

Mrs. Jones' Responses to the 2022 FRQ

Disclaimer: The following responses are the answers that I would have written if I was taking the exam. I am adding some extra information into the answers to do some explanation that might not be needed on those questions. I DO NOT have any insider knowledge as to these questions nor to their scoring guidelines. The scoring guidelines will not be released to the public until September (traditionally).

In addition, I am human so there might be information that should be included that isn't included (or I might be wrong about answers).

The FRQs are not included in this document. If you would like to see the FRQs, please refer to:

<https://secure-media.collegeboard.org/apc/ap22-frq-biology.pdf>

AP Biology 2022 Mrs. Jones' Responses # 1

(a) The plasma membrane is made up of phospholipids. These are amphipathic with a polar/hydrophilic region (phosphate head) and a nonpolar/hydrophobic region (fatty acids tails). The fatty acids cause the interior of the membrane to be hydrophobic which repels hydrophilic materials like charged molecules (chloride ions). The channel will provide a hydrophilic region for the passage of the charged chloride ions down their concentration gradient.

As the chloride ions move out of the intestinal cells, the extracellular region gets more hypertonic. The difference in tonicity causes the water to move out of the cells into the extracellular space to decrease the concentration (and balance the tonicity between the two regions).

(b) The independent variable was the addition of cholera toxin to the sample. The independent variable as the addition of GTP to the sample.

The negative control does not receive the treatment, so it would be sample I. Sample I does not have either GTP nor cholera toxin. This allows for a comparison between the other samples where these treatments were used.

Sample III was used as a control treatment to determine the effects of cholera without GTP. Since the GTP is used to bind to activate the pathway, this ensures that the GTP is needed for the release of cAMP and the cholera alone is not the cause of the cAMP release.

(c) Comparing sample II and sample IV there is an increase in cAMP production rate when cholera toxin is present. The presence of cholera toxin increases the synthesis of cAMP.

$$\begin{aligned} \text{percent change} &= \frac{(\text{final} - \text{initial})}{\text{initial}} * 100 \\ \text{percent change} &= \frac{(127 - 10)}{10} * 100 = \frac{117}{10} \\ \text{percent change} &= 11.7 * 100 \\ \text{percent change} &= 1170\% \end{aligned}$$

(d) Due to the toxin binding to the cholera toxin, then adding this with the GTP to the membrane, I predict this would model sample II since it has a presence of GTP with no cholera toxin. I predict the rate of cAMP production would be 10.0 pmol per mg adenylyl cyclase per min.

The mutant adenylyl cyclase will be unable to be activated by the G protein. Since it does not get activated, there is no longer an increase in cAMP. Since the cAMP is not produced the protein kinase is not activated. Since the protein kinase is not activated, the chloride ion does not get secretion from the cell. Since the chloride ion does not get secreted the extracellular region is not becoming more hypertonic which was the reason that water left the cell. This will allow the cell to no longer have excessive water loss.

AP Biology 2021 Mrs. Jones' Responses # 2

(a) (I'm going to be completely honest – I do not know what this answer is wanting. I am going to answer, then I will do a google search and see if I can find a concrete answer for y'all)

DNA can be broken by breaking the phosphodiester linkage between the nucleotides in DNA. Since this is a double strand break, it would need to break BOTH strands so I feel it would be more of the mechanical stress on DNA. As different parts are pulled as the chromatids get paired up during prophase I, the mechanical stress could cause a breakage (??).

(I wonder if they are looking for hydrolysis due to an enzyme like topoisomerase or something!?)
Article that I found that might be the answer:

[Asian J Androl](#). 2021 Nov-Dec; 23(6): 572–579.

