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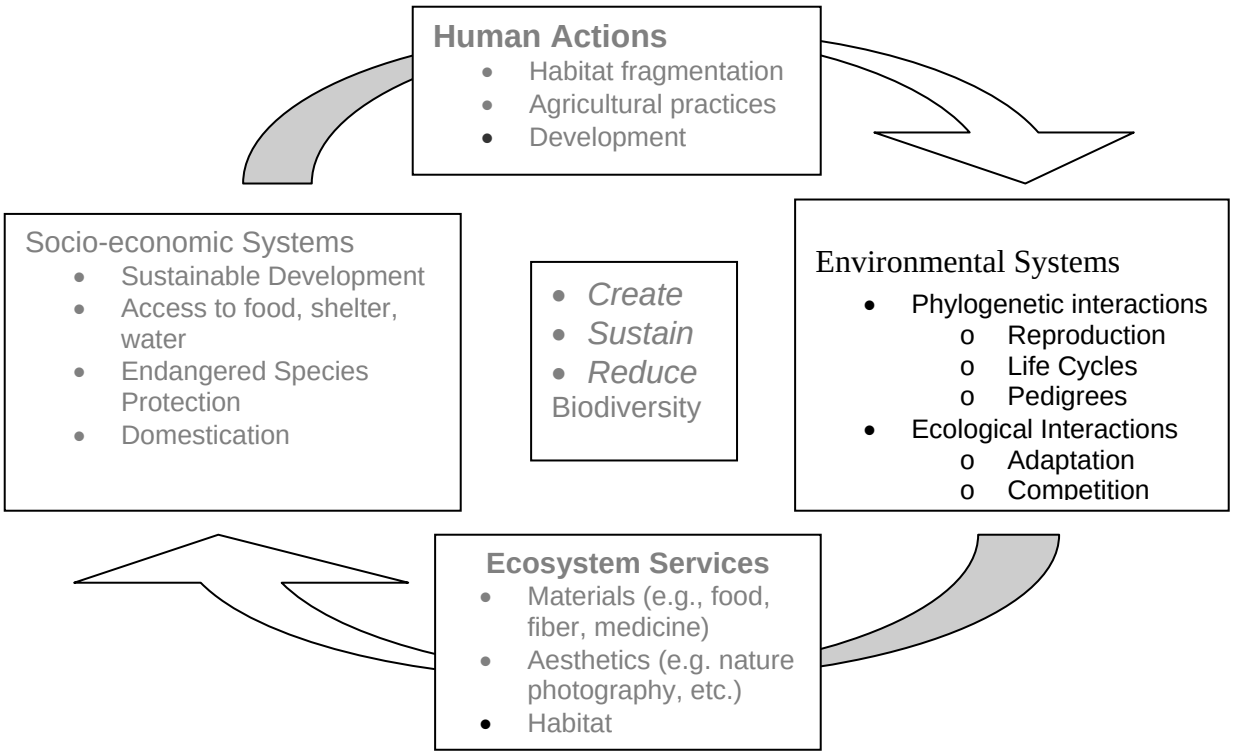
Answer Key for High School Biodiversity Environmental Literacy Assessment January 2008

"Answer key" may not be quite the right word to describe this document since the environmental literacy assessments are not primarily about right and wrong answers. We have developed this assessment because we are trying to create *learning progressions for environmental science literacy:* Learning progressions are "descriptions of the successively more sophisticated ways of thinking about a topic that can follow one another as children learn about and investigate a topic over a broad span of time (e.g., six to eight years)" (NRC, 2007).

We are developing assessments for three strands (carbon, water, and biodiversity) at three levels (upper elementary, middle, and high school). So as the title says, this assessment is focuses on the biodiversity strand and is designed to be used at the high school level.

The first 3 pages of this answer key explain our thinking about levels of achievement for the --- strand in environmental literacy. We briefly describe (a) the *upper anchor,* our ideas about what environmentally literate high school graduates should understand, (b) the *lower anchor,* our hypotheses about informal thinking that we would like to explore, and (c) *levels of achievement,* our hypotheses about connections between the upper and lower anchors.

