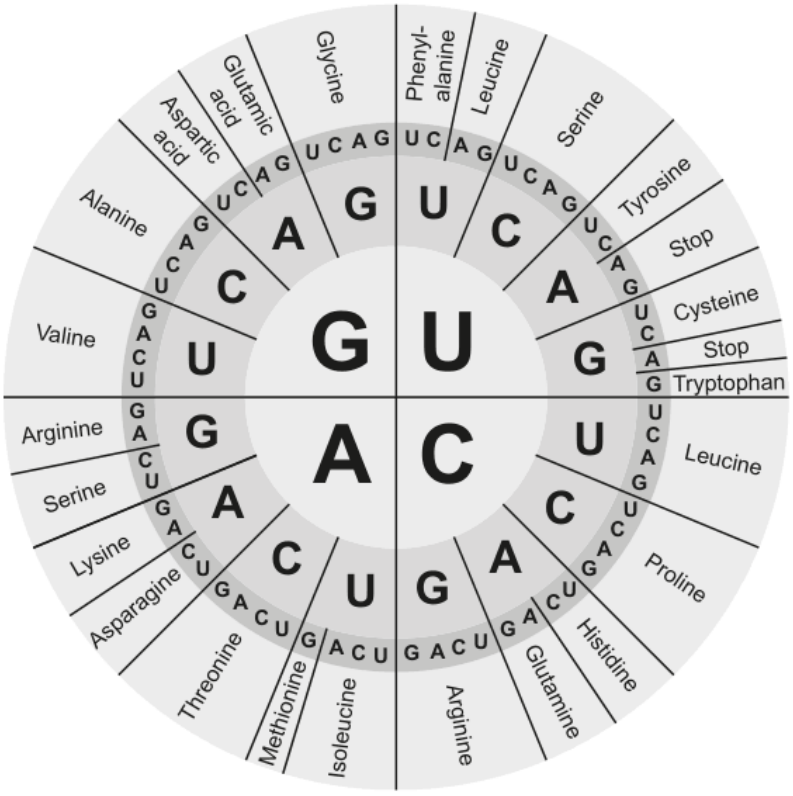



**Fig. 16.3**

**(i)** Use **Fig. 16.3** to identify the missing amino acids 1 and 2 in **Fig. 16.2**.

1 .....

2 .....

**[2]**


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**Question 13 · A level Paper 2 · June 2022 · Q16(b)(iv) · 6 marks**

**(iv)*** In sickle cell disease, the mutated haemoglobin has a reduced ability to carry oxygen.

Some gene mutations do not affect protein function.

Use **Fig. 16.3 and** levels of protein structure to explain why some gene mutations do **not** affect the function of a protein.

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..... **[6]**

Additional answer space if required.

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Turn over


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**Question 14 · A level Paper 3 · June 2023 · Q6 · 6 marks**

**6*** Homeobox genes, including Hox genes, code for transcription factors and regulate the expression of structural genes.

Describe the general roles of homeobox genes in the human body **and** suggest the roles of these genes in the development of the brain.

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Additional answer space if required.

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Turn over


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**Question 15 · A level Paper 2 · June 2025 · Q16(c) · 6 marks**

**(c)*** The development of body form begins in embryonic stem cells.

Using examples, explain the importance of mitosis **and** apoptosis as mechanisms controlling the development of body form.

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Extra answer space if required.

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## Mark schemes

**Question 1 · A level Paper 2 · June 2022 · Q22(a) · 5 marks**

| | | | | |
|---|---|---|---|---|
| **22** | **(a)** | | environmental ✓<br>stimuli ✓<br>apoptosis ✓<br>enzymes ✓<br>phagocytes / phagocytosis ✓ | **5** |

| | |
|---|---|
| 1.2 | **ALLOW** stress / factors<br>**ALLOW** proteases / caspases<br>**IGNORE** lysosomes<br>**ALLOW** macrophages / endocytosis |

**Question 2 · A level Paper 2 · June 2022 · Q22(b) · 1 mark**

| | | | | |
|---|---|---|---|---|
| **(b)** | Hox / homeotic / homeobox ✓ | **1** | 1.2 | **IGNORE** regulatory |

**Question 3 · A level Paper 2 · November 2020 · Q16(a) · 5 marks**

| | | | | |
|---|---|---|---|---|
| **16** | **(a)** | homeobox ✓<br>DNA ✓<br>transcription ✓<br>plant ✓<br>kingdoms ✓ | **5** | 1.1 |


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**Question 4 · A level Paper 2 · November 2021 · Q16(c)(i) · 2 marks**

| | | | | |
|---|---|---|---|---|
| **16** | **(c)** | **(i)** | editing of primary , mRNA / transcript ✓<br>not present in mature mRNA ✓<br>not translated ✓<br>regulatory , sequences / genes ✓ | **2 max** |

| | |
|---|---|
| 1.2 | **IGNORE** introns are non-coding (as this is not an explanation)<br>**ALLOW** introns removed<br>**ALLOW** used to make , tRNA / rRNA |

