Past-paper walk-through

Community Ecology ▪ 8.5

eXercise

Questions in this set

- 2025 Q3
- 2025 Q4
- 2024 Q4
- 2023 Q3
- 2022 Q5
- 2019 Q1
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- 2018 Q3
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- 2017 Q1

Questions in this set

- 2017 Q7
- 2016 Q5

Reading the mark scheme

- **B1** a mark that stands on its own – the point is either made or not.
- **M1** a *method* mark: the right approach, even if the number is wrong.
- **A1** an *answer* mark, and it usually needs its M mark first.
- **C1** a working mark on the way to the answer.
- // separates answers the examiner accepts equally.
- **ecf** = error carried forward: a later part is marked on your own earlier answer.
- **owtte** = "or words to that effect" – the wording need not match.

Question 3

2025 ▪ Q3

Buffelgrass, an invasive grass species in southwestern desert ecosystems, is threatening the saguaro cactus, a keystone species in these ecosystems. Buffelgrass is drought-tolerant and can survive wildfires. However, the dry buffelgrass also acts as fuel for wildfires, causing the fires to be more severe. Older saguaro cacti can survive wildfires; however, many of the young cacti cannot.

Scientists conducted an experiment to determine whether they could control the abundance of the buffelgrass population. The scientists identified several native grass species that, when grown with buffelgrass, might reduce the abundance of buffelgrass. They grew buffelgrass in the presence of several different native grass species in greenhouses, in either nondrought (watered every 3 days) or drought (watered every 9 days) conditions. After twelve weeks, they measured the height and dry weight of the buffelgrass in each treatment group.

Question 3

(a) Describe the effect that removing a keystone species will have on an ecosystem.
(b) Identify a control group the scientists should include in their experiment.
(c) State the null hypothesis of the experiment in which buffelgrass is grown in the presence of native grass species.
(d) Scientists have found that the population growth rates of native grasses are much slower than the population growth rate of buffelgrass following a wildfire. The scientists claim that wildfires will therefore increase the abundance of buffelgrass plants in the ecosystem. Based on the information given, justify the scientists' claim.

Solution 3

(a)

Mark scheme

- Removing a keystone species reduces biodiversity/diversity/resilience of the ecosystem, and can cause the ecosystem to collapse.

Solution 3

(b)

Mark scheme

- A control group with only buffelgrass planted (no native grass species) — i.e., buffelgrass grown alone under each water condition, to compare against buffelgrass grown together with native grasses.

Solution 3

(c)

Mark scheme

- Null hypothesis: there will be no difference in / effect on the abundance/dry weight/height/size of buffelgrass when grown alone compared with when grown together with native grass species (equivalently: no difference in these measures of buffelgrass grown under drought vs nondrought conditions).

Solution 3

(d)

Mark scheme

- With fewer native plant species surviving after a wildfire (since native grasses regrow much more slowly than buffelgrass), buffelgrass will face less/no competition for resources and so will have more resources available for growth, development, and reproduction — supporting the claim that wildfires increase buffelgrass abundance.

Question 4

2025 ▪ Q4

Twenty million years ago the Caribbean Sea and Pacific Ocean were connected, and water flowed freely between the two bodies of water. Many of the same marine species were found in both areas. Over millions of years, the land referred to as the Isthmus of Panama formed, eventually closing off the connection between the Caribbean Sea and Pacific Ocean and creating two separate bodies of water. The ecology of these two marine habitats was dramatically altered by this land formation. The warmer Caribbean water could no longer flow west, so the Pacific water cooled and became more nutrient-rich, while the Caribbean water became warmer.

(a) Describe the genetic evidence that evolution is occurring in a population.

(b) Explain how the isolation of marine species by the formation of a land barrier can lead to divergent evolution of those species.

Question 4

(c) The formation of the Isthmus of Panama connected two continents, North America and South America. Many North American land animal species migrated to South America after the formation of the isthmus and occupied similar niches as South American species.
Predict the effect the formation of the isthmus had on resource availability for South American species.
(d) Justify your prediction in part C.

Solution 4

(a)

Mark scheme

- Genetic evidence of evolution occurring in a population includes changes in allele/gene frequencies over time, and/or heritable changes in phenotypes across generations.