1. The upper anchor for the Biodiversity Strand: Goals for environmentally literate high school graduates. One way that we represent our upper anchor is with a loop diagram that shows the relationships between environmental systems and human social and economic systems.



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We think of environmental literacy as being able to "complete the loop," connecting events in one part of the loop with implications for all the other parts. **Environmental *science* literacy focuses on the environmental systems box,** and to a lesser extent the arrows going into and out of the box. Students need to understand environmental systems in ways that enable them to make connections with the arrows and with human needs and activities. Here, we elaborate on the environmental systems box.

In the biodiversity strand, we feel that students especially need to understand two aspects of environmental systems:

1. Phylogenetic theme – This theme investigates student understanding of processes relating to reproduction (e.g., life cycles, pedigrees). It examines genetic relationships between families, populations, species, etc. At a local scale, the phylogenetic theme includes an ability to describe organisms in terms of their traits, to distinguish from genetic from acquired traits, and to recognize genetic diversity in populations of plants, animals, bacteria, and fungi. At larger scales in time and space, this theme includes understanding of our phylogenetic classification system and of how natural or human selection can cause populations to change over time—the process of evolution.
2. Ecological theme – This theme investigates student understanding of processes relating to survival (e.g., adaptations, competition, succession). It examines relationships between biotic and abiotic factors, niches, etc. At a local scale, the ecological theme includes recognizing the many different plants, animals, and decomposers that live in every ecosystem and picking out the relationships among them (and how humans sometimes alter those organisms and relationships). At larger scales in time and space, this theme includes understanding how natural processes and human management practices can alter the mix of organisms in a place—the process of ecological succession.

It is important for students to understand the phylogenetic and ecological themes in space and time. Natural and artificial selection are where phylogenetic and ecological interactions converge.

2. The lower anchor: Hypotheses about students' informal thinking that we would like to explore. Our research has convinced us that "upper anchor" thinking about environmental systems is a hard-won intellectual achievement. When people—children and adults—think informally about the environmental systems and processes associated with the biodiversity strand, they think in very different terms. For example, here are two characteristics of lower-anchor reasoning that we have seen in our previous research and we would like to explore further.

1. When asked how many different modern breeds of dogs could all be descended from wolf ancestors, students suggested many different stories about dogs and wolves mating and breeding with one another, wolves eating different kinds of food or living in different environments, etc. Only a few students suggested that genetic variations in wolves played an important role, and not a single student mentioned selective breeding by humans.
2. When asked why there were so many species in a prairie, students said that the plants needed each other to survive. For example, if all the species weren't there, they would die because they needed each other. Students rarely invoked the concepts of competition, adaptation, and niche when answering the question.

3. Transitional Levels: Connecting the anchors. If we are generally right about the upper and lower anchors, the next question is "**how do we get from here to there**?" If most students (and most adults) normally tend to think about environmental systems in informal terms, how can we help them learn to identify the occasions when more scientific "upper anchor" thinking is helpful and to reason using scientific concepts?

We have been working on this question, too, though we still have a *lot* of work to do. One result of our work is the teaching materials (available on our website). Another result is the table on the following page, which describes a series of levels connecting the lower anchor (Levels 1 and 2) to the

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upper anchor (Level 5). Levels 6 and 7 are beyond the scope of what we expect high school students to know.