PMCID: PMC8577251

Published online 2021 Oct 22. doi: [10.4103/aja202191](https://doi.org/10.4103/aja202191)

PMID: [34708719](https://pubmed.ncbi.nlm.nih.gov/34708719/)

The formation and repair of DNA double-strand breaks in mammalian meiosis

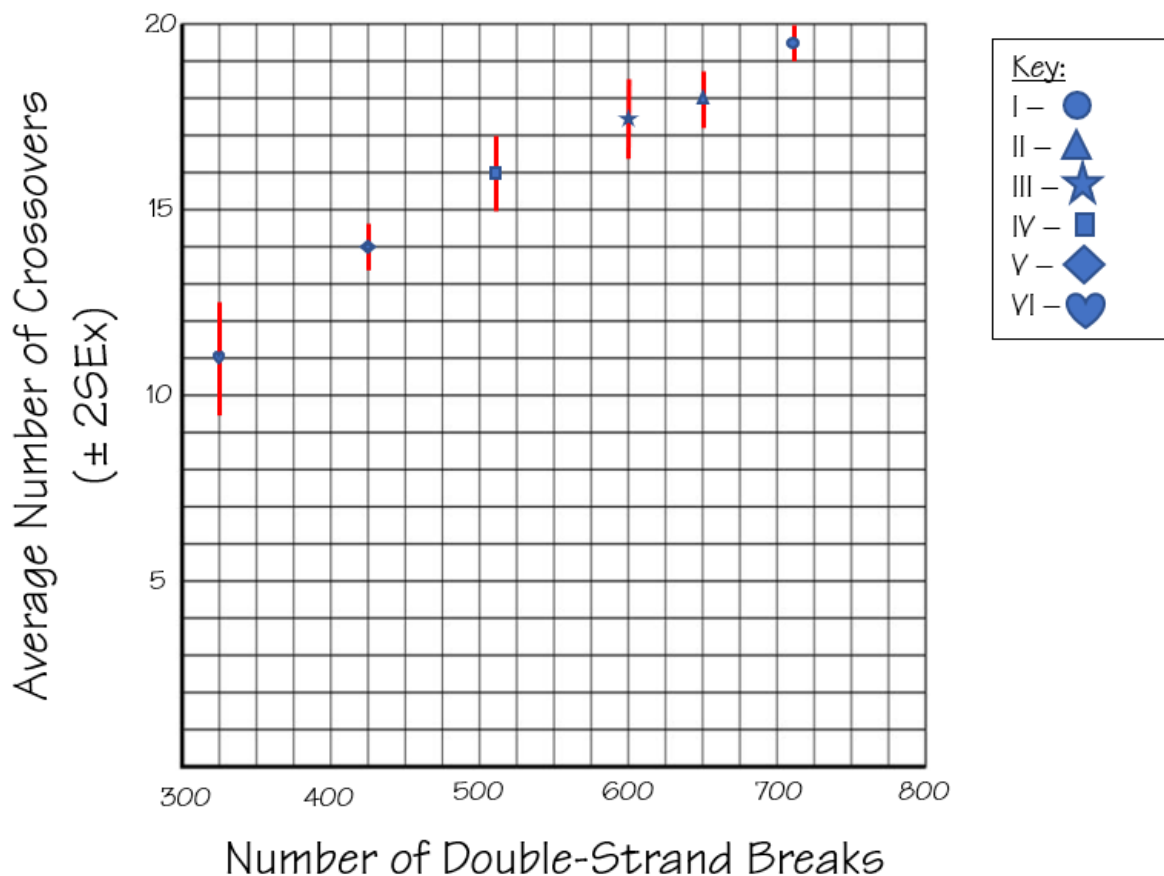
[Wei Qu](#), [Cong Liu](#), [Ya-Ting Xu](#), [Yu-Min Xu](#), and [Meng-Cheng Luo](#)

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Meiotic recombination is initiated by the programmed induction of DSBs by a topoisomerase-like enzyme SPO11. At the beginning of meiosis, SPO11 binds to DNA strands and generates DSBs.⁶ The

Answer: The double stranded breaks are caused by an enzyme (topoisomerase). This enzyme is capable for breaking the DNA strand. Traditionally, this is completed to relieve the strain due to helicase breaking the hydrogen bonds to allow for replication but it can be used to introduce genetic recombination after receiving a signal.

