

Question 2: Analyze an Environmental Problem and Propose a Solution

10 points

A	Based on the information in Figure 1, identify the type of plate boundary that runs beneath Serengeti National Park. Acceptable identification point: Divergent (boundary)	Point 01
B	Based on the information provided, identify the dominant biome within the Serengeti. Examples of acceptable responses may include the following: - Savanna - Tropical grassland	Point 02
C	Wildebeest give birth to their young when new grasses are growing. Based on the information in Figure 2, identify the location in the Serengeti where wildebeest are most likely to give birth. Examples of acceptable responses may include the following: - Grumeti Game Reserve - The west/northwestern side/edge (of Serengeti National Park)	Point 03
D	Explain why resource partitioning allows for the coexistence of the wildebeest and the gazelle in the Serengeti. Examples of acceptable responses may include the following: (Resource partitioning) reduces the (negative) impact of competition for (limited) resources. (Resource partitioning) allows species to use (limited) resources in different ways/places/at different times.	Point 04
E	Describe one way the proposed highway shown in Figure 2 could negatively affect the wildebeest population in the Serengeti. Examples of acceptable responses may include the following: - Building the highway would fragment/destroy habitat/food/resources. - The highway could prevent/reduce/disturb migration. - Wildebeest could be hit/killed by vehicles. - Noise pollution could cause stress/change migratory routes.	Point 05

F **Propose** a solution to the negative effect created by the planned highway described in part E. **Point 06**

Examples of acceptable responses may include the following:

Problem in part E	Realistic Potential Solution
Building the highway would fragment/destroy habitat/food/resources.	- Construct a habitat corridor over/under the highway - Construct the highway over/above the habitat - Relocate the highway north/outside of the migratory path - Expand the national park/create additional protected habitat
The highway could prevent/reduce/disturb migration. Wildebeest could be hit/killed by vehicles.	- Relocate the highway north/outside of the migratory path - Construct a habitat corridor over/under the highway
Noise pollution could cause stress/change migratory routes.	- Install a sound barrier to mitigate noise pollution - Relocate the highway north/outside of the migratory path

G **Describe** a characteristic of an invasive species, such as the spotted knapweed, that allows them to outcompete native species. **Point 07**

Examples of acceptable responses may include the following:

- They have many offspring/reproduce quickly/mature early/invest minimal energy in each offspring (tend to be r-selected).
- They can feed on/use many different types of resources.
- They can survive in conditions outside their normal habitat/have a wide range of tolerance (tend to be generalists).

H **Justify** the use of crop rotation as an environmental solution by providing an additional advantage, other than controlling pest populations. **Point 08**

Examples of acceptable responses may include the following:

- Improved soil fertility/soil structure/soil quality
- Increased nutrient cycling/reduction in fertilizer use
- Reduced soil erosion
- Increased food security/crop yield
- Increased biological activity (in the soil)

I	Describe an environmental problem associated with controlling pest populations with large amounts of pesticide. Examples of acceptable responses may include the following: • Pesticides can harm/kill nontarget species. • Pests can develop resistance to the pesticide.	Point 09
J	Propose a solution to controlling pests, other than pesticides or crop rotation. Examples of acceptable responses may include the following: • Use biocontrol/intercropping/natural predators • Trap insects/use mechanical controls to eliminate the pests • Use genetically modified crops that are pest resistant	Point 10

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- (a) Based on the data in the graphs, **identify** the amount of land required to produce 1 kilogram of chicken protein. **1 point**
- 50 m²
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- (b) Based on the information provided, **identify** the type of survivorship curve exhibited by the darkling beetle. **1 point**
- Type III
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- (c) **Explain** why the reproductive strategy of the darkling beetle is an advantage for using mealworms as an alternative protein source for the rapidly growing human population. **1 point**
- Accept one of the following:
- Darkling beetles reproduce quickly, which allows for a large amount of protein to be produced in a short period of time.
 - Darkling beetles have many offspring, which allows for a large amount of protein to be produced in a short period of time.
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- (d) Based on the data in the graphs, **explain** whether producing 1 kilogram of chicken protein or 1 kilogram of pork protein would cause less environmental damage. **1 point**
- Accept one of the following:
- Chicken production has a lower global warming potential than pork production, so it would cause less environmental damage because chicken production releases less greenhouse gas.
 - Chicken production has a lower land use than pork production, so it would cause less environmental damage because there would be less deforestation/habitat destruction/soil erosion/fossil fuel use.
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- (e) Based on the data in the graphs, **explain** why the production of 1 kilogram of beef protein has a different impact on global warming than the production of 1 kilogram of protein from any of the other animals studied would have. **1 point**
- Accept one of the following:
- Beef has a larger impact because methane has a high global warming potential.
 - Beef has a larger impact because methane is a greenhouse gas.
 - Beef requires more land use, which results in loss of forests/habitat/grasslands leading to release of CO₂/reduction in carbon storage.
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(f)	Describe how water quality can be altered by cattle grazing that occurs near a stream or river.	1 point
	Accept one of the following: • Cattle cause erosion, which increases sedimentation/turbidity in water. • Cattle feces can add nutrients/nitrogen/phosphorus to waterways. • Cattle feces may contaminate waterways with bacteria.	
(g)	Propose a solution to reduce the negative impacts on waterways that result from cattle grazing, while still allowing cattle to graze.	1 point
	Accept one of the following: • Practice rotational grazing/alternate grazing parcels. • Eat a diet with less meat/beef. • Fence/barricade the riparian zone. • Provide other water sources for the cattle.	
(h)	Crop production can cause soil erosion. Describe a sustainable agricultural practice used to reduce soil erosion.	1 point
	Accept one of the following: • Switch crops to perennial plants. • Plant crops on terraces. • Implement contour plowing/farming. • Use no-till farming/cover crops.	