Solution 4

(b)

Mark scheme

- A land barrier isolating marine species results in reproductive isolation / lack of gene flow between the separated populations (allopatric speciation); different environmental conditions/pressures on each side then select for different alleles/genotypes/phenotypes, so selective pressures produce different allele frequencies, driving divergent evolution.

Solution 4

(c)

Mark scheme

- Resource availability for South American species would have decreased, since migrating North American land animals now occupy niches similar to those of South American species and compete for the same resources.

Solution 4

(d)

Mark scheme

- More species (native South American plus the migrated North American species) would now be competing for the same set of resources, resulting in fewer resources available to each individual — justifying the prediction that resource availability decreased.

Question 4

2024 ▪ Q4

The common wild oat is native to regions of Europe and Asia but is an invasive species in central California grasslands. In California, the common wild oat has almost completely replaced some species of native bunchgrass. Researchers found that aphids, a type of small insect that often carries plant viruses, have a much higher reproductive rate in grasslands that include the common wild oat than in grasslands composed of only native bunchgrass species. Additionally, the viruses carried by the aphids appear to affect only the native bunchgrasses and not the common wild oat. Native bunchgrasses infected by the virus have much higher death rates than do native bunchgrasses that are not infected.

(a) Describe the change in the resilience of an ecosystem when there is a decrease in the number of species.

Question 4

(b) Explain how the addition of the common wild oat affects the number of native bunchgrass plants that can be supported by the California grasslands ecosystem.
(c) Researchers suggest adding ladybugs, predators of aphids, to the California grasslands. **Predict** the effect of adding ladybugs on the abundance of the native bunchgrass population.
(d) Justify your prediction in part (c).

Solution 4

(a)

Mark scheme

- The resilience of the ecosystem will decrease when the number of species decreases.

Solution 4

(b)

Mark scheme

- Accept either: the addition of the wild oat limits the resources available to native bunchgrass, resulting in a decrease in bunchgrass population size; or the addition of the wild oat enables the aphid population to increase (more aphids feeding on/carrying viruses) and increases bunchgrass exposure to plant viruses, resulting in a decrease in the native bunchgrass population size (since infected bunchgrass has a much higher death rate).

Solution 4

(c)

Mark scheme

- The native bunchgrass population will increase in abundance if ladybugs are added.

Solution 4

(d)

Mark scheme

- Adding ladybugs (predators of aphids) will decrease the number of aphids, which will decrease the transmission of/infection by the plant viruses that raise bunchgrass death rates — so fewer bunchgrass plants die of infection and the native bunchgrass population increases.

Question 3

2023 ▪ Q3

Sand lances of the genus *Ammodytes* are small fish that function as keystone organisms in several coastal ecosystems. These sand lances are prey fish that support organisms at higher trophic levels. Scientists performed experiments to examine how sand lance populations are likely to be affected by the rising temperatures and CO_2 levels associated with climate change.

Sand lance embryos typically develop and mature into adult fish at low temperatures (approximately $5°$C) and stable, low CO_2 levels (approximately 400 μatm). Over the course of two years, the scientists measured the survival rate of sand lance embryos allowed to develop and mature in a laboratory at three different temperatures, $5°$C, $7°$C, and $10°$C, with the level of CO_2 maintained at 400 μatm, 1,000 μatm, and 2,100 μatm for each temperature.

Question 3

(a) Describe the effect of increased biodiversity on the resilience of an ecosystem in a changing environment.
(b) **Justify** the scientists' selecting $5°$C as the lowest temperature and 400 μatm as the lowest CO_2 level in their study of sand lance embryo survival.
(c) State a null hypothesis for the experiment.
(d) The scientists claim that a reduction in the population size of the *Ammodytes* sand lances will affect the stability of the entire coastal ecosystem. Provide reasoning to **support** the scientists' claim.

Solution 3

(a)

Mark scheme

- Increased biodiversity increases the resilience of an ecosystem in a changing environment — i.e., an ecosystem's resilience (ability to recover from or withstand disturbance/change) is greater when biodiversity is higher.

Solution 3

(b)

Mark scheme

- 5°C and 400 μatm CO2 were chosen because they represent the normal/current environmental conditions under which sand lance embryos typically develop and mature; using these as the baseline lets the researchers use them as a basis of comparison to evaluate the effects of increases in temperature and CO2 (i.e., climate-change-associated changes) on embryo survival relative to current, unaltered conditions.

