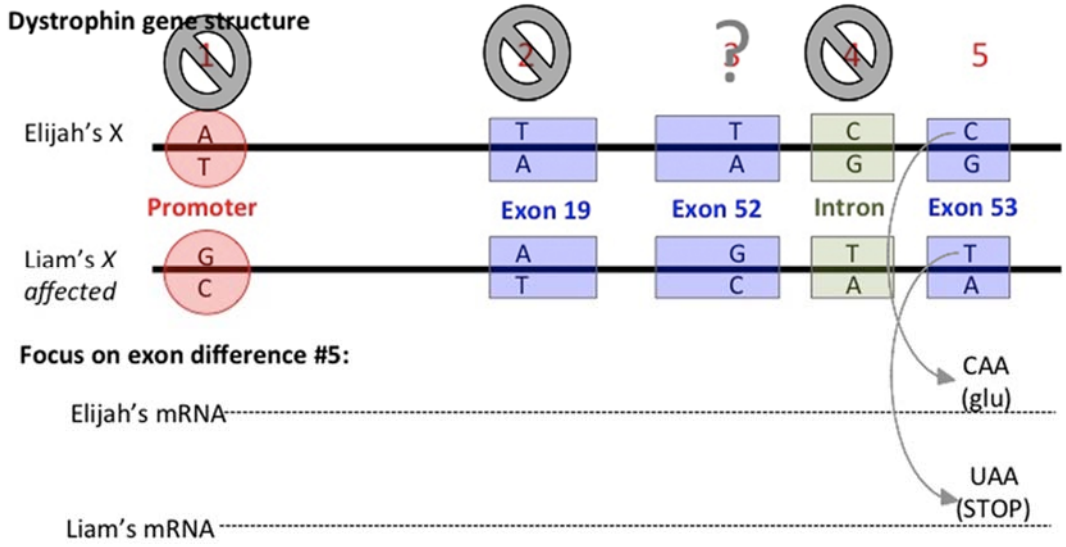
Supplemental Material

CBE—Life Sciences Education

Pelletreau *et al.*

Supplemental Figure 1. Example of how the faculty modified a clicker question from Version 1 to Version 2 of the instructional unit.

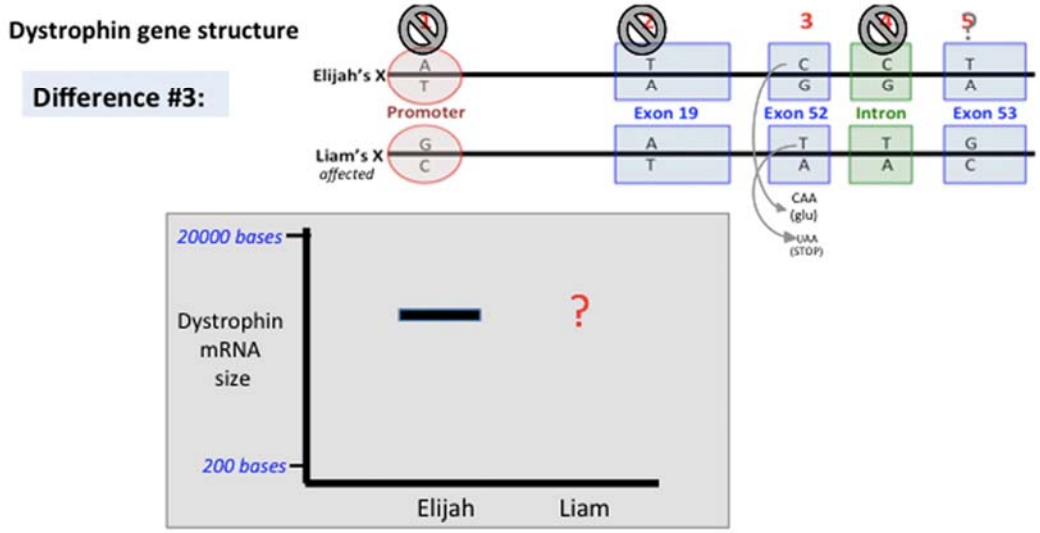
Version 1



Q8: Will difference #5 cause the mRNA to be shorter in Liam?

A. Yes
B. No *(correct)*

Version 2



Q5: What do you predict will be the effect of the premature stop codon on mRNA size? It will result in:

A. a shorter mRNA in Liam.
B. a longer mRNA in Liam.
C. the same size mRNA in both Liam and Elijah. *(correct)*

Supplemental Figure 2. Final exam questions used by faculty who taught the instructional unit. Correct responses are in blue font.