Level	***Biodiversity***
Framing Questions	***How are individuals and eco-systems alike and different? How did they get that way?***
Level 7: Quantitative Reasoning about Uncertainty	Can apply models of change that include quantification of probabilities (uncertainty) of events such as mutation rates, drift, birth and death rates and natural or human-caused disturbances.
Level 6: Quantitative Model-based Reasoning	Quantitatively traces information across multiple scales. Quantifies the relative contribution of multiple sources of variation; rates of change; and variables associated with diversity at the ecosystem and population levels.
Level 5: Qualitative Model-based Reasoning	Traces information through short and long term processes at both the population and ecosystem level. Considers multiple sources of variation, processes than maintain variation, reduce, or increase variation in natural and human-controlled systems.
Level 4: "School Science" Narratives	Recognizes many of the appropriate systems and processes that explain change over time in natural and human-controlled systems, but fails to connect the systems and/or processes in a manner constrained by scientific principles.
Level 3: Hidden mechanisms explained by cultural models and experience	Recognizes connections between micro and macro, and macro and large scale systems, but the mechanisms connecting those systems are explained by cultural narratives or embodied experience. Diversity in systems not considered in explanations of processes or change.
Level 2: Sequences of Events Narrative descriptions at the macroscopic scale	Recognizes variation in systems where it is visible at the macroscopic scale. No connections made between small scale systems such as genes and large scale phenomena such as phenotypic variation.
Level 1: Anthropomorphic and natural tendency narratives	Explain what happens to organisms, species or ecosystems in terms of humans needs or natural tendency.

We know that these Levels are still hypotheses. **Your students' answers to the questions on this assessment will help us to come up with a better sequence of levels—and with assessments that are valid and reliable for assessing where students are in the sequence.** Thank you for your help with this work!

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Assessment Questions and Answers

The actual questions that the students will answer are in regular black type. Our comments are in blue italics .We have tried to design this assessment so that it can be completed by your students in 30-45 minutes.

Environmental Literacy Biodiversity Assessment: High School

Science is easier to understand if you can make connections between what you know now and the new ideas that you are studying. This is a test that will help us to understand what you know now. Please answer these questions as carefully and completely as you can. If you are not sure of the answer, please write about any thoughts that you have. If you can help us to understand how you think about these questions, then we can do a better job of explaining science in ways that make sense to you.

Please put your initials (not your full name) in the boxes

First Middle Last

Date _____

Class _____ Teacher _____

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Forest Test Answers

Picture C (to the left) - The land area in this picture used to be only sand dunes. It did not have any beech or maple trees. Below, Pictures D, E, and F are close-ups of different parts of this land.

Picture D (below) – This is a close-up picture of the sand dunes.

Picture E – This is a close-up picture of some grasses in the sand dunes close to the water.

Picture F – This is a close-up picture of the beech maple forest.

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1. Pictures D, E, and F are close-ups of different parts of Picture C. Both grasses from the beach and trees from the forested area produce seeds that are carried by the wind and animals.

a. Some tree seeds land in the sand on the beach. But there are no trees growing close to the water (on the beach). Why do you think there are not trees growing on the beach?

Trees need more nutrients than are available in sand. Furthermore, their roots and leaves may not be adapted to withstand the wind and waves.

b. Picture E shows some each grass growing in the sand dunes. You find lots of grass growing in the sand dunes. But you do not find much grass growing in the forest, even though some grass seeds sprout under the trees (Picture F). Why do you think there is not much grass in the forest?

The composition of soil under the trees may not be ideal for beach grasses. They have long, deep roots that are ideally suited for sandy areas. Their long roots help them withstand wind and absorb water. The shade provided by the trees could be a factor that makes it unsuitable for grass to flourish at that location.

General: Beach grasses are adapted to the wind and waves and low levels of nutrients in sand (adapted to a less stable environment). As the beach grasses die and decompose, they begin the transform the sand into more nutrient rich soil. Eventually, small plants start to grow, decompose, and add to the soil richness. This allows larger plants and trees to start growing. The trees are farther away from the shoreline because the soil contains more nutrients and they are more protected from the wind and waves (adapted to a more stable environment).

(Qn1 Sand dune→ Beech maple forest succession): *We are interested in student understanding of how individuals are adapted to their niches and habitats and what, if anything, keeps individual populations from dominating the landscape, what limits the growth of populations and encourages diversity, and how land changes over time due to ecological interactions.*

1c. Picture F shows a beech maple forest. Why are there so many species of plants and trees in a beech maple forest? Why don't one or two species take over the entire area?

Things in ecosystems interact and this tends to create many niches. For plants, relationships are mostly competitive. But there are plants that can specialize. For example, some plants grow better under low light conditions closer to the floor of the forest, some grow up high under higher light conditions, and some grow at different times of the year. Even though there is competition, various species can find gaps and fill in particular niches.

