6. Scientists can quantify the rate of translation as ribosomes move along an mRNA from one codon to the next. Using a procedure called ribosome profiling, the scientists measured how long a ribosome remains stationary at each codon of each mRNA. They determined the average translation rate across all codons is 5.2 amino acids per second but that the average translation rate for specific codons in different mRNA sequences can vary widely. These variations in translation rates are thought to facilitate correct folding of the protein being produced. The rate at which three different codons were translated was measured in 100 different mRNAs. The scientists determined the distribution of rate (number of times each rate was recorded) for each of the three codons: GAC (Figure 1A), AUU (Figure 1B), and UGG (Figure 1C).

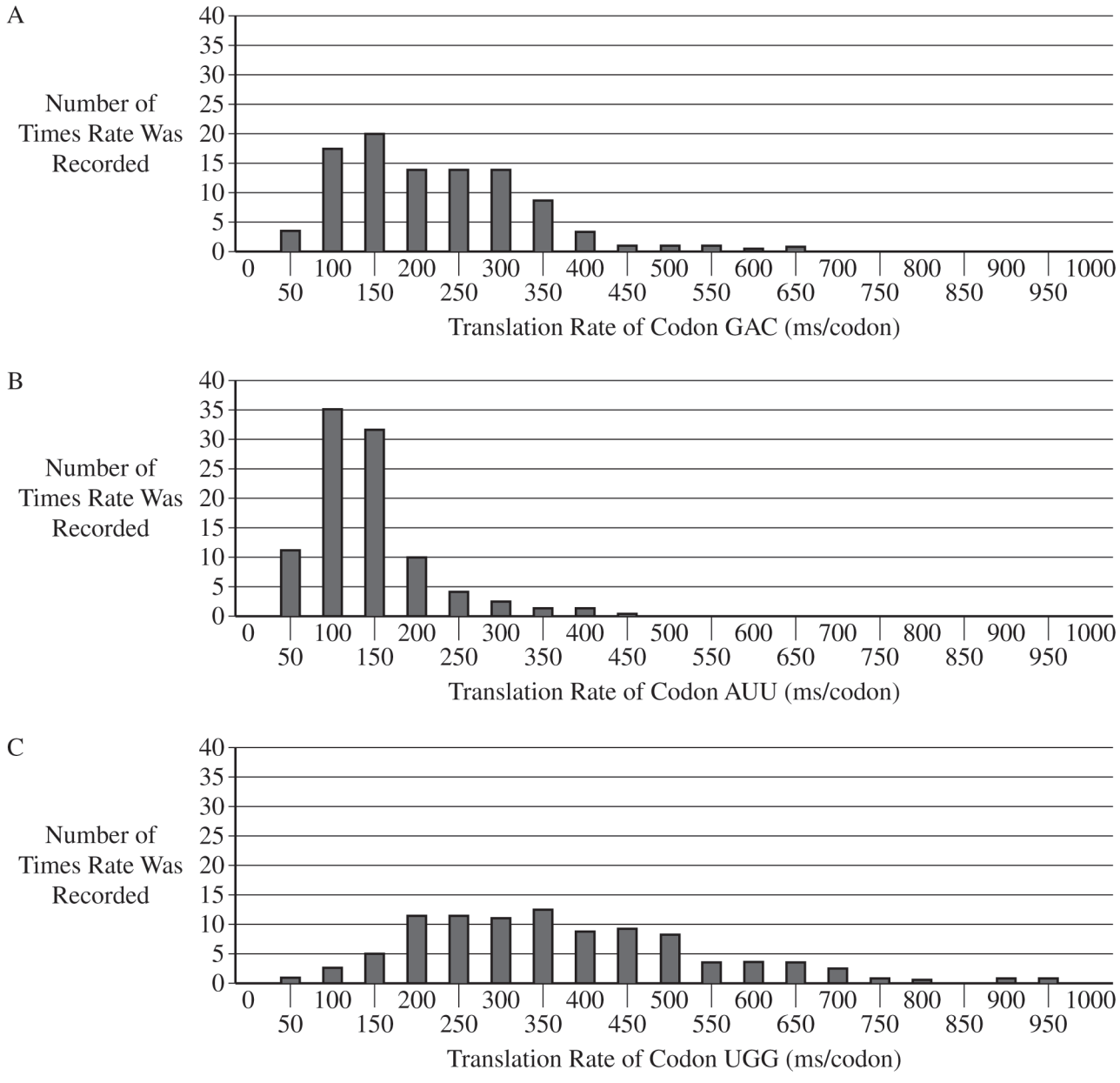

Figure 1. The distribution of translation rates for three different codons (A) GAC, (B) AUU, and (C) UGG

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(a) Using the data in Figure 1, graph A, **identify** the rate (in ms/codon) that was recorded the greatest number of times for the GAC codon.

(b) Using the data in Figure 1, graphs B and C, **describe** the variation in translation rate of the AUU codon compared with that of the UGG codon.

(c) Scientists hypothesize that tRNA molecules that bind to UGG codons are available in lower abundance than are tRNAs that bind to AUU codons. **Support** the scientists' hypothesis using the data in Figure 1.

(d) Amino acids can be encoded by multiple codons. In many organisms, certain codons for the same amino acid occur more frequently in an mRNA than do other codons. Based on the data provided, **explain** why the use of one codon over another for the same amino acid might result in increased levels of protein production from a particular mRNA.

Write your responses to this question only on the designated pages in the separate Free Response booklet.

If there are multiple parts to this question, write the part letter with your response.

GO ON TO THE NEXT PAGE.

(a)	Using the data in Figure 1, graph A, **identify** the rate (in ms/codon) that was recorded the greatest number of times for the GAC codon. • 150	**1 point**
(b)	Using the data in Figure 1, graphs B and C, **describe** the variation in translation rate of the AUU codon compared with that of the UGG codon. Accept one of the following: • There is greater variation in (the translation rate of) UGG codons (than in the translation rate of AUU codons). • (The translation rate of) UGG ranges from 50 (ms/codon) to 950 (ms/codon), while (the translation rate of) AUU ranges from 50 (ms/codon) to 450 (ms/codon).	**1 point**
(c)	Scientists hypothesize that tRNA molecules that bind to UGG codons are available in lower abundance than are tRNAs that bind to AUU codons. **Support** the scientists' hypothesis using the data in Figure 1. Accept one of the following: • The (average) translation rate of UGG is slower (than that of AUU). • Translation of UGG takes longer (per codon than does translation of AUU). • More of the UGG codons were translated at slower rates (than AUU codons were).	**1 point**
(d)	Amino acids can be encoded by multiple codons. In many organisms, certain codons for the same amino acid occur more frequently in an mRNA than do other codons. Based on the data provided, **explain** why the use of one codon over another for the same amino acid might result in increased levels of protein production from a particular mRNA. • Certain codons are translated at faster rates than are others (and result in increased levels of protein production from a particular mRNA).	**1 point**
	Total for question 6	**4 points**