Solution 3

(c)

Mark scheme

- A null hypothesis for the experiment (any one of): climate change (increased temperature and/or CO2) will have no effect on sand lance embryo survival/development or on the size of sand lance populations; equivalently, there will be no difference in sand lance embryo survival rates/development measured at the different (or all) temperatures and CO2 levels tested.

Solution 3

(d)

Mark scheme

- Reasoning to support the claim (either): a reduction in sand lance population size will have a negative effect on organisms at other trophic levels because sand lances serve as a food source (prey) for many other species — fewer sand lances means less food/energy available for predators; or, there would be reduced energy transfer to higher trophic levels, destabilizing the coastal food web/ecosystem since sand lances are a keystone prey species.

Question 5

2022 ▪ Q5

The following models represent all the interacting species in two different communities with some of the same species and feeding relationships. These models assume that both communities have the same initial biomass. The models can be used to understand the effects of human activities on the communities.

[Figure 1: two food-web diagrams side by side, "Community A" and "Community B", arranged in four horizontal trophic-level rows (top to bottom): Tertiary Consumers (TC), Secondary Consumers (SC), Primary Consumers (PC), Primary Producers (PP). Community A: PP1, PP2, PP3 at the base; arrows go PP1→PC1, PP1→PC2, PP2→PC2, PP2→PC3, PP3→PC3, PP3→PC4; then PC1→SC1, PC2→SC1, PC2→SC2, PC3→SC2, PC3→SC3, PC4→SC3; then SC1→TC1, SC2→TC1, SC2→TC2, SC3→TC2. Community B: PP1 and PP3 at the base (no PP2); arrows go PP1→PC2, PP3→PC3; then PC2→SC2, PC3→SC2; then SC2→TC2.]

Question 5

Figure 1. Models of two different communities with some of the same species

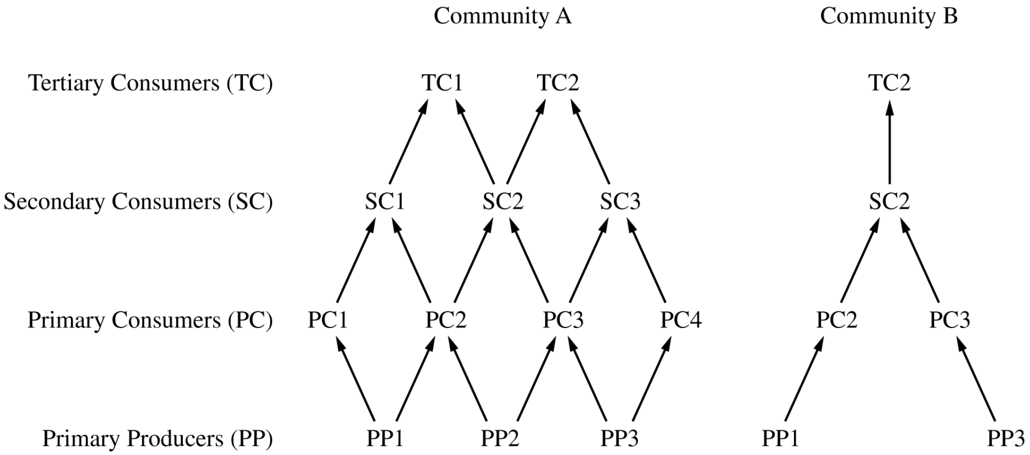
(a) Describe a characteristic of a community that makes a species invasive in that community but not invasive in a different community.

(b) Explain why removing species PP1 will have a greater effect on community B than on community A.

(c) An invasive species (INV) that eats individuals of species SC2 is introduced into community B. Using the template in the space provided for your response, for community B, indicate the feeding relationship for this invasive species by correctly placing INV to represent the invasive species and an arrow to represent the feeding relationship within community B.

(d) Explain how human activities that add toxins to the soil could change a community with many species at each trophic level, such as community A, into a community with few species at each trophic level, such as community B.