(Qn.1c Forest landscape): *We are interested in student understanding of diversity in landscapes. We are interested whether or not students recognize that when biotic and abiotic factors in ecosystems interact, they create niches. Various species adapt to particular niches in an ecosystem.*

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2. Beech and maple seedlings grow well in shade. Cottonwood seedlings, on the other hand, grow better with more sunlight. Here is a story of how the forest grew on the sand dunes.

Year 0: Beginning of forest growth. A part of the sand dunes became sheltered from the wind and waves. At first it had only beach grasses like in Picture C above and shrubs. Some cottonwood, maple, and beech seeds fell among the grasses and started to grow.

Year 20: Growing forest. The tallest trees were mostly cottonwoods around 20 years old. There were some beech and maple seedlings under the cottonwoods, but they were all small and less than 10 years old.

Year 100: Beech-maple forest. The forest looked like Picture D. The tallest trees were mostly beeches and maples. There were no cottonwood trees growing in the forest.
Use the information above to help you explain why after 20 years, the tallest trees were cottonwood, but after 100 years the tallest trees were beech and maples.

The cottonwood and oaks trees grow well in areas with more sunlight. Initially, the area was open and there was more sunlight, so the cottonwood and oaks grew faster than the maples and beeches. As the cottonwoods and oaks grew taller, then provided shade for the maples and beeches. Thus, the maples and beeches grew more quickly.

(Qn.2 Shade tolerance): *We are interested in student understanding of competition, niches and adaptations. We are also interested in whether or not the students can use the information provided and apply their knowledge of ecological interactions*

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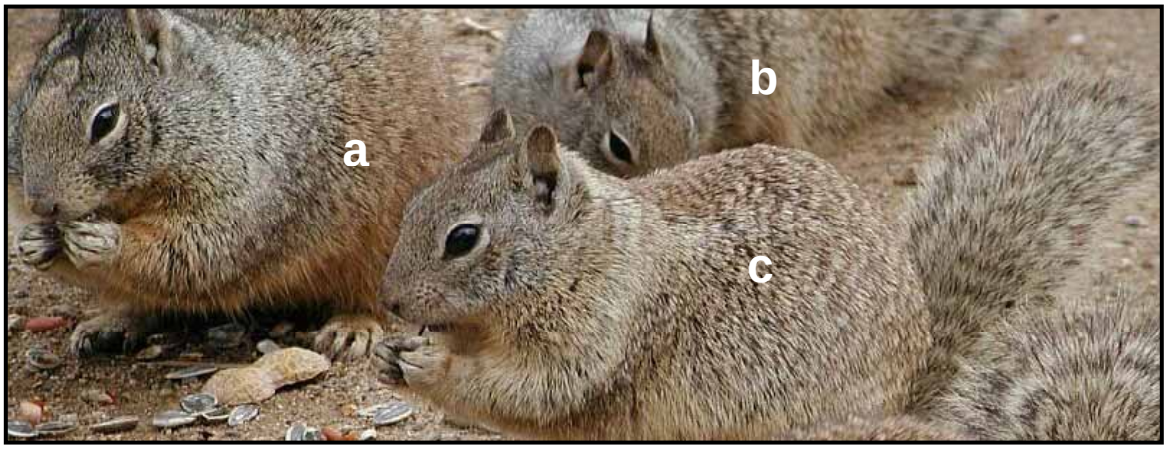

Picture G – Squirrels that live in the beech maple forest

3. As the land in Picture C gradually changed from sand dunes to a forest, squirrels began to inhabit the forest.

a. Why do squirrels live in the forest and not in the sand dunes? What does the forest have that helps the squirrels survive? What do the sand dunes not have that the squirrels need to survive?