(b) (the released questions do not include the graph – this is the graph that I would create)



(you could probably just label the points as I – VI but I was being “extra” when I made my graph/key)

Sample I differs in the number of cross overs from Sample II due to the error bars not overlapping between these two points.

Sample I differs in the number of cross overs from Sample III due to the error bars not overlapping between these two points.

Sample II does not differ in the number of cross overs from Sample III due to the error bars overlapping between these two points.

(c) As the number of double strand breaks increases, the average number of cross over events increases.

(d) Looking at this question stem ONLY, it states the crossing over MUST occur in order for the proper separation of homologous chromosomes. Traditionally, there would be 4 chromosomes in each cell. But since one of the four pairs do not cross over there would be three in two of the cells (the crossed over ones that were able to separate) and five in the other two cells (the three that were able to separate plus the two chromosomes that did not separate).

(to overthink this question – would they be able to separate in meiosis II?!? so is it 3, 3, 3, 7 – 7 being the 4 from the homologous chromosome that didn't separate and the three that were able to separate)

If the farmers wanted to create new varieties, they would want to increase the number of crossover events which provides new combinations of the plant. DNA can be damaged by radiation or chemicals, so they would want to investigate how to appropriately introduce radiation and chemicals to the plant environments to cause double strand DNA breaks which would introduce more cross over events to the plants to create new varieties.

AP Biology 2021 Mrs. Jones' Responses # 3

- (a) Enzymes speed up chemical reactions by binding to the substrate and decreasing the activation energy. The luciferase has an active site that binds to the luciferin and oxygen in the appropriate orientation which will decrease the activation energy required for the reaction.
- (b) The dependent variable is the amount of light emitted from the reaction in the first three seconds. As they changed the temperature (independent variable), the scientists measured the amount of light emitted in the first three seconds (dependent variable).
- (c) The null hypothesis states that the treatment had no effect on the result. Since they were changing the temperature, the null hypothesis is the amount of light emitted in the first three seconds will be the same with different temperature. This could also be stated as temperature has no effect on the amount of light emitted from the reaction in the first three seconds.
- (d) An increase in temperature will increase the kinetic energy of the molecules. The increased kinetic energy of the molecules will provide environmental energy to the reaction to allow it to overcome the activation energy which will increase the reaction rate. As the reaction rate increases, there will be an increase in the product which is light. Thus, as the temperature increases, the reaction moves faster to increase the amount of light given off in the first three seconds.

AP Biology 2021 Mrs. Jones' Responses # 4

(a) The brook trout population was fragmented at the end of the most recent glaciation period so they have undergone habitat isolation which could also be considered ecological isolation or geographical isolation. This means that they are in two different habitats or locations with a geographical barrier between them. Since the two organisms were unable to meet, they were unable to mate. This is prezygotic because it would occur before the zygote forms since they are unable to reproduce.

(b) The longer-finned individuals will have a higher fitness. The longer fin allows the fish to swim faster (which their prey has evolved to be faster swimmers). Since it can swim faster, it will be more likely to obtain food. If it is more likely to obtain food, it is more likely to survive and reproduce plus its offspring will be more likely to survive and reproduce as they will also be able to get more food.

The shorter-finned individuals will have a lower fitness. The shorter fin does not allow the fish to swim faster. It might be unable to compete with the faster swimming long-finned fish and obtain less food. Since it has less food, it will be less likely to reproduce and have offspring. Over time, we will see a decrease in the population of short-finned fishes.

(c) As the trout populations will be reproductively isolated, they will have an increase in genetic variation between the two populations. A mutation might occur in one population that doesn't occur in the other population, so the two populations will become more different from one another. As they continue to have these small changes, there might be no longer to reproduce and produce fertile, viable offspring. This means they might undergo allopatric speciation to become two different species.

(d) The two populations are on two different branches of the phylogenetic tree. This means that each population has undergone genetic changes over time. If we were to name them population A and population B, then assume each have 5 differences from the ancestor; there would be 10 differences between the population. As these two populations no longer mate with one another, the genetic differences are not shared between the two populations leading to the two populations diverging and become more dissimilar from one another than the ancestral species.