- (i) **Justify** the use of the sustainable practice described in part (h) by describing an additional advantage, other than the reduction of soil erosion. **1 point**

Accept one of the following:

Solution proposed in (h)	Justification of solution with additional advantage other than the reduction of soil erosion
Switch to perennial plants	• Reduces the use of fossil fuels. • Reduces the cost of farming. • Increases/maintains carbon storage in soils. • Preserves habitats for organisms in soils.
Plant crops on terraces	• Allows areas to be farmed that are otherwise too steep. • Sediments and other contaminants settle out behind the terrace ridge reducing the amount of soil that runs off. • Increases groundwater absorption.
Implement contour plowing/farming	• Allows areas to be farmed that are otherwise too steep. • Increases groundwater absorption.
Use no-till farming/cover crops	• Reduces the use of fossil fuels. • Reduces the cost of farming. • Increases/maintains carbon storage in soils. • Preserves habitats for organisms in soils. • Cover crops can be used as green manure.

- (j) Crop production around the world is affected by climate change. **Describe** how crop production could be negatively affected by climate change. **1 point**

Accept one of the following:

- Crop production/yields could decrease because of:
 - Increased drought
 - Increased flooding
 - Increased insect infestation from warmer temperatures
 - Increased temperature
 - Changes in seasonal rain patterns (or temperatures)
 - Expansion of geographic range of invasive pests/species
 - Climate may be outside range of tolerance of crops

Total for question 2 10 points

Question 1: Design an Investigation**10 points**

(a) Identify the control group in this experiment.**1 point**

Accept one of the following:

- Plot D
- Unmodified beans

(b) Identify the scientific question for the investigation.**1 point**

Accept one of the following:

- Will genetically modified green beans have higher crop yields than unmodified green beans?
- Is there a difference between the crop yields of genetically modified and unmodified green beans?
- Does genetically modifying green beans affect crop yield?

(c) Researchers repeated the experiment modifying the length of time for the spray irrigation to 20 minutes per day. **Explain** how the results of the experiment could be altered with this modification.**1 point**

Accept one of the following:

- With less water, there will be lower crop yield/fewer green beans harvested in all plots.
- The genetically modified beans will remain similar in yield because they are resistant to drought/need less water, but the unmodified beans will decrease in crop yield because they will receive less water.

(d) Based on the data in the table, **identify** the plot with the lowest soil temperature.**1 point**

Accept one of the following:

- Plot D
- The unmodified green beans

(e) Describe how sediment runoff and fertilizer runoff compare between the unmodified green beans and the genetically modified green beans.**1 point**

Accept one of the following:

- Both types of runoff/Sediment and fertilizer (phosphorus/nitrogen) runoff are lower with the genetically modified beans.
 - Both types of runoff/Sediment and fertilizer (phosphorus/nitrogen) runoff are higher with the unmodified beans.
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- (f) The Type 2 GMO beans in Plot B were developed to grow more quickly than the unmodified beans in Plot D. Researchers have hypothesized that the Type 2 beans would use fertilizer more completely than the other varieties. Based on the data in the table and the experimental design, **explain** whether the researchers' hypothesis was supported or refuted. **1 point**

Accept one of the following:

- The hypothesis is supported because there is less fertilizer (phosphorus/nitrogen) in the runoff from plot B, so the beans in plot B are absorbing/taking up more fertilizer (phosphorus/nitrogen).
- The hypothesis is supported because there is more fertilizer (phosphorus/nitrogen) in the runoff from plot D, so the beans in plot D are absorbing/taking up less fertilizer (phosphorus/nitrogen).
- The hypothesis is supported because the plants in plot B were able to produce more beans given the same amount of fertilizer.

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- (g) **Describe** the ecological process that occurred on the plots after the crops were burned. **1 point**

Accept one of the following:

- Fast growing/early successional organisms returned to/colonized the soil after the fire/major disturbance.
- Secondary succession occurred where plants recolonize a habitat after the fields were burned/after a major disturbance.

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- (h) After each flooding event, the plot with twice the plant diversity returned to its prior level of biodiversity more quickly than the other plots did. **Explain** why a community with more plant diversity will recover more quickly from the flooding. **1 point**

Accept one of the following:

- The plot with higher diversity/richness has more species/organisms, so the floods harm a smaller proportion of the species/organisms.
 - The plot with higher diversity/richness has more connections between organisms, so the floods disrupt a smaller percentage of the connections between organisms.
 - The plot with higher genetic diversity within species may have more flood tolerant individuals that will survive a flood.
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- (i) After the last flooding event, a beetle not previously known in the area appeared in one of the plots with less plant diversity. Over a period of a few months, the new beetle population increased, whereas the existing beetle species in the plot had declining populations. **Explain** why the new beetle species could be better able to successfully populate this plot than the existing beetle species could. **1 point**

Accept one of the following:

- The new beetle is a generalist/r-selected species and could more quickly populate the area/outcompete the existing/native beetle species.
- The flooding of the plot caused a natural disruption to the existing community, eliminating species/natural predators and opening niches for the new/invasive beetle.
- Low diversity communities are susceptible to disruption and can't recover allowing the new/nonnative beetle species to invade
- The new beetle is an invasive species that can live outside its normal environment and threaten native species

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- (j) **Describe** one realistic method to prevent the new beetle from spreading beyond the experimental plot. **1 point**

Accept one of the following:

- Remove beetles by trapping/physical removal to reduce their population size.
- Apply a chemical/pesticide to kill beetles.
- Add a predator/parasite/pathogen/biological control that harms beetles.

Total for question 1 10 points