Squirrels live in a habitat that provides them with the needs to survive. In particular, food, shelter, and water. Sand dunes do not provide the squirrels with protection/cover from predators such as hawks. They also do not provide adequate food and water sources. Squirrels depend on food that comes from plants and trees that live in the forest. The trees provide squirrels with places to build nests and shelter from predators in the sky and on the ground.

b. Before it was a forest, chipmunks lived in the area. Now, there are fewer chipmunks and more squirrels. Why are there fewer chipmunks now? Why are there more squirrels?

Chipmunks and robins were better adapted to the environment. As the environment changed, so did the animals the live in the environment.

(Qn.3 Squirrel niche): *We are interested in student understanding of niches and adaptations. As environments change, so do he resources that they afford animals. Some animals are better suited for particular environments than others. We are particularly interested in how students make connections between:*

- *Characteristics of individual organisms—their traits described in terms of structures, functions, and behavioral patterns—and*

Characteristics of ecosystems—the niches and habitats that are available in particular living communities and non-living environments.

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4. In the picture G, there are three squirrels a, b, and c that live in the forest and resemble one another. Suppose you are a scientist who is asked to determine how closely the squirrels are related to one another. Name two tests or observations that you could make to decide how closely the squirrels are related and what evidence you would look for in each one.

a. Suppose you could observe the squirrels, but not handle them. How could you test to see how close they are related? What would you observe?

Compare and contrast the physical characteristics of the three squirrels, comparing the size, coloration, face, arms, ears, eyes, etc. If the parts of the squirrels closely resemble one another – similar face, arms, ears, eyes, etc, then it would suggest that the three squirrels are of the same species.

b. Suppose you had blood samples from the squirrels. How could you test the blood samples to find out how closely they are related? What could you test?

Extract genetic material from each squirrel and run tests in the laboratory to see if they are similar. If the genetic material is similar, then it would mean that the squirrels are the same species and possibly even from the same family.

(Qn 4 Squirrel family): *We are interested in student understanding of how populations are linked phylogenetically. We are also interested in whether students understand that genetic makeup, life cycle stage and environmental variability are all important in determining the phenotype of individuals. Visible (morphological) answers and invisible (biochemical, DNA) answers are both correct.*

5. Squirrels have claws that they use to help them climb the bark of trees and jump from branch to branch. They had ancestors that did not have good claws, so they were not as good at climbing and jumping. Explain how modern day squirrels have claws that are good for climbing and jumping even though their ancestors did not.

There was initial genetic variation amongst the population of squirrels. The squirrels who were better adapted to their environment (claws that helped them climb and jump) enabled those squirrels to survive and reproduce, thus passing their genes on to the next generation. Over time, the proportion of squirrels in the population that had "good" claws increased.

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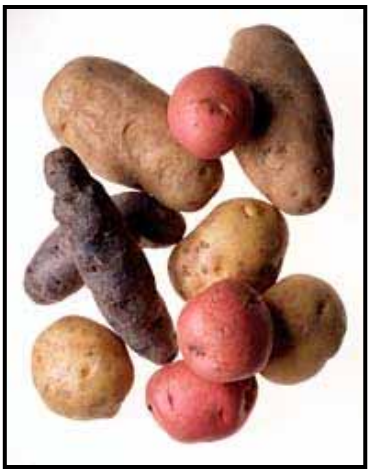
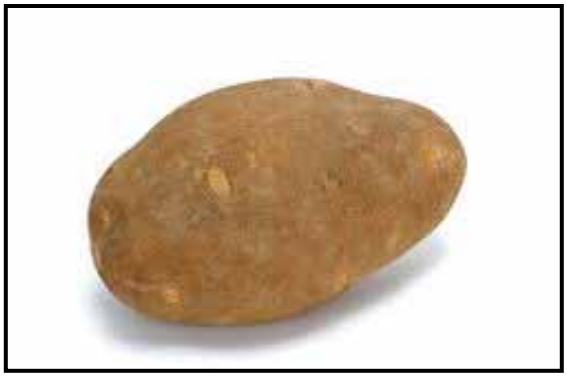
Farm Test Answers

1. When Europeans first came to Peru, they found that the Peruvians were growing a crop that they had never seen before: potatoes. Each Peruvian field contained many types of potatoes, as shown in the picture on the left. The Europeans worked hard to improve Peruvian potatoes. Eventually they developed potatoes like the one on the right—all bigger and providing more food than Peruvian potatoes.