Question 5


Community A
Community B
Tertiary Consumers (TC)
Secondary Consumers (SC)
Primary Consumers (PC)
Primary Producers (PP)
TC1
TC2
SC1
SC2
SC3
PC1
PC2
PC3
PC4
PP1
PP2
PP3
TC2
SC2
PC2
PC3
PP1
PP3

Solution 5

(a)

Mark scheme

- A species is invasive in a community where there are no/reduced natural predators of the species, no/reduced competitors of the species, or no/reduced diseases to which the species is susceptible - conditions that may not hold in a different community, where the species is therefore not invasive.

Solution 5

(b)

Mark scheme

- Removing species PP1 has a greater effect on community B than on community A because in community B there will be decreases in PC2, SC2, and TC2 (PC2, SC2, and PC3), whereas in community A, PC2 has alternative food sources (other primary producers, PP2/PP3) to rely on. More generally, with fewer/less diverse primary producers (and primary consumers) there are fewer paths for energy to move through community B, so with fewer species/feeding interactions/less diversity, community B is less resilient to future environmental change.

Solution 5

(c)

Mark scheme

- On the Community B diagram, INV should be added in a position horizontally aligned with TC2 (i.e. at the tertiary-consumer level), with an arrow drawn from SC2 pointing to INV, representing that the invasive species (INV) feeds on SC2.

Solution 5

(d)

Mark scheme

- Human activities that add toxins to the soil could eliminate primary producers, which reduces species diversity at higher trophic levels; alternatively, the toxins could biomagnify up the food chain, becoming more concentrated and toxic at higher trophic levels and reducing species diversity there - either mechanism could transform a many-species-per-trophic-level community like A into a few-species community like B.

Question 1

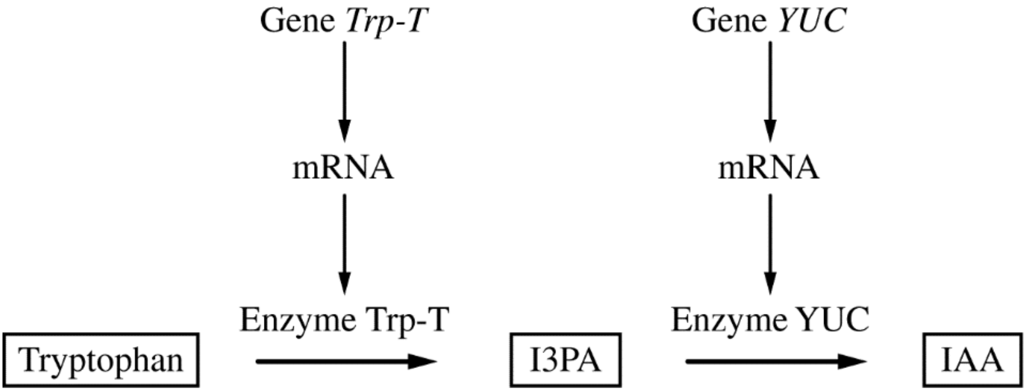
2019 ▪ Q1

[Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan: Gene Trp-T -> (arrow down) mRNA -> (arrow down) Enzyme Trp-T; Tryptophan –(Enzyme Trp-T)–> I3PA. Gene YUC -> (arrow down) mRNA -> (arrow down) Enzyme YUC; I3PA –(Enzyme YUC)–> IAA.]

Auxins are plant hormones that coordinate several aspects of root growth and development. Indole-3-acetic acid (IAA) is an auxin that is usually synthesized from the amino acid tryptophan (Figure 1). Gene *Trp-T* encodes an enzyme that converts tryptophan to indole-3-pyruvic acid (I3PA), which is then converted to IAA by an enzyme encoded by the gene *YUC*.

(a) Circle ONE arrow that represents transcription on the template pathway. **Identify** the molecule that would be absent if enzyme YUC is nonfunctional.

Question 1


Gene *Trp-T*
mRNA
Enzyme Trp-T
Gene *YUC*
mRNA
Enzyme YUC
Tryptophan
I3PA
IAA

Question 1

2019 ▪ Q1

[Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan: Gene Trp-T -> (arrow down) mRNA -> (arrow down) Enzyme Trp-T; Tryptophan –(Enzyme Trp-T)–> I3PA. Gene YUC -> (arrow down) mRNA -> (arrow down) Enzyme YUC; I3PA –(Enzyme YUC)–> IAA.]

