Nucleotides & Nucleic Acids

Model Answers 2

Level	A Level
Subject	Biology
Exam Board	OCR
Module	Foundations in Biology
Topic	Nucleotides & Nucleic Acids
Booklet	Model Answers 2

Time allowed: **49 minutes**

Score: **/36**

Percentage: **/100**

Grade Boundaries:

A*	A	B	C	D	E
>69%	56%	50%	42%	34%	26%

Question 1

The genetic code carries instructions for the synthesis of polypeptides.

(a) **(i)** State the number of DNA nucleotide bases that code for a single amino acid. **[1]**

- **3**

Three bases on the mRNA make up a codon, which is read and a specific amino acid is coded for.

(ii) There is a maximum of 64 different base combinations in DNA that could each code for an amino acid.

How is this number of combinations calculated? **[1]**

- **4 x 4 x 4.**

For each of the three base positions in the codon, there are 4 potential amino acids (A,C,G,T)

(iii) Twenty different amino acids are commonly used for protein synthesis. In theory, this would need only 20 different base combinations.

Explain the uses of the remaining 44 combinations. **[2]**

- This is because there are several codons that differ in their triplet base sequence, but code for the **same amino acid.**
- Some of these codons are used as **start** and **stop codons**.
- Therefore **mutations** may not result in a change in amino acid **(silent mutation)**.

(iv) Which nucleotide bases are common to DNA and RNA? **[1]**

- **Adenine (A), Cytosine (C), and Guanine (G)** are all common to DNA and RNA.

RNA has the base Uracil instead of Thymine (which DNA has).

(b) Describe how a nucleotide base sequence in a gene is used to synthesise a polypeptide.

In your answer you should describe the steps of the process in the correct order.

[7]

By **transcription**, the **gene** sequence on the template strand of DNA is copied into **mRNA**:

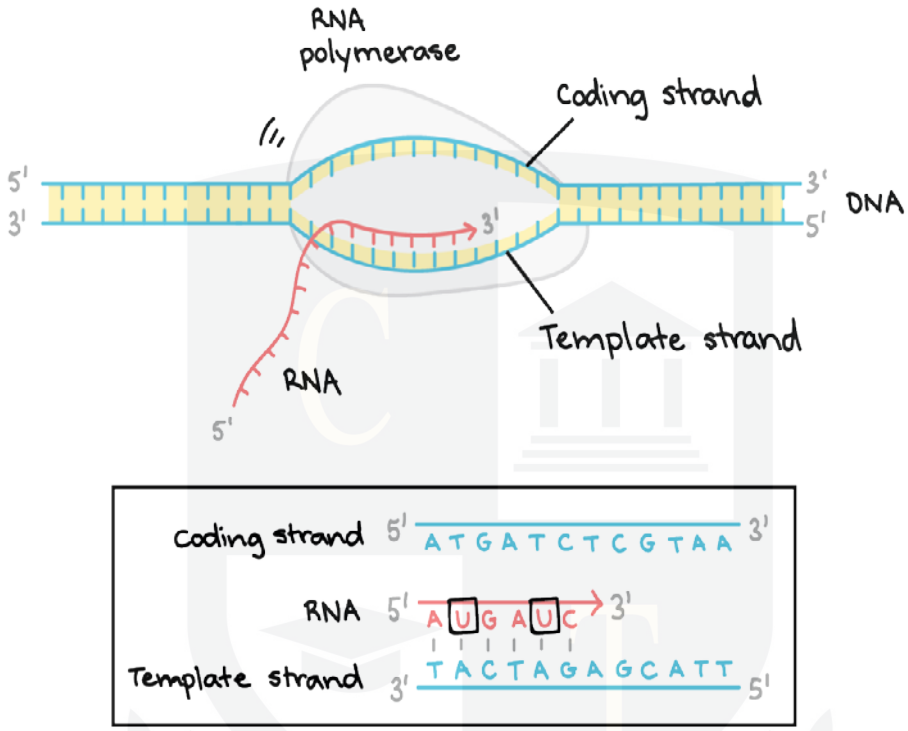
- After a DNA strand unzips, **free RNA nucleotides** in the nucleus will line up to form **complementary base pairs**.
- The **one strand** of DNA bases acts as a template.
- mRNA is then formed by **RNA polymerase**.