**Question 5 · A level Paper 2 · November 2021 · Q16(c)(ii) · 1 mark**

| | | | | |
|---|---|---|---|---|
| **(ii)** | not selected against / AW ✓ | **1** | 2.5 | **ALLOW** doesn't affect survival |

**Question 6 · A level Paper 3 · June 2025 · Q4(b) · 2 marks**

| | | | |
|---|---|---|---|
| **4** | **(b)** | | removal of , introns / non-coding mRNA ✓<br>joining / rearrangement , of , exons / coding mRNA ✓<br>RNA editing ✓<br>AVP ✓ |

| | | |
|---|---|---|
| **2 max** | 1.2 | **ALLOW** 'spliced out' for 'removed'<br>**ALLOW** 'spliced' for 'joined'<br>e.g. (5') capping of mRNA **or** addition of poly-A tails in mRNA<br>e.g. ref. spliceosome |


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**Question 7 · A level Paper 2 · June 2017 · Q20(b)(iii) · 2 marks**

| | |
|---|---|
| **(iii)** | (mammal diet high in milk, so) high lactose concentration ✓<br><br>(structural) gene for protein channel / lactose permease gene / lac Y , is , transcribed / expressed / switched on ✓<br><br>(protein is) lactose permease ✓ |

| | |
|---|---|
| **2 max** | **ORA** for older mammals<br>**ALLOW** lactose is present<br><br>**ALLOW** description of lactose causing repressor protein to leave operator<br>**ALLOW** *lac* operon is switched on |

**Question 8 · A level Paper 3 · June 2018 · Q1(c)(iii) · 2 marks**

| | | | | | |
|---|---|---|---|---|---|
| | | **iii** | B, produces / codes for, repressor protein / repressor polypeptide / enzyme / transcription factor ✓<br><br>(protein / polypeptide / product of B) binds to, promoter (of A) / mRNA / ribosome ✓<br>(product of allele B) stops, transcription / translation (of allele A) / protein synthesis / described✓<br><br>product of B inhibits the enzyme (encoded by A) ✓ | **2 max** | **IGNORE** ref to genes instead of alleles<br>**IGNORE** B is a regulatory gene<br><br>**IGNORE** binds to operator<br><br>**IGNORE** 'allele B turns off allele A'<br>**ALLOW** 'product of allele B stops production of (named) product of allele A'<br>**DO NOT ALLOW** 'B produces an enzyme which breaks down pigment produced by A'(as this is happening after expression of allele A) |

**Question 9 · A level Paper 3 · June 2025 · Q6(a)(ii) · 1 mark**

| | | | | | | |
|---|---|---|---|---|---|---|
| **6** | **(a)** | **(ii)** | shorter (protein/chain) **and** (because early) stop codon (has been introduced) ✓ | **1** | 2.5 | **ALLOW** 'unfinished / truncated / incomplete / fewer amino acids in the chain' for 'shorter'<br>**ALLOW** 'nonsense mutation' for 'stop codon'<br>**CON** frameshift / silent mutation / missense |


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**Question 10 · A level Paper 2 · June 2019 · Q17(b)(ii) · 2 marks**

| | |
|---|---|
| **(ii)** | frameshift ✓<br>altered triplet(s) ✓<br>adjacent / nearby , genes (on same chromosome) switched , on / off ✓<br>*idea that* new gene could disable a functioning gene if inserted into it ✓ |

| | |
|---|---|
| **2 max** | **IGNORE** mutation without further qualification<br>**ALLOW** altered codons<br>**ALLOW** affects , transcription / expression , of the next gene along<br>**ALLOW** inserted into promoter |

**Question 11 · A level Paper 2 · June 2017 · Q19(b)(iv) · 1 mark**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **(iv)** | no / little , because , homeobox genes / they , are highly conserved (within animal kingdom) ✓<br>(only) that humans and chimpanzees , belong to the same kingdom / are animals ✓ | **1 max** | | |
| | | | **Total** | **13** | | |


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**Question 12 · A level Paper 2 · November 2020 · Q16(b)(i) · 2 marks**

| | | | |
|---|---|---|---|
| **(b)** | **(i)** | **1** | low cost ✓ |
| | | **2** | rapid reproduction (rate) / more generations in a given time ✓ |
| | | **3** | *idea that* fruit fly genetics / development is well understood ✓ |
| | | **4** | simple , genetics / body plan ✓ |
| | | **5** | (many) mutations / structures , observable with , light / low powered , microscope ✓ |

| | | |
|---|---|---|
| **2 max** | 3.4 | **1 ALLOW** easy to keep<br>**1 IGNORE** small<br>**2 ALLOW** short lifespan / grow quickly |