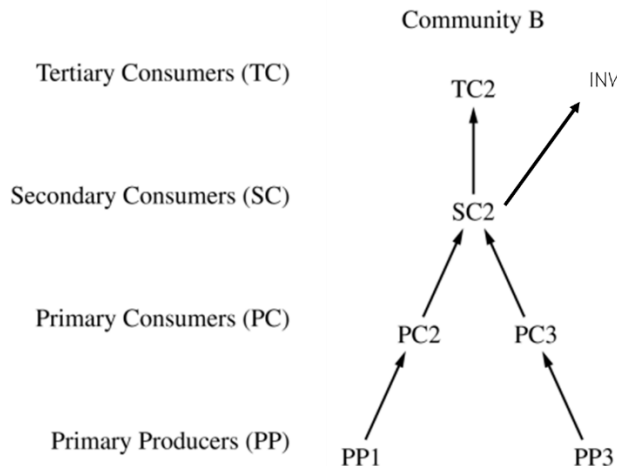
AP Biology 2021 Mrs. Jones' Responses # 5

(a) Invasive species are invasive because of their absence of natural predators and unlimited resources. If one community has limited resources that it requires or has predator, the invasive species would not be invasive in that community. If one community has those unlimited resources or no predators, the invasive species would be invasive in that community.

(b) PP1 is consumed by ONLY PC2 in community B. This removal of PP1 would lead to the decrease and most likely removal of PC2 which would lead to a decrease in SC2 and TC2. This will have a great effect on community B as there is this decrease in biodiversity.

PP1 is consumed by both PC1 and PC2 in community A. This leads to a decrease and most likely removal of PC1 and the decrease of PC2 (but it can still consume PP2 so it won't be removed). This decrease could decrease SC1, but it will not lead to their removal as it still has prey (PC2). This will lead to less of a decrease in biodiversity than we saw in Community B since most of the organisms have multiple food sources.

(c)



(d) Human activities introduce toxins to the environment. These toxins will be absorbed by the primary producers and then biomagnify into higher trophic levels. As the toxin magnifies up the higher trophic levels, it causes organisms populations to decrease from the toxins.

Human activities introduced could kill primary producers leading to a change in the trophic structure. Let's assume that PP2 was subject to the toxin caused death. The death of PP2 could cause an increase in the competition between PC1 and PC2 where PC2 is more successful

leading to a decrease and removal of PC1 and something similar happens between PC3 and PC4 competition for PP3 which lead to a decrease and removal from PC4. As PC1 and PC4 decreased, there was less food for SC1 and SC3 which lost in the competition with SC2 and TC2 was also more successful.

AP Biology 2021 Mrs. Jones' Responses # 6

- (a) The cap that most likely protected the end of the mRNAs from degradation was modified cap II. This is observed due to the highest half-life. This means that it remained in the cell the longest and due to its presence was more able to be used to produce protein.
- (b) As the half-life increases, the total amount of protein translated increases. This is logical as the mRNA is the template for protein synthesis, so if the mRNA remains in the cytosol for a longer period of time it will have more opportunities for translation (and thus an increased amount of protein).
- (c) The hypothesis is valid. Although the mRNA with the normal GTP cap remains in the cell for a longer period of time (half life with normal GTP was 16.10 with a mean of 1.0 protein synthesized compared to a normal GTP cap and half-life with cap 1 was 15.50 with a mean of 4.77 protein synthesized compared to a normal GTP cap. Since there is four times more protein synthesized than the normal GTP cap, this means that mRNA with cap 1 was translated more frequently.
- (d) Aside from the obvious that mRNA is functional in the cytosol versus DNA should be in the nucleus for the transcription process, mRNA is already in the usage format for the ribosome to be able to translate and synthesize proteins. If it was injected as DNA, it would need to get into the nucleus, then we would need activators, an active promoter sequence, and the entire process of transcription. It is more efficient to start with the mRNA.