**Q1.**

This question is about mitosis in cells.

The image below shows the arrangement of the genetic material in a cell during prophase.

(a)  Describe and explain the arrangement of the genetic material shown in the above image.

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**(2)**

(b)  The diploid number of chromosomes in the body cell of an insect species is four.

Tick (**✓**) the box next to the diagram **A**, **B**, **C** or **D** that represents the appearance of chromosomes in a cell during metaphase in this species.

**(1)**

(c)  Name the fixed position occupied by a gene on a DNA molecule.

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**(1)**

(d)  Describe how a gene is a code for the production of a polypeptide. Do **not** include information about transcription or translation in your answer.

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**(3)**

**(Total 7 marks)**

**Q2.**

(a)     The nucleus and a chloroplast of a plant cell both contain DNA.

Give **three** ways in which the DNA in a chloroplast is different from DNA in the nucleus.

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2  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(3)**

(b)  Some DNA nucleotides have the organic base thymine, but RNA nucleotides do not have thymine. RNA nucleotides have uracil instead of thymine.

Give **one** other difference between the structure of a DNA nucleotide and the structure of an RNA nucleotide.

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**(1)**

The diagram shows a tRNA molecule.

(c)  Name the structures labelled **W** and **X** in the diagram.

**W** \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**X**  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(d)  Not all mutations in the nucleotide sequence of a gene cause a change in the structure of a polypeptide.

Give **two** reasons why.

1  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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2  \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

**(Total 7 marks)**

**Q3.**

The diagram shows part of a DNA molecule.

(a)     Name the **two** components of the part of the DNA molecule labelled **M**.

1. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(b)     What is the maximum number of amino acids for which this piece of DNA could code?

**(1)**

(c)     Scientists calculated the percentage of different bases in the DNA from a species of bacterium. They found that 14% of the bases were guanine.

(i)      What percentage of the bases in this species of bacterium was cytosine?

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(ii)     What percentage of the bases in this species of bacterium was adenine?

Answer \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

(d)     The scientists found that, in a second species of bacterium, 29% of the bases were guanine.

Explain the difference in the percentage of guanine bases in the two species of bacterium.

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**(2)**

**(Total 7 marks)**

**Q4.**

(a)     Describe how mRNA is produced from an exposed template strand of DNA.

Do **not** include DNA helicase or splicing in your answer.

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**(3)**

(b)     Define the term exon.

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**(1)**

The table below shows **mRNA** codons for some amino acids.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Serine** | **Proline** | **Glycine** | **Threonine** | **Alanine** |
| UCU | CCU | GGA | ACU | GCA |
| UCC | CCA | GGG | ACC | GCG |

(c)     **Figure 1** shows the DNA template nucleotide base sequence that determines the sequence of four amino acids.

**Figure 1**

**AGG**    **CGT**    **CCT**    **GGA**

Use information from the table and **Figure 1** to give the amino acid sequence determined by this sequence of nucleotides.

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**(1)**

(d)     A mutation in the nucleotide sequence shown in **Figure 1** resulted in the following amino acid sequence.

**Figure 2**

**Serine**    **Glycine**    **Glycine**    **Proline**

A student concluded that the mutation involved the addition of one nucleotide within the sequence shown **Figure 1**. Does information in this question support the student’s conclusion? Give reasons for your answer.

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**(2)**

**(Total 7 marks)**

**Q5.**

(a)     DNA is a polymer of nucleotides. Each nucleotide contains an organic base.

Explain how the organic bases help to stabilise the structure of DNA.

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**(2)**

(b)     Triplets of bases in a DNA molecule code for the sequence of amino acids in a polypeptide. The genetic code is frequently written as the three bases on mRNA that are complementary to a triplet on DNA. **Table 1** shows what different combinations of bases on mRNA code for. The names of amino acids are abbreviated. For example, ‘Ala’ stands for alanine.

|  |
| --- |
| **Table 1** |
| **First base** | **Second base** | **Third base** |
| **Guanine (G)** | **Adenine (A)** | **Cytosine (C)** | **Uracil (U)** |
| **G** |  GGG    Ala GGA    Gly GGC    Gly GGU    Gly |  GAG    Glu GAA    Glu GAC    Asp GAU    Asp |  GCG    Ala GCA    Ala GCC    Ala GCU    Ala |  GUG    Val GUA    Val GUC    Val GUU    Val | **G****A****C****U** |
| **A** |  AGG    Arg AGA    Arg AGC    Ser AGU    Ser |  AAG    Lys AAA    Lys AAC    Asn AAU    Asn |  ACG    Thr ACA    Thr ACC    Thr ACU    Thr |  AUG    Met AUA    Iso AUC    Iso AUU    Iso | **G****A****C****U** |
| **C** |  CGG    Arg CGA    Arg CGC    Arg CGU    Arg |  CAG    Gln CAA    Gln CAC    Hist CAU    Hist |  CCG    Pro CCA    Pro CCC    Pro CCU    Pro |  CUG    Leu CUA    Leu CUC    Leu CUU    Leu | **G****A****C****U** |
| **U** |  UGG    Trp UGA    **stop** UGC    Cyst UGU    Cyst |  UAG    **stop** UAA    **stop** UAC    Tyr UAU    Tyr |  UCG    Ser UCA    Ser UCC    Ser UCU    Ser |  UUG    Leu UUA    Leu UUC    Phe UUU    Phe | **G****A****C****U** |

Suggest **one** advantage of showing the genetic code as base sequences on mRNA, rather than triplets on DNA.

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**(1)**

(c)     What name is given to a group of three bases on mRNA that codes for an amino acid?

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**(1)**

(d)     Use information from **Table 1** to explain why the genetic code is described as degenerate.

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**(2)**

(e)     Suggest the role of the mRNA base triplets UGA, UAG and UAA.

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**(2)**

(f)      **Table 2** shows the sequence of mRNA bases forming part of a single gene.

|  |
| --- |
| **Table 2** |
| Base on DNA template |   |   |   |   |   |   |   |   |   |
| Base on mRNA | G | U | G | U | A | C | U | G | G |
| Encoded amino acid |   |   |   |

Complete **Table 2** to show the base sequence of the DNA template from which this mRNA was transcribed and the encoded amino acid sequence.

**(2)**

**(Total 10 marks)**

**Q6.**

(a)     The genetic code is **degenerate** and **non-overlapping**.

Explain the meaning of:

Degenerate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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Non-overlapping \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**(2)**

The table shows a short section of a messenger RNA (mRNA) molecule and the section of a polypeptide for which it codes.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **mRNA** | G G G | G C U | U C A | C C G | G C A | A C G |
| **Polypeptide** | glycine | alanine | serine | proline | alanine | threonine |

(b)     Name the bases represented in the table by:

A \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

C \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

G \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

U \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(2)**

(c)     Use information in the table to give the sequence of bases in **DNA** that codes for serine.

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**(1)**

**(Total 5 marks)**