1.

Biologists are interested in preserving the diversity of living organisms on the planet.

(a) **Explain** THREE of the following processes or phenomena, using an appropriate example for each.

- mutation
- adaptive radiation
- polyploidy
- population bottlenecks
- growth of the human population

(b) For each process or phenomenon you selected in (a), **discuss** its impact on the diversity of life on Earth.

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(b) For each process or phenomenon you selected in (a), **discuss** its impact on the diversity of life on Earth.

One point for each definition, example, impact and explanation.

	Definition	**Example**	**Impact on diversity of life on earth**	**Explanation**
mutation	change in DNA	deletion/insertion point mutation chromosomal aberration	increase or decrease	altered proteins new geno/phenotypes raw material for selection
adaptive radiation	multiple species from 1 ancestor	Galapagos finches mammals angiosperms	increase	new species co-existence of species
polyploidy	more than 2 complete chromosome sets	plants (common) animals (rare e.g., fish, amphibians)	increase	development of new species (autoploidy speciation, alloploidy speciation)
population bottlenecks	sudden/drastic decrease in population size (usually natural)	cheetahs northern elephant seals	decrease	random/not adaptive population not representative of original smaller gene pool
growth of human population	near carrying capacity exponential evidence from age pyramid	rapid increase – developing countries slow growth - U.S. no growth - Italy	decrease	Use of resources leads to extinction of other species

2.

Survival of organisms depends on adaptive behavior and species interactions.

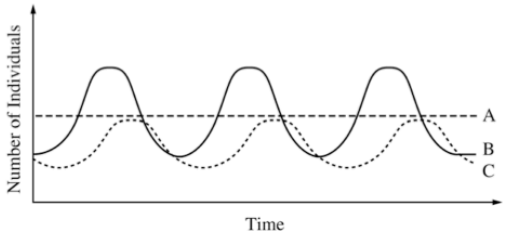
(a) Behaviors of organisms may be influenced by environmental factors. Select two of the following types of behavior. For each type, explain

(i) how the environment affects the behavior, and

(ii) why this behavior increases the survivorship of individuals of a species.

- Taxis/Kinesis
- Migration
- Courtship

(b) Interactions among populations may have an effect on densities of the species that interact. Predation represents an important interaction among populations. The curves below depict the population densities of three species: a small herbivore, a larger herbivore, and a carnivore.



Identify which curve represents which of the species listed, and **justify** your answer by describing the changes in the population densities of these three species over time.

Part (a) (6 points maximum)

Answer must include at least one environmental point (*how*) and one survivorship point (*why*) to reach the 3-point maximum for each behavior.

Students were instructed to choose TWO types of behavior

Taxis/Kinesis
How: Identification of environmental stimulus/trigger (e.g., light, moisture, pH, nutrients, temperature)
Why: Adaptiveness of response (e.g., escape from predators, find food, avoid desiccation)

Migration
How: Identification of environmental stimulus/trigger (e.g., changes in light/dark cycle, nutrients, temperature, ecological changes/catastrophes)
Why: Adaptiveness of response (e.g., access to food, water, nutrients, temperature tolerance)

Courtship
How: Identification of environmental stimulus/trigger (e.g., changes in light/dark cycle, nutrients, temperature, ecological changes/catastrophes)
Why: Adaptiveness of response (e.g., mated pair has better access to food, water, nutrients, temperature tolerance) increasing survival of parents and/or offspring

Part (b) (2 points maximum per curve)

The justifications are required for any credit to be awarded.

"Large" and "small" assignments for herbivores are interchangeable if the appropriate justification is provided in the essay. Partial credit for stating that curve A is the predator was awarded in essays that stated the predator readily switched between large and small herbivores as its prey.

Curve A

- large herbivore
- population not affected by predators in curve C
- food sources constantly available; eats different food than small herbivore

Curve B

- small herbivore
- largest population size
- short generation time
- population decreases as predator increases

Curve C

- predator
- smallest population size
- increase of predators follows increase of herbivores; increase of predators drives decrease of herbivores

3.

An experiment was conducted to measure the reaction rate of the human salivary enzyme α-amylase. Ten mL of a concentrated starch solution and 1.0 mL of α-amylase solution were placed in a test tube. The test tube was inverted several times to mix the solution and then incubated at 25°C. The amount of product (maltose) present was measured every 10 minutes for an hour. The results are given in the table below.

Time (minutes)	Maltose Concentration (μM)
0	0
10	5.1
20	8.6
30	10.4
40	11.1
50	11.2
60	11.5

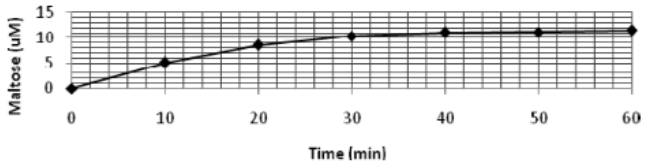
(a) **Graph** the data on the axes provided and **calculate** the rate of the reaction for the time period 0 to 30 minutes.

(b) **Explain** why a change in the reaction rate was observed after 30 minutes.

(c) **Draw** and **label** another line on the graph to predict the results if the concentration of α-amylase was doubled. **Explain** your predicted results.

(d) **Identify** TWO environmental factors that can change the rate of an enzyme-mediated reaction. **Discuss** how each of those two factors would affect the reaction rate of an enzyme.