Auxins are plant hormones that coordinate several aspects of root growth and development. Indole-3-acetic acid (IAA) is an auxin that is usually synthesized from the amino acid tryptophan (Figure 1). Gene *Trp-T* encodes an enzyme that converts tryptophan to indole-3-pyruvic acid (I3PA), which is then converted to IAA by an enzyme encoded by the gene *YUC*.

(b) Predict how the deletion of one base pair in the fourth codon of the coding region of gene *Trp-T* would most likely affect the production of IAA. **Justify** your prediction.

Question 1

2019 ▪ Q1

[Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan: Gene Trp-T -> (arrow down) mRNA -> (arrow down) Enzyme Trp-T; Tryptophan –(Enzyme Trp-T)–> I3PA. Gene YUC -> (arrow down) mRNA -> (arrow down) Enzyme YUC; I3PA –(Enzyme YUC)–> IAA.]

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(c) Explain one feedback mechanism by which a cell could prevent production of too much IAA without limiting I3PA production.

Question 1

2019 ▪ Q1

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Auxins are plant hormones that coordinate several aspects of root growth and development. Indole-3-acetic acid (IAA) is an auxin that is usually synthesized from the amino acid tryptophan (Figure 1). Gene *Trp-T* encodes an enzyme that converts tryptophan to indole-3-pyruvic acid (I3PA), which is then converted to IAA by an enzyme encoded by the gene *YUC*.

(d) Rhizobacteria are a group of bacteria that live in nodules on plant roots. Rhizobacteria can produce IAA and convert atmospheric nitrogen into forms that can be used by plants. Plants release carbon-containing molecules into the nodules. Based

Question 1

on this information, **identify** the most likely ecological relationship between plants and rhizobacteria. **Describe** ONE advantage to the bacteria of producing IAA.

Question 1

2019 ▪ Q1

[Figure 1. Model of two-step enzymatic plant pathway for synthesis of IAA from tryptophan: Gene Trp-T -> (arrow down) mRNA -> (arrow down) Enzyme Trp-T; Tryptophan –(Enzyme Trp-T)–> I3PA. Gene YUC -> (arrow down) mRNA -> (arrow down) Enzyme YUC; I3PA –(Enzyme YUC)–> IAA.]

Auxins are plant hormones that coordinate several aspects of root growth and development. Indole-3-acetic acid (IAA) is an auxin that is usually synthesized from the amino acid tryptophan (Figure 1). Gene *Trp-T* encodes an enzyme that converts tryptophan to indole-3-pyruvic acid (I3PA), which is then converted to IAA by an enzyme encoded by the gene *YUC*.

(e) A researcher removed a plant nodule and identified several “cheater” rhizobacteria that do not produce IAA or fix nitrogen. **Describe** the evolutionary advantage of being a bacterial cheater in a population composed predominantly of noncheater bacteria.

Question 1

Plants can adjust the amount of carbon-containing molecules released into nodules in response to the amount of nitrogen fixed in the nodule. **Predict** the change in the bacterial population that would cause the plant to reduce the amount of carbon-containing molecules provided to the nodule.

Solution 1

(a)

Mark scheme

- Circle: Circle either arrow that points from a gene (Trp-T or YUC) to its mRNA — this represents transcription. [1 point] Identify: If enzyme YUC is nonfunctional, the molecule IAA would be absent, because YUC catalyzes the conversion of I3PA to IAA (the final step of the pathway); with no functional YUC, I3PA cannot be converted to IAA. [1 point]

Solution 1

(b)

Mark scheme

- Prediction: Deletion of one base pair in the fourth codon of the Trp-T coding region would most likely reduce IAA production, or result in no IAA production. [1 point] Justification (any one): the frameshift mutation results in translation of an inactive/nonfunctional Trp-T enzyme; OR the mutation results in no translation of the Trp-T enzyme (e.g., a premature stop codon); OR the mutation results in no/reduced production of I3PA (since Trp-T is needed to convert tryptophan to I3PA, and I3PA is the precursor for IAA). [1 point]

Solution 1

(c)

Mark scheme

- This is a negative feedback (feedback inhibition) mechanism: as IAA accumulates, increasing amounts of IAA inhibit the pathway that produces it. [1 point] Specifically, the rising IAA level inhibits production of the YUC enzyme, or inhibits YUC enzyme activity — this blocks only the second step (I3PA $\rightarrow$ IAA), so I3PA production (via Trp-T, the first step) is not limited. [1 point]