Then begins the process of **translation**:

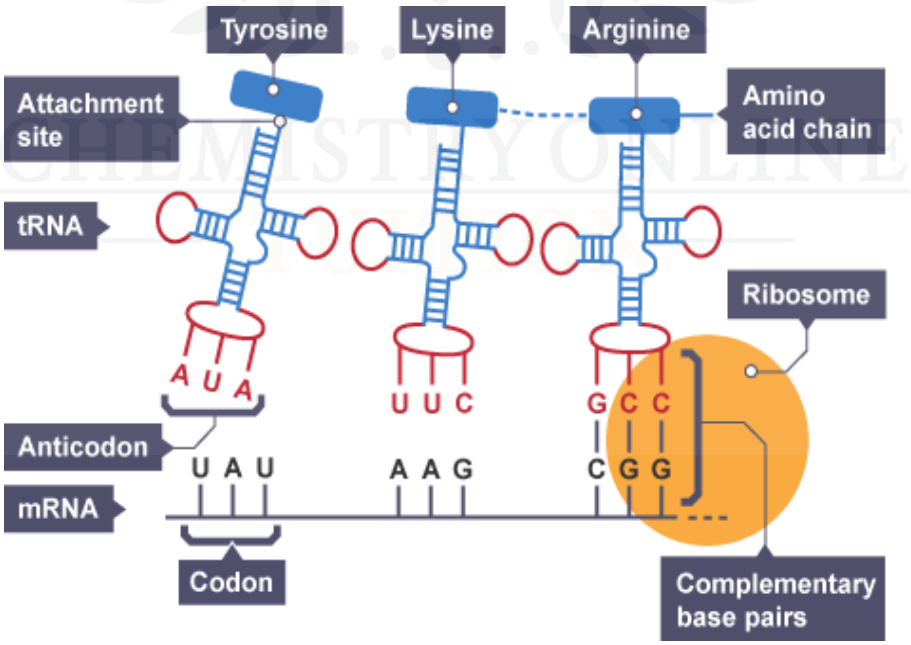
- The mRNA strand moves to the **ribosomes**.
- **tRNA** molecules bind to **mRNA**
- **tRNA** have **anticodons** that pair with the **mRNA codons**
- **Specific amino acids** are attached to each tRNA molecule
- **Peptide bonds form** between adjacent amino acids which will form the **polypeptide**.

***Exam tip**: In order to gain QWC marks in this question, you need to include details about BOTH transcription AND translation.*

A diagram to show the process of transcription in the nucleus:



A diagram to show the process of translation:



[Total: 12]

Question 2

Fig. 5.1 is a circular representation of the genetic code.