Peruvian fields



European fields

1a. What do you think the Europeans did to get their big, uniform potatoes from smaller, more variable Peruvian potatoes?

This is another version of the question about dogs that we mentioned in the introduction, and closely related to the process of evolution by natural selection. We will be interested to see if more students mention artificial selection and reproduction in this question: Europeans selected the biggest potatoes and grew the next generation of potatoes from the big potatoes through many generations.

1b In the mid 1800's, the potato blight killed most of the potato crop in Ireland, a European country, resulting in starvation and the death of about one million people. How was this related to their decision to plant only one type of potato?

If the Europeans had grown a genetically diverse mixture of potato crops, it is likely that some of the potatoes would not have been susceptible to the disease, decreasing the effects of the potato blight on food for humans.

***(Qn.1 Potato):** Our purpose in asking this question is to understand students' reasoning about*

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genetic diversity leading to increased ecosystem resistance and resilience to catastrophic events. We are interested in whether students use genetics to explain why the appearance of the Peruvian potatoes is more variable than the appearance of the European potato. We are also interested in whether students see a link between genetic diversity and resistance or resilience to disturbance.

2. Farmers often spray their crops to help prevent bugs from eating their crops. Over time, the bugs slowly become resistant to these sprays, and so the farmers have to use different sprays to protect their crops. Tell a story about how the bugs become resistant to the sprays.

Insecticide resistance is related to the genotype of the insect. Some insects are less susceptible to the insecticide than others. Those are the insects that survive and reproduce, thus passing their genes to the next generation. Over time, the proportion of insects in the population that are resistant to the insecticide will increase.

***(Qn.2 Insecticide Resistance):** Our purpose in asking this question is to understand students' reasoning about genetic diversity, differential survival and reproduction, heritability of traits and evolution of a population. We are interested in whether students understand that both genetic diversity and selection are required for evolution to occur.*

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3. Farmers till the soil (stir it up with machines) to get rid of weeds. Why are weeds bad for crops?

Weeds reduce corn plant survival and reproduction because weeds compete with the crop for resources such as water, nutrients and light.

(Qn3 Weeds): *We are interested in whether students particularly understand competition and niches, that human modification of the environment can increase the probability of survival and reproduction, which is necessary for food production. We are also interested in whether or not students understand the beginning stages of ecological succession.*

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4. The pictures below show characteristics of some different plants and animals. Describe how the characteristics might help the plants or animals to survive and reproduce.

	**Apples: Why are they round and sweet?** *Apples are the fruit of the apple tree and they contain the apple tree's seeds. Round, sweet fruit attracts animals that will eat the apple and carry its seeds to locations where the seeds can grow into new apple trees.*
	**Grass: Why does grass have long roots that grow deep into the ground?** *The mushroom caps shown in the picture are the fruiting bodies of the fungus that lives in the ground or in a decaying tree. The fruiting bodies release small spores that can spread to other areas and grow into new mushrooms.*
	**Cow Tongue: Why is it long and tough?** *The cow has a long, tough tongue that is used to reach out and grab blades of grass and clover growing on the ground. This large tongue allows the cow be more efficient when grazing in a pasture, thus increasing its food intake and chances of survival.*

4a. This corn plant has been genetically modified so that it produces a toxin called BT that kills insects when they eat the corn plant. Why would a farmer choose to plant this genetically modified variety of corn?

The farmer may grow more corn and healthier corn because his crop will have fewer insects eating it. The farmer may also be able to save time and money because he will not have to spray his crops with as much insecticide.

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4b. Genetically modified corn is banned in Europe. What is it about genetically modified organisms that Europeans might be worried about?

There is uncertainty about the safety of consuming genetically modified crops, so some people do not buy genetically modified foods. There is also uncertainty about whether and how genes from a genetically modified organism can end up in other nearby populations and what the consequences of that would be. Also, genetic modifications to organisms may not produce the desired effect (e.g. reduction in number of insects eating the crop) for long because insects may eventually become resistant to BT if many farmers use BT to prevent insects from eating their crops.