**Question 13 · A level Paper 2 · June 2022 · Q16(b)(iv) · 6 marks**

| | | | | | | |
|---|---|---|---|---|---|---|
| | | **(iv)*** | ***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** | | | |
| | | | **Level 3 (5–6 marks)**<br>Explains in detail why mutations may leave the function of a protein unchanged using Fig 16.3 **and** referring to more than one level of protein structure.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3–4 marks)**<br>Explains why mutations may leave the function of a protein unchanged using Fig 16.3 **and** referring to protein structure.<br><br>*There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br>Suggests why mutations may leave the function of a protein unchanged using Fig 16.3 **or** referring to protein structure.<br><br>*There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*<br><br>**0 marks**<br>*No response or no response worthy of credit.* | **6** | 2.1 | **Indicative points may include**<br><br>*Mutations*<br>• genetic code is degenerate<br>• point mutation might code for the same amino acid<br>• use of example from Fig 16.3 to support<br><br>*Protein structure and function*<br>• haemoglobin function is dependent on tertiary structure<br>• silent mutation would leave primary structure unchanged<br>• unchanged primary structure would leave tertiary structure unchanged<br>• substitution of amino acid with similar properties to the original amino acid might leave tertiary or secondary structure unchanged<br>• mutation might change part of the tertiary structure away from the functional part of the protein, e.g. away from the active site of an enzyme |


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## Question 14 · A level Paper 3 · June 2023 · Q6 · 6 marks

| | | | | | | |
|---|---|---|---|---|---|---|
| 6* | | | ***Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.*** | | | |
| | | | **Level 3 (5-6 marks)**<br>A detailed description of the general roles of homeobox genes **and** valid suggestions for the roles in the development of the brain.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3-4 marks)**<br>A description of the general role of homeobox genes **and** a valid suggestion for a role in the development of the brain.<br><br>*There is a line of reasoning with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1-2 marks)**<br>An outline of the general role of homeobox genes **or** a valid suggestion for a role in the development of the brain.<br><br>*The information is basic and communicated in an unstructured way. The information is supported by limited evidence and the relationship to the evidence may not be clear.*<br><br>**0 marks**<br>No response or no response worthy of credit. | **6** | **1.2**<br>**2.5** | **Indicative scientific points may include (but are not limited to):**<br><br>*General roles*<br>• determine overall body plan<br>• switch different genes on and off in different cells and tissues<br>• (and therefore) determine cell identity<br>• expressed in a set order during development<br>• regulate patterning and positioning of (named) structures<br>• determine polarity<br>• regulate levels of apoptosis and mitosis<br><br>*Roles in brain development*<br>• determine the head and tail regions / anterior and posterior regions and therefore where the brain and spinal cord will develop<br>• expressed in a set order to determine (named) regions of the brain<br>• and neural organisation in the brain<br>• switch genes on or off in the brain<br>• to form specialised, neurones / nerve cells<br>• regulate mitosis and apoptosis of neurones to adjust neural organisation |
| **Question** | | | **Answer** | **Mark** | **AO Element** | **Guidance** |

## Question 15 · A level Paper 2 · June 2025 · Q16(c) · 6 marks

| | | | | | | |
|---|---|---|---|---|---|---|
| **16** | **(c) *** | | Please refer to the marking instructions on page 4 of this mark scheme for guidance on how to mark this question.<br><br>**Level 3 (5–6 marks)**<br><br>Explains in detail the importance of mitosis **AND** apoptosis as mechanisms controlling the development of body form with examples.<br><br>*There is a well-developed line of reasoning which is clear and logically structured. The information presented is relevant and substantiated.*<br><br>**Level 2 (3–4 marks)**<br><br>Explains the importance of mitosis **AND** apoptosis as mechanisms controlling the development of body form with at least one example.<br><br>*There is a line of reasoning presented with some structure. The information presented is relevant and supported by some evidence.*<br><br>**Level 1 (1–2 marks)**<br><br>Explains the importance of mitosis **OR** apoptosis as mechanisms controlling the development.<br><br>*There is an attempt at a logical structure with a line of reasoning. The information is in the most part relevant.*<br><br>**0 marks**<br><br>*No response or no response worthy of credit.* | **6** | **1.2** | **Indicative points may include**<br><br>*Mitosis*<br>• produces genetically identical cells<br>• increases number of cells for growth **or** used to grow , tissues / organs / organisms<br>• ref. Hayflick limit<br><br>*Apoptosis*<br>• programmed / controlled cell death<br>• removes damaged / old / unnecessary cells<br>• ref. to phagocytosis<br><br>*Either mitosis or apoptosis*<br>• stimulated by some genes and repressed by others<br>• (genes / cells) respond to internal and external stimuli<br>• under control of homeotic genes / regulatory genes / transcription factors<br>• prevents, tumour formation / cancer<br>• during development of embryo / fetus / child / organs<br>• idea of rate of mitosis greater than rate of apoptosis during fetal development<br><br>*Examples could include (from the animal kingdom)*<br>• digit separation / removing webbing / preventing polydactyl / syndactyly<br>• tadpoles losing tails / metamorphosis (tadpole to frog)<br>• development of any named body part (not at cellular level)<br>• development of neurones / synapses<br>• removing immune system cells / preventing autoimmune diseases<br>• **IGNORE** – examples of tissue repair<br><br>**Aspects of the communication statement might typically n have been met when irrelevant / incorrect information (e.g. cell growth, detail of stages of mitosis) has been included.** |
| **Question** | | | **Answer** | **Mark** | **AO** | **Guidance** |


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