Question #1: Addresses a conceptual difficulty about DNA replication
Below are two different mutations of a DNA sequence in a eukaryotic organism.
Original DNA sequence (coding strand), starting at the beginning of the gene:
Normal: ATGATCTCCTAATATAA
Mutation: TTGATCTCCTAATATAA

Original DNA sequence (coding strand), starting at the beginning of the gene:
Normal: ATGATCTTCCTAATATAA
Mutation: ATGATCTTCCTAAGATAA

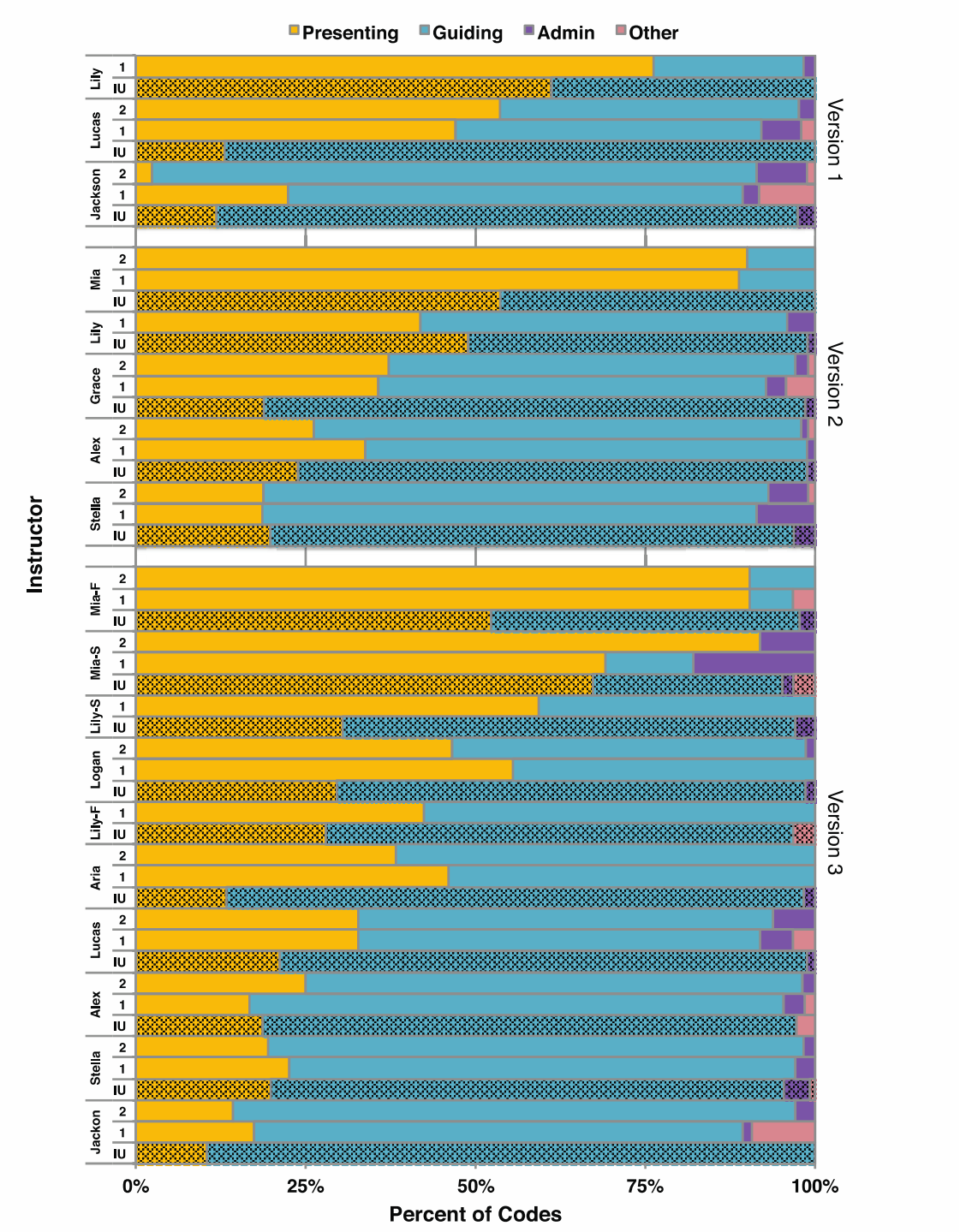
In the sequences above (that show mutations in the bold underline), which mutation would stop DNA replication?
A. Both
B. Neither
C. Only the first mutation
D. Only the second mutation

Question #2: Addresses a conceptual difficulty about transcription
A student was asked the following question: "The following DNA sequence occurs near the middle of the coding region of a gene.
DNA: 5' A A T G A A T G G* G A G C C T G A A G G A 3'

There is a G to A base change at the position marked with an asterisk. Consequently, a codon normally encoding an amino acid becomes a stop codon. How will this alteration influence transcription?"

The student responded with the following:
"When the transcription process reaches a stop codon, transcription will end, causing a shorter mRNA"
How would you re-word this statement to more accurately describe the affect of this mutation?
A. This statement is accurate as written
B. "When the RNA polymerase reaches that stop codon, transcription will end, causing a shorter mRNA and protein."
C. "When the transcription machinery reaches nucleotides that code for a stop codon, it will not be affected by the base pair change and transcription will proceed normally."
D. "When the transcription process reaches that stop codon, transcription will terminate early, resulting in a shorter protein."