4c. All farmers plant special varieties of corn that have been developed by humans. What is the difference between genetically modified corn and those other special varieties?

Genes from other species are inserted into the DNA of crop plants to provide the crop plant with a specific trait. The genes are inserted using bacteria, viruses and machines that splice DNA pieces into the existing crop genome.

Other special varieties of corn were created by artificial selection of genes that were already present in the gene pool of that species. Evolution by mutation requires a random change in the genome for new traits to be present. Genetic modification requires human intervention to add a new gene to an existing genome; therefore chance mutations are not needed.

***Q4 – GMO**. We are interested in identifying what students thoughts are about GMOs and whether they see risks and benefits of producing GMOS and whether they see ways in which production of GMOs is different than evolution by natural selection. We would also like to learn more about what "genetically modified" means to students.*

5. To the right is a photo of flock of sheep. Which of the statements below best describes the group of sheep? Circle your answer below:

a) The sheep are all identical to each other.

b) The sheep are all identical on the inside, but have many differences in appearance.

c) The sheep are all identical in appearance, but are all different on the inside.

d) The sheep share many characteristics, but also vary in many features.

e) The sheep are all completely unique and share no features with other sheep.

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Explain your answer. How are the sheep alike and how are they different?

Alike: *The sheep all look similar because they are the same species and have similar genetic structure, but they are a little different.*
Different: *Three factors that make the sheep different are their genetic structure, their interaction with the environment (food, habitat availability, contact with humans) and their age.* ***(Qn5. Sheep):*** *In this question, we are looking for student responses that identify sheep as similar because they are the same species (similar genetic codes, morphology and behavior). We also are interested in whether students can identify the sheep as slightly different, and identify three important factors that make them different (Genetic structure, environmental interaction and life cycle).*

Photo A
Corn Field

Photo B
20 years later

Photo C
80 years later

6a. A farmer stopped planting his corn field. The photos above show what the corn field looks like 20 and 80 years after he stopped planting. During the 20 years after the farmer stopped planting, the number of plant species increases. Why do you think this happens?

The number of plant species increases because the farmer no longer prevents the weeds from growing in his/her cornfield. The different plant species each have a unique niche and are adapted to different conditions, allowing them to survive together in the field

6b. After 80 years, most of the smaller plants have been replaced by trees. Why do you think this happens?

The trees reproduce by seed, and take longer to get to the corn field. Once the tree seeds somehow get to the field, they grow taller than all of the other plants and are better competitors for sunlight. ***(Qn.6 Succession):*** *In this question, we are trying to understand not just whether students understand succession, but more asking them why succession happens. We are particularly interested in why students think that multiple species exist in an area, and why some species (trees) replace others during succession.*

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7. Below is a picture of a Michigan forest next to a soybean field. A herd of deer live in the area. Why are the deer sometimes found in the forest and sometimes found in the field?

Individual deer have different needs for survival and reproduction. For, example they need food, shelter from weather conditions and predators, water, and space. The corn field might be better at providing food for the deer and the forest might be better at providing shelter.

(Qn7 Deer): *We are interested in whether students particularly understand the concept of niches, and that organisms need more than food for survival, but also need shelter from the elements and predators.*

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Park Test Answers

1. The two pictures below show a park. Picture A shows the north side and Picture B the south side of the same park. Looking at both pictures, respond to the questions that follow.

Picture A – North side of park

Picture B – South side of park

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1. In picture A you can see a neat lawn where people are having picnics. In the background behind the people there is a forested area with different trees and shrubs. Both grass from the lawn and trees from the forested area produce seeds that are carried by the wind and scattered everywhere.

a. Why do you think that very little grass is growing under the trees, even though some grass seeds sprout under the trees?

People remove tree seedlings from the lawn and grass from under the trees. It is too shaded under the trees for grass to grow well.

b. Why do you think there are no trees growing in the lawn, even though some tree seeds sprout in the lawn?