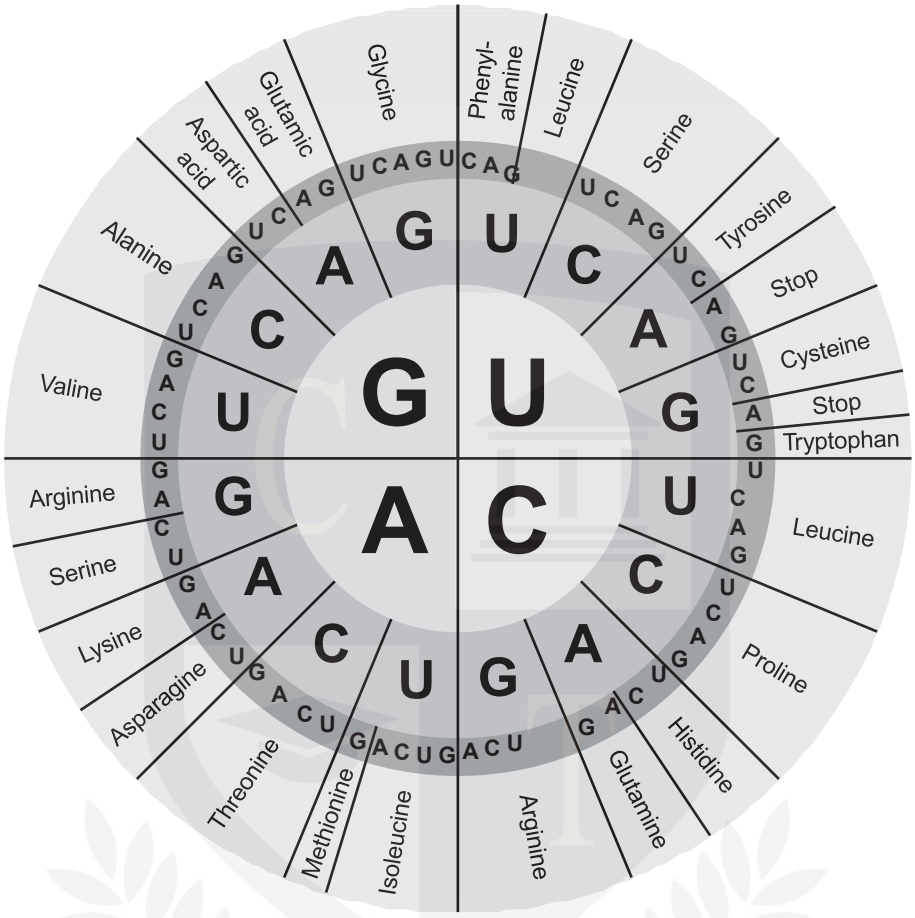


Fig. 5.1

(a) Fig. 5.2 shows a sequence of bases coding for a sequence of amino acids. The name of the third amino acid in the sequence has been filled in.

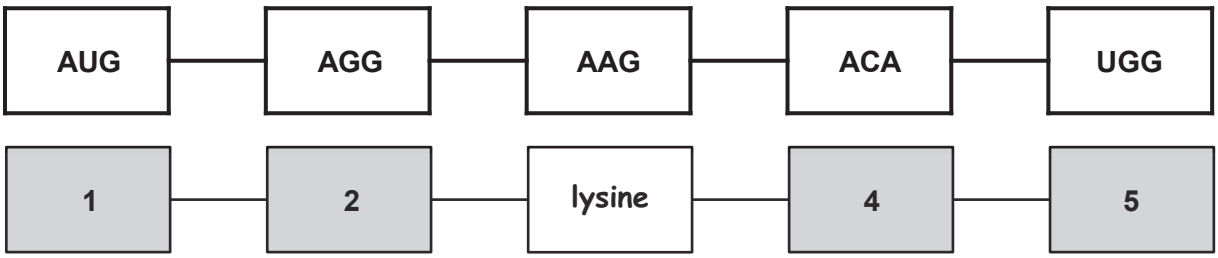


Fig. 5.2

Identify the remaining amino acids in the sequence. **[2]**

1 .....methionine.....

2 .....arginine.....

3 lysine

4 .....threonine.....