Supplemental Figure 3. Collapsed code COPUS data for the faculty on 1-2 days when they did *not* teach the instructional unit (1,2; solid bars) and on days when the instructional unit was taught (IU; hatched bars). The semester is noted after the instructor name if the same instructor taught Version 3 more than once (F=fall and S=spring).



Supplemental Table 1: Information about the faculty including total years teaching, current position, and role: D – developer, T – taught the unit, I – interview participant.

Instructor Pseudonym	Total Years Teaching	Position	Role in Instructional Unit Development
Logan	3	Lecturer	D,T
Ethan	5	Assistant Professor	D
Grace	6	Lecturer	D,T
Aiden	9	Associate Professor	D,I
Stella	9	Associate Professor	D,T
Charlotte	10	Academic Specialist	D,I
Jackson	12	Assistant Professor	D,T,I
Lucas	16	Lecturer	D,T,I
Alex	17	Associate Professor	D,T,I
Mia	17	Lecturer	D,T,I
Emma	19	Associate Professor	D,I
Chloe	20	Senior Lecturer	D,I
Aria	22	Associate Professor	D,I
Blake	22	Associate Professor	D,I
Sophia	22	Professor	D,I
Lily	33	Senior Lecturer	D,T,I

Supplemental Table 2: Information on the type of courses and number of student responses on the stop codon questions for each version of the instructional unit. Student responses are included if they answered the pre- and post-assessment questions, and were in class for the instructional unit (attendance based on answering clicker questions). The number of responses is marked as not available in classes where it was not possible to link students present in class on the day of the instructional unit with the pre-post responses. Version 3 of the activity was taught in the fall 2015, spring 2016, and fall 2016 semesters. The semester is noted after the instructor name if the same instructor taught Version 3 more than once (F=fall and S=spring). Abbreviations for the courses are Intro Bio: Introductory Biology for Majors; Intro M&C: Introduction to Molecular and Cell Biology for Majors; Intro Genetics: Introduction to Genetics for Majors; and Non Majors: Non Majors Biology.

Instructor	Course	Number of Responses
No Instructional Unit (Fall 2014)		
Riley	Intro Bio	407
Version 1 (Fall 2014)		
Jackson	Intro M&C	122
Lily	Intro M&C	201
Lucas	Intro Bio	251
Version 2 (Spring 2015)		
Lily	Intro M&C	61
Stella	Intro Genetics	72
Grace	Non Majors	85
Alex	Intro Genetics	201
Mia	Intro M&C	not available
Version 3 (Fall 2015 - Spring 2016)		
Jackson	Non Majors	33
Stella	Intro Genetics	62
Aria	Intro M&C	80
Lily (S)	Intro M&C	82
Logan	Non Majors	99
Lily (F)	Intro M&C	268
Alex	Intro Bio	342
Mia (F)	Intro M&C	not available
Mia (S)	Intro M&C	not available
Version 3 (Fall 2016)		
Lucas	Intro Bio	218
Total Number:		**2177**

Supplemental Table 3. Percent of students in individual classes who answered the AACR stop codon questions correctly before (pre-assessment) and after (post-assessment) the three versions of the instructional unit were implemented and the corresponding normalized gain <g>. NA indicates classrooms where instructors used the instructional unit and associated assessments, but we were unable to track individual students.

Instructor	Percent Correct Replication			Percent Correct Transcription			Percent Correct Translation		
	Pre	*Post*	*Gain*	*Pre*	*Post*	*Gain*	*Pre*	*Post*	*Gain*
Version 1									
Jackson	58	66	0.19	57	61	0.09	69	81	0.39
Lily	66	79	0.38	53	69	0.34	58	76	0.43
Lucas	43	58	0.26	43	50	0.12	50	60	0.20
Version 2									
Lily	85	88	0.20	53	69	0.34	57	82	0.58
Stella	69	96	0.87	67	90	0.70	61	88	0.69
Grace	49	78	0.57	39	66	0.44	29	54	0.35
Alex	84	90	0.38	66	83	0.50	87	91	0.31
Mia	NA	NA	NA	NA	NA	NA	NA	NA	NA
Version 3									
Jackson	47	68	0.40	35	50	0.23	59	79	0.49
Stella	56	82	0.59	44	89	0.80	63	90	0.73
Aria	43	78	0.61	55	64	0.20	50	79	0.58
Lily (S)	73	85	0.44	70	85	0.50	73	85	0.44
Logan	42	59	0.29	45	64	0.35	42	59	0.29
Lily (F)	63	79	0.43	57	77	0.47	63	78	0.41
Alex	51	83	0.65	39	85	0.75	42	87	0.78
Lucas	46	68	0.41	50	75	0.50	48	67	0.37
Mia (S)	NA	NA	NA	NA	NA	NA	NA	NA	NA
Mia (F)	NA	NA	NA	NA	NA	NA	NA	NA	NA

Supplemental Table 4. Percentage of students who answered correctly on the pre-assessment and also answered correctly on the post-assessment AACR stop codon questions.

	Version 1	**Version 2**	**Version 3**
Replication	84	93	82
Transcription	73	86	79
Translation	71	89	83