UNIVERSITY OF BOLTON

SCHOOL OF CLINICAL AND BIOMEDICAL SCIENCES

BSC (HONS) MEDICAL BIOLOGY

SEMESTER ONE EXAMINATION 2023/24

MOLECULAR GENETICS

MODULE NO: BIO5008

Date: Monday 8th January **Time: 10:00 – 12:30**

INSTRUCTIONS TO CANDIDATES:

Candidates are advised that the examiners attach importance to legibility of writing and clarity of expression. YOU ARE STRONGLY ADVISED TO PLAN AND SHOW WORKINGS FOR YOUR ANSWERS

This examination paper carries a total of 75 marks.

This examination is 2 hours and 30 minutes long.

There are TWO sections on this paper.

Section A: Answer ALL questions.

Section B: Answer TWO questions.

INSTRUCTIONS TO INVIGILATORS:

Please ensure all candidates are provided with a copy of the supplementary document

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Answer **ALL** questions in Section A and **TWO** questions from Section B.

Make use of labelled diagrams where appropriate.

Section A – answer ALL questions
A supplementary document has been provided for this section. If you do not have one please ask an invigilator to provide you with it.

1. As part of a protein expression study, a class of students were asked to clone the gene for insulin into a plasmid vector and use the recombinant plasmid to transform *E. coli* cells. The students opted to use *E. coli* cells that were made chemically competent using a $CaCl_2$ solution.

   a) Calculate the number of grams required to make a 500 mM stock solution of $CaCl_2$ in 250 mL of water. (Molar mass (Mr)= 111g/mol).

   (4 marks)

   b) The 250 mL of $CaCl_2$ stock solution also requires the students to add 50g of glycerol. Glycerol is added to prevent the cells from bursting when frozen. What was the final percentage of glycerol in the stock solution?

   (2 marks)

   c) To make the competent cells, the students were required to resuspend *E .coli* in a total volume of 5 mL of 100 mM $CaCl_2$. Calculate what volume of the original 500 mM stock each student would need to use to make 5mL of $CaCl_2$ at 100 mM.

   (3 marks)

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d) Describe the steps involved in the process of $CaCl_2$ bacterial transformation with a plasmid vector. Specifically, explain the importance of making *E. coli* cells competent and why it is necessary to include a "Heat shock" step.

(6 marks)

2. In figure 1, we have a messenger RNA (mRNA) transcript that has been produced from the results of the cloning experiment.

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  1- CUGCAGGUGG GGCAGGUGGA GCUGGGCGGG GGCCCUGGUG CAUGAGGAGG
 51- UUUGCCCUUG AUGGCCCUGU GGAUGCGCCU CCUGCCCCUG CUGGCGCUGC
101- UGGCCCUCUG GGGACCUGAC CCAGCCGCAG CCUUUGUGAA CCAACACCUG
151- UGCGGCUCAC ACCUGGUGGA AGCUCUCUAC CUAGUGUGCG GGGAACGAGG
201- CUUCUUCUAC ACACCCAAGA CCCGCCGGGA GGCAGAGGAC CUGCAGGUGG
251- GGCAGGUGGA GCUGGGCGGG GGCCCUGGUG CAGGCAGCCU GCAGCCCUUG
301- GCCCUGGAGG GGUCCCUGCA GAAGCGUGGC AUUGUGGAAC AAUGCUGUAC
351- CAGCAUCUGC UCCCUCUACC AGCUGGAGAA CUACUGCAAC UAAGUCAGAA
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Figure 1: mRNA transcript coding for insulin

a) The nucleotide sequence that is underlined in the mRNA transcript is known as a ribosome binding site (RBS). In *E. coli*, what is the specific name given to this sequence and fully describe its use?

(3 marks)

b) In the mRNA transcript there are two codons in **bold** (**AUG** and **UAA**). Explain the role of each of these codons.

(2 marks)

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c) Using the Supplementary document provided, write out the first ten amino acids that are would be produced from the translation of the mRNA transcript in Figure 1.