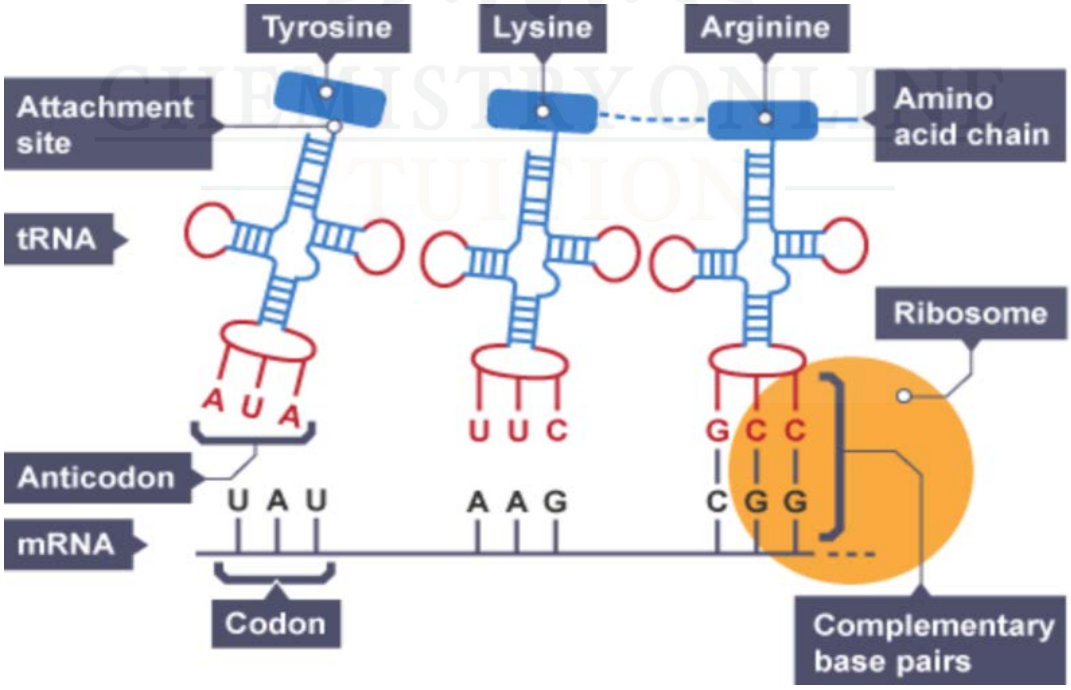
5 .....tryptophan.....

Using the diagram start from the centre and follow to the edge reading the letters, one base per ring of the circle.

(b) State the name of the stage of protein synthesis represented in Fig.5.2 **and** name the organelle in the cell where this takes place. **[2]**

Translation, this takes place at the **ribosomes.**

A diagram to show the process of translation:



(c) Identify the type of nucleic acid that holds the sequence of bases shown in Fig. 5.2. **[2]**

mRNA – messenger RNA

(d) Using the information in **Fig. 5.1**, list the **three** triplet codons that would cause termination of a polypeptide chain (stop codons) **and** explain why these codons have this effect.

[2]

UAA, UAG, UGA – these are all 'stop' codons and they **do not code for an amino acid**

(e) What name would be given to a mutation that resulted in a change of the codon **UUU** to **UUC**?

[1]

A **silent mutation**

Both UUU and UUC code for the same amino acid so will have no effect on the primary structure of the polypeptide. This is also a type of point/substitution mutation, where only one base is changed.

[Total: 9]

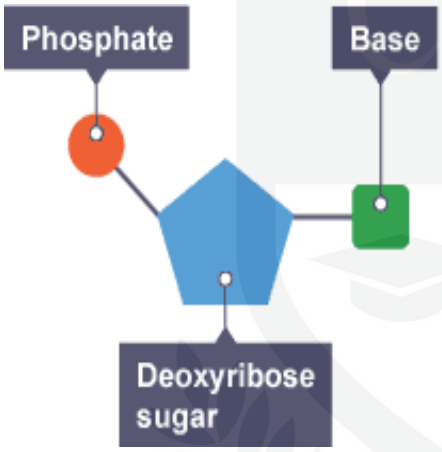
Question 3

DNA and RNA are nucleic acids.

(a) **(i)** State the components of a **DNA** nucleotide. **[3]**

***Exam tip**: Make sure you are careful with exactly what you write here*

- Deoxyribose sugar
- Phosphate group
- Nitrogenous base



(ii) Describe how the structure of RNA differs from that of DNA. **[2]**

RNA is:

- **single** stranded (DNA is double)
- contains the **nitrogenous** base **uracil** instead of **thymine** in DNA
- Has **ribose** sugar (DNA has deoxyribose)
- There are three forms of RNA (only one kind of DNA): messenger, transfer and ribosomal

(b) Before a cell divides, the DNA needs to be accurately replicated.

Describe how a DNA molecule is replicated.