Solution 1

(d)

Mark scheme

- Identification: The relationship between plants and rhizobacteria is mutualism — both organisms benefit. [1 point] Description: One advantage to the bacteria of producing IAA is that IAA promotes root growth, which increases the plant's habitat/number of nodules available to house the rhizobacteria; in exchange, the bacteria receive carbon-containing molecules released by the plant (as a result of the increased plant growth). [1 point]

Solution 1

(e)

Mark scheme

- Description: 'Cheater' bacteria that benefit from nodule resources without expending energy to produce IAA or fix nitrogen have more energy available for their own reproduction, giving them a reproductive/evolutionary advantage over noncheater bacteria as long as cheaters remain a minority. [1 point]
  Prediction: A decrease in the nitrogen-fixing/noncheater bacteria (or a decrease in the total amount of nitrogen fixed in the nodule) would cause the plant to reduce the amount of carbon-containing molecules it releases into that nodule. [1 point]

Question 2

2019 ▪ Q2

A student studying two different aquatic, plant-eating, unicellular protist species (species A and B) designed an experiment to investigate the ecological relationship between the two species (Table 1).

TABLE 1. EXPERIMENTAL TREATMENT GROUPS

Group	Description
Group I.	Species A and B are each grown in separate containers.
Group II.	Species A and B are grown together in the same container.

Question 2

In treatment group I, the student placed 10 individuals of species A into a container with liquid growth medium and 10 individuals of species B into a separate container with an equal amount of the same liquid growth medium. In treatment group II, the student placed 5 individuals of each species into a single container with the liquid growth medium. The student then maintained the containers under the same environmental conditions and recorded the number of individuals in each population at various time points. The results are shown in Table 2.

TABLE 2. NUMBER OF INDIVIDUALS IN EACH PROTIST POPULATION IN BOTH TREATMENT GROUPS

Time (h)	Group I. Grown Separately — Species A	Group I. Grown Separately — Species B	Group II. Grown Together — Species A	Group II. Grown Together — Species B
0	10	10	5	5
10	100	50	45	20
20	400	200	100	50
30	1100	500	250	25
40	1400	650	525	20
50	1500	700	900	10
60	1500	700	1250	0
70	1500	700	1400	0

Question 2

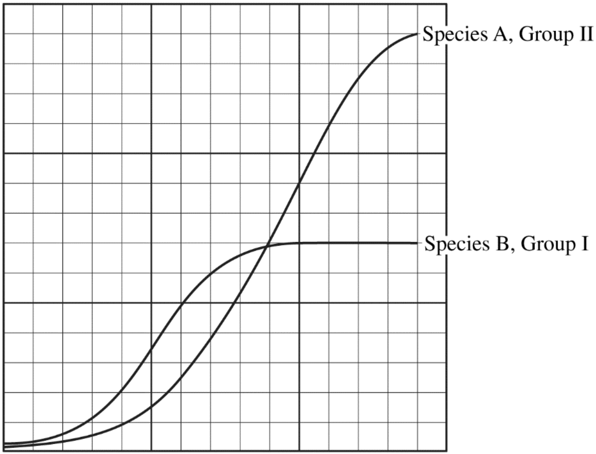
[Graph template: a blank grid (graph paper) with two curves already plotted (shaded columns of Table 2): "Species A, Group II" - an S-shaped curve rising steeply then leveling off at the top right; "Species B, Group I" - an S-shaped curve rising then leveling off at a lower plateau, labeled partway up the right side. Axes are unlabeled on the template, to be completed by the student with the unshaded columns (Species A, Group I and Species B, Group II).]

(a) The growth curves for species B in group I and for species A in group II (shaded columns) have been plotted on the template. Use the template to **complete** an appropriately labeled line graph to illustrate the growth of species A in treatment group I and species B in treatment group II (unshaded columns).

Question 2

	Group I. Grown Separately		Group II. Grown Together	
Time (h)	Species A	Species B	Species A	Species B
0	10	10	5	5
10	100	50	45	20
20	400	200	100	50
30	1100	500	250	25
40	1400	650	525	20
50	1500	700	900	10
60	1500	700	1250	0
70	1500	700	1400	0

Question 2



Question 2

Group I.	Species A and B are each grown in separate containers.
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