(5 marks)

[Total 25 marks]

Section B – answer TWO questions

1. Discuss the role of the promoter sequence in gene expression. Using specific examples, explain how gene expression can be controlled either positively or negatively using inducers or repressors.

(25 marks)

2. Summarise the structure of DNA and outline the **THREE** experiments that first pointed to DNA being the genetic material in cells.

(25 marks)

3. In as much detail as possible, outline the process of translation in prokaryotes and explain any differences that occur in eukaryotic protein synthesis.

(25 marks)

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4. The central dogma theory explains how we can convert a four-letter DNA code into a 20-letter amino acid code. Using at least two detailed examples, explain how mutations in the genetic code can result in non-functioning protein variants that are responsible for genetic disease.

(25 marks)

5. Outline the role of reverse transcriptase as a tool in molecular biology. Describe THREE different techniques in which it can be used to provide genetic information.

(25 marks)

[Total 50 marks]

END OF QUESTIONS

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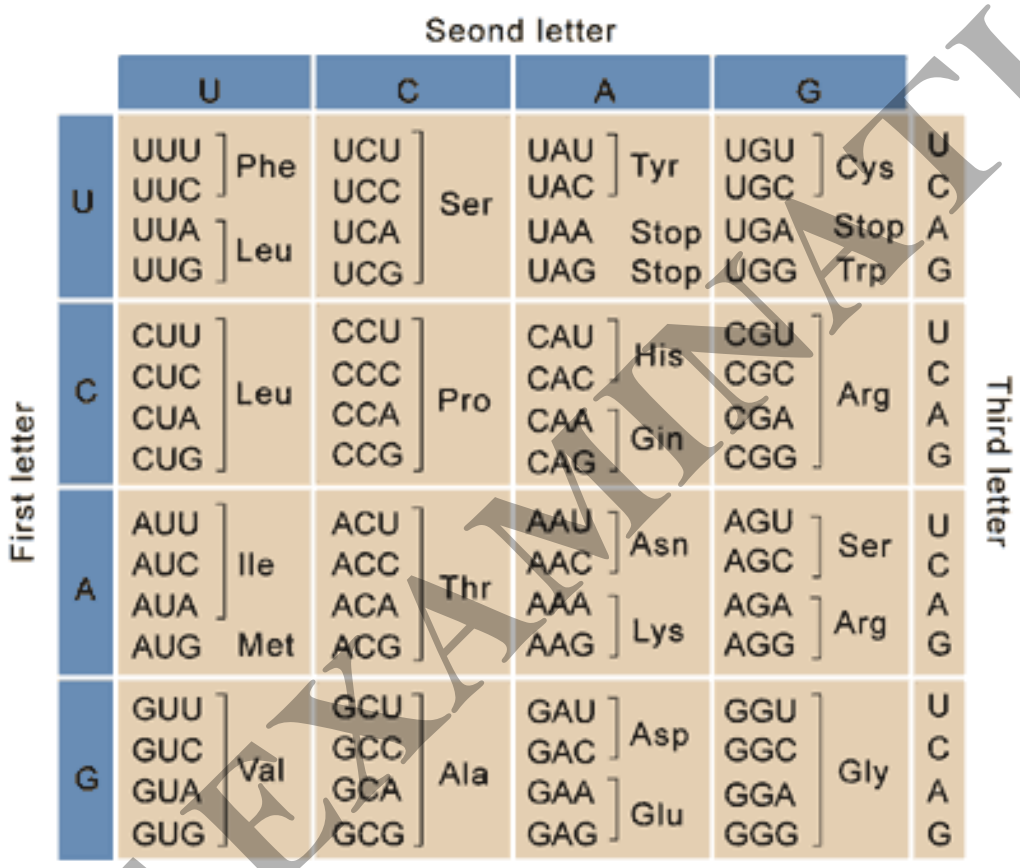
Supplementary document



Supplementary Figure 1: Amino Acid Codon Table