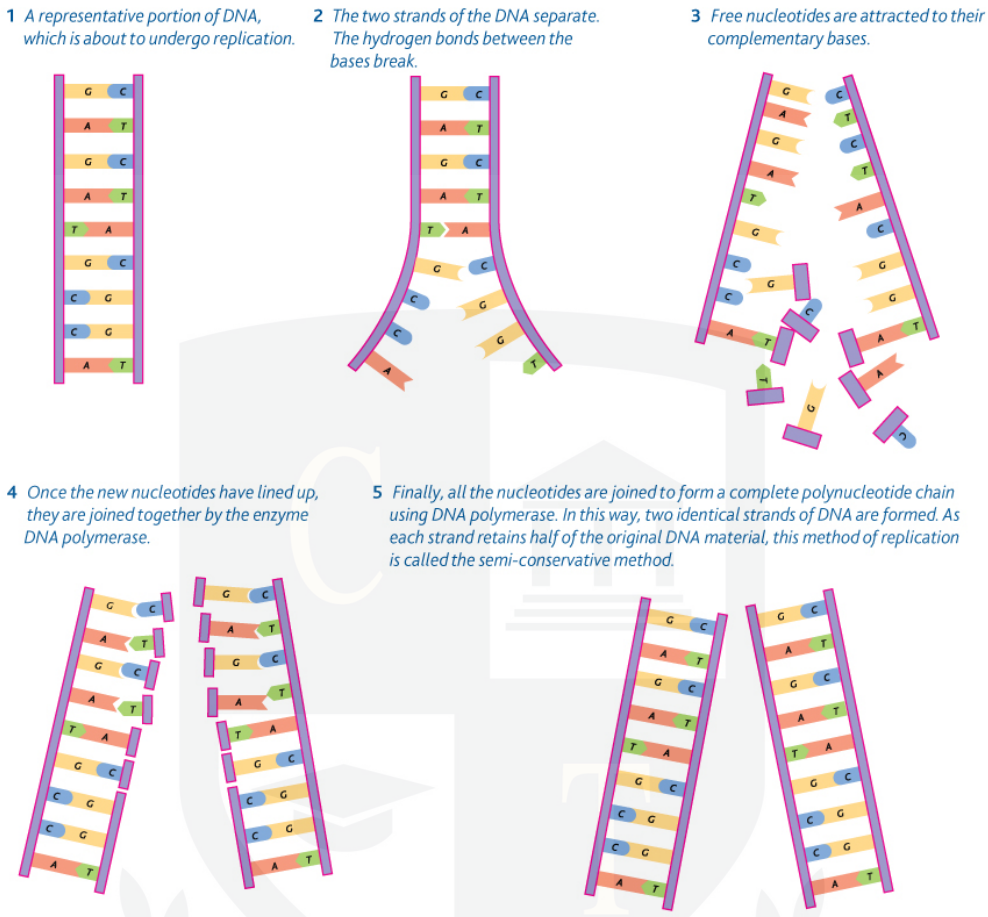
In your answer you should make clear how the steps in the process are sequenced.

[7]

***Exam tip**: To gain marks in this question, you need to consider the order in which you write your points. Try to structure your answer to describe the process from start to finish*

- DNA replicates via **semi-conservative replication**:
- The DNA double helix **unwinds** (by enzyme DNA gyrase)
- The DNA double helix **unzips** (by enzyme **DNA helicase**)
- and the **hydrogen** bonds between bases are broken
- Both strands are then free to act as **templates**
- where free DNA **nucleotides**
- that are **complementary** to the sequence of the template strand align
- (in the 5' to 3' direction)
- C binds to G (3 H bonds) and T binds to A (2 H bond)
- and **hydrogen bonds** reform between them
- The **sugar-phosphate backbone** is then reformed by **DNA polymerase**,
- connected by **phosphodiester** (covalent) bonds

Diagram showing semi-conservative DNA replication:



(c) **(i)** State what a gene codes for. **[1]**

A **polypeptide/ primary structure**

(ii) Suggest how changing the sequence of DNA nucleotides could affect the final product the DNA codes for. **[2]**

- Because different nucleotides result in a different sequence of amino acids (**primary structure**)
- which produces a different **secondary** & **tertiary** structure
- This may result in a different protein which may no longer function or have a different function

  (for example the active site of an enzyme may no longer be complimentary to the substrate)

[Total: 15]