Model Answers: Hard

1

The correct answer is **A** because:

- Ribosomes are **ribonucleoprotein complexes**, which mean they consist of ribosomal RNA (**rRNA**) and **protein** together in the same structure.
- The proteins aid in maintaining ribosome structure and can have functional roles and are found in both ribosome subunits.
- Ribosomes are made of a **small (30S)** subunit and a **larger (50S)** subunit.
- The interface between the subunits is where mRNA binds, and the **aminoacylated** (amino acid bound) **tRNAs** bind to and are stabilised by the 50S subunit.
- The 50S subunit also catalyses the formation of **peptide bonds** between amino acids and therefore makes the structure a **ribozyme** (RNA is used in the catalysis, rather than protein in enzymes).

B is incorrect as	there are no **lipids** involved in protein synthesis.
C is incorrect as	**mRNA** is not part of the ribosome structure, it binds to the ribosome subunits to undergo translation.
D is incorrect as	**tRNAs** are not part of the ribosome structure, their **anti-codons** associate with the mRNA codons in order to add the correct amino acid to the growing polypeptide chain. tRNAs are held in place and stabilised by the ribosome but are **not** part of the **ribosome** structure.

2

The correct answer is **C** because:

- Each amino acid is coded for by **3 bases**.
- Therefore, if there is a substitution mutation on the 10th base this will affect the **4th amino acid** (10 ÷ 3 = 3.3) which is lysine.
- Specifically, if the 10th base is changed, the mutation will be of the 1st base in the lysine.

Originally:

Amino acid code: alanine – alanine – valine – lysine – valine – serine

DNA code: GCT GCT GTA **A**AA GTA TCG

After substitution:

DNA code: GCT GCT GTA **T**AA GTA TCG

Amino acid code: alanine – alanine – valine – STOP

3

The correct answer is **A** because:

- The **ribosomes** of humans are **slightly bigger** (80S) in size than the ribosomes of bacteria (70S).
- Both have **two subunits** however the structure is slightly different.
- Antibiotics are the correct **shape** that when they bind to the bacteria ribosome the antibiotic jams the movement along the **mRNA**.
- Stopping protein synthesis will kill bacteria cells as they cannot produce any enzymes, structural proteins or transport proteins needed to survive.
- If antibiotics bind to human ribosomes there are no areas that the antibiotic can bind to and therefore protein synthesis is not disrupted.

B is incorrect as	**antibiotics** do **not** recognise antigens, they enter all cells and will try to bind to what they can. This is why it is important research is done into their shape and binding so no human processes are affected.
C is incorrect as	**DNA** is **not** involved in translation, which occurs at ribosomes, and therefore its position in the cell will not affect the antibiotics function.
D is incorrect as	all DNA nucleotides are the same: adenine, thymine, guanine and cytosine.

4

The correct answer is **A** because:

- All DNA is a **double stranded molecule** with a sequence of **complementary nucleotides** held together by **hydrogen bonding**.
- The DNA complementary nucleotide pairs are: Adenine with thymine, attached by two hydrogen bonds, and guanine with cytosine attached by three hydrogen bonds.
- Not all the DNA contains genes, there are long sections of **non-coding DNA** which is not transcribed to produce proteins. These long sections are referred to as 'junk DNA' however they may have some roles in signaling, control and increased risk of certain diseases.

B is incorrect as	a gene **is** a sequence of nucleotides that can be **transcribed** using **RNA polymerase** enzyme and free activated RNA nucleotides, which results in the formation of **mRNA**.
C is incorrect as	a gene **is** a length of DNA which carries **coded information** as a sequence of nucleotides that can result in the formation of a **polypeptide chain**. Each amino acid in a polypeptide chain is coded for by a triplet of nucleotides.
D is incorrect as	a gene **is** a sequence of nucleotides which can be copied by complementary base pairing into an **mRNA** molecule and then be **translated** at a ribosome into a **polypeptide**.

5

The correct answer is **D** because:

- Only **DNA** is involved in **replication** as this is the process of creating two DNA molecules from one original DNA molecule during cell division.
- Both **DNA** and **RNA** are involved in **transcription** because the DNA acts as a template and **RNA polymerase** synthesises a complementary RNA molecule (messenger RNA) of the specific gene. RNA polymerase uses **free RNA nucleotides** to produce **mRNA**.
- **Translation** only requires **RNA,** and three different types at that! **mRNA** binds to ribosomal RNA (**rRNA**) and amino acids coded for by the mRNA are brought to the ribosome by transport RNA (**tRNA**) molecules. The ribosome catalyses the formation of **peptide bonds** between amino acids to produce a protein.
- **Protein synthesis** is the complete process of creating a protein from DNA and includes **transcription**, **post-transcriptional modification** and **translation**. Therefore, both DNA and RNA are involved.

6

The correct answer is **C** because:

- The tRNA **anticodons** have the same sequence as the **template DNA** strand because both are **complementary** to mRNA. However, DNA contains thymine (T) not uracil (U).
- Each amino acid is coded for by **3 bases**.
- Therefore, if the 18th base is deleted this will affect the **6th amino acid** (18 ÷ 3 = 6) which is histidine.
- Specifically, if the 18th base is deleted it will delete the 3rd base in the histidine codon (T in DNA) and cause a **frameshift**.

Originally:

Amino acid code: histidine – glutamine – lysine – alanine – valine – histidine – valine

DNA code: CAT CAG AAA GCT GTA CA**T** GTA

After deletion:

Amino acid code: histidine - glutamine - lysine - alanine - valine - **glutamine**

DNA code: CAT CAG AAA GCT GTA CA**G** TA