The tree seedlings are removed by people and not allowed to grow into trees.

c. What do you think that people (including park groundskeepers, visitors, etc.) are doing that makes grass grow well and trees grow poorly on the lawn?

They can be mowing, weeding and spreading herbicides. These activities create an environment that eliminates species competition for the grass and allows the grass to grow well.

(Qn.1 Lawn & trees): *We are interested in student understanding of how individuals are adapted to their niches and habitats and what, if anything, keeps individual populations from dominating the landscape, what limits the growth of populations and encourages diversity.*

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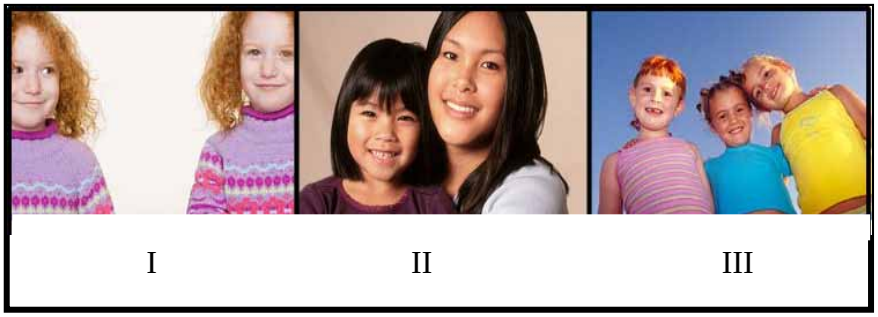
2. Among the picnickers in Picture A are the following people:



I II III

a. Which of the above pictures show twins? How are they alike and different?

Alike: *Picture I. They are identical twins and so have the same genetic makeup from the same parents, they are essentially genotypic clones so they look physically identical.*
Different: *They are different in the ways they interact with and are therefore influenced by the environment. They may have different likes and dislikes in spite of being genotypic clones.*

b. Which of the above pictures show friends? How are they alike and different?

Alike: *Picture III. They are alike in that they are all girls and appear to be the same age.*
Different: *Friends are unrelated to one another so they do not inherit from a common gene pool. They are different because they do not share similar traits – e.g. they have different hair colors and other facial features because they have different genetic makeups because they have different parents. They also interact with the environment in different ways which contributes to building their own unique personalities.*

c. Which of the pictures show sisters? How are they alike and different?

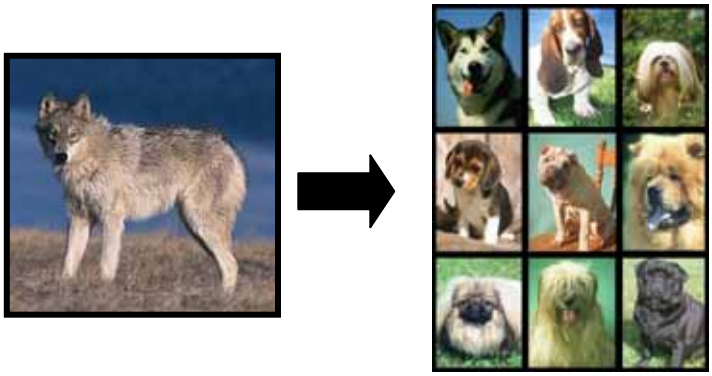
Alike: *Picture II. The sisters have the same parents (same gene pool) so they could have inherited similar traits from the parents, e.g. both have black hair because the parents carry the allele for black hair.*
Different: *The sisters are different in that although they share some traits they are not genotypic clones like the twins. Hence they are not physically identical like twins. Also, they interact with the environment in different ways which contributes to building their own unique personalities.*

d. Suppose you have blood samples of the two individuals in picture II. How would you figure out their relationship (twins, sisters, or friends) from the blood samples?

Run DNA analysis of the blood samples.

(Qn.2 Twins, sisters & friends): *We are interested in student understanding of how individuals within populations are alike and different and how they are related to one another, as well as how life cycle stage and environmental variability