(a) **Graph** the data on the axes provided and **calculate** the rate of the reaction for the time period 0 to 30 minutes. **(4 points maximum)**

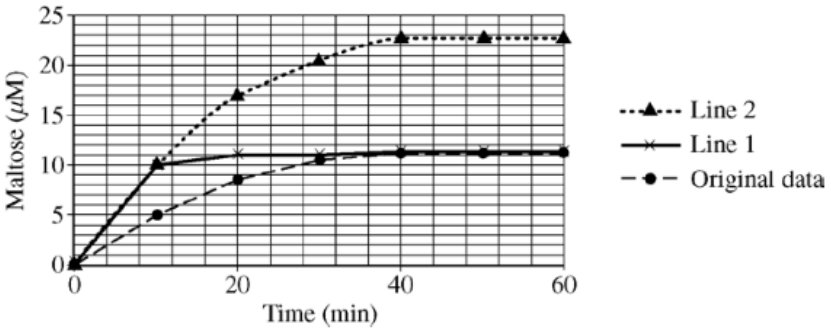


Graph 1 point each (3 points maximum)	Calculation (1 point maximum)
• Correct orientation of the independent (time) and dependent (maltose) variables. • Correct display of units and intervals **(scale and labels)**. • Correct graphing of **all** data points on a properly scaled and oriented graph **(0–60 minutes)**.	• Correct setup **or** rate calculation (0.3–0.4 μM/min or, e.g., 1μM/3 min, 10.4 μM/30 min or 10.4–0.0 /30–0 μM/min), **with units**. (No points if setup is incorrect or if calculated number is wrong and contradicts a correct setup.)

(b) **Explain** why a change in the reaction rate was observed after 30 minutes. **(2 points maximum)**

Change (1 point maximum)	**Explanation of change (1 point maximum)**
• Reaction rate slows/levels off.	• Rate slows as substrate concentration declines (substrate used). • Enzyme inactive by about 40 minutes — enzyme loses activity over time (labile enzyme). • Product inhibition.

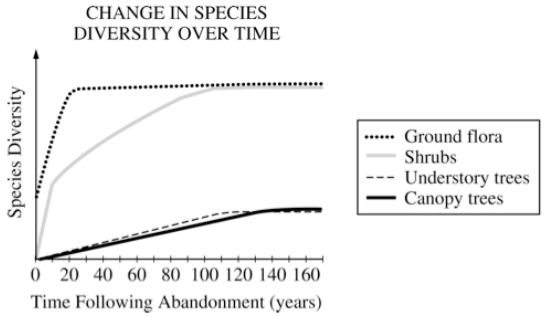
(c) **Draw** and **label** another line on the graph to predict the results if the concentration of α-amylase was doubled. **Explain** your predicted results. **(2 points maximum)**



Drawing and labeling point (1 point maximum)	**Explanation point (1 point maximum)**
• Drawing and labeling of new line showing appropriate prediction (increased initial rate). o **Draw either line 1 OR line 2.**	• Line 1: Substrate is consumed more quickly because twice as much enzyme is present, but overall final product concentration remains the same. • Line 2: More product is formed at each time point because twice as much enzyme is present; product formation levels off as enzyme loses activity.

4.

Ecological succession describes the pattern of changes in communities over time. The graph below shows changes in plant diversity following the abandonment of an agricultural field in a temperate biome.



(a) **Discuss** the differences in plant diversity shown in the graph and **explain** how the changes affect the animal species composition between years 0 and 120.

(b) **Identify** TWO biotic and TWO abiotic factors and **discuss** how each could influence the pattern of ecological succession.

(c) **Design** a controlled experiment to determine how the diversity of plant species in a newly abandoned field would be affected by large herbivores.

(a) **Discuss** the differences in plant diversity shown in the graph and **explain** how the changes affect the animal species composition between years 0 and 120.
(*4 points maximum*)

Discussion of differences in diversity shown in the graph (2 points maximum)

- Differences in the amount of diversity
  - More diversity in ground flora and shrubs
  - Less diversity in understory and canopy
- Differences in the rate of change in diversity
  - Rapid change in ground flora and shrubs
  - Slow change in understory and canopy
- Differences in the rate to community stabilization
  - Faster for ground flora
  - Slower for understory and canopy

Explanation of effect on animal species composition (2 points maximum)

- Pioneer community consists of small herbivores, insects, and other small, ground-dwelling animals.
- Climax community consists of insects, birds, and mammals and is multilayered.

(b) **Identify** TWO biotic and TWO abiotic factors and **discuss** how each could influence the pattern of ecological succession.
(*4 points maximum*)

Examples of biotic factors (1 point for each identification and 1 point for each appropriate discussion of its influence on succession; 2 points maximum)

- Competition
- Predation
- Herbivory

- Disease
- Parasitism
- Seed dispersal
- Nitrogen fixation
- Reproductive strategy
- Human impact

Examples of abiotic factors (1 point for each identification and 1 point for each appropriate discussion of its influence on succession; 2 points maximum)

- Climate
- Rainfall
- Light
- Wind
- Temperature
- Soil composition
- Fire
- Drought
- Altitude
- Geographic location

(c) **Design** a controlled experiment to determine how the diversity of plant species in a newly abandoned field would be affected by large herbivores.
(*4 points maximum*)

Experiment design (1 point each)

- Identify the independent variable and how it is manipulated.
- Identify the dependent variable and how it is measured (e.g., "count number of species"; not "observe diversity").
- Discuss variables to be held constant (at least three; one can be "divide the field in half").
- Identify the control (e.g., no herbivores).
- Verification and replication (e.g., large plot or many plots).
- Hypothesis or testable prediction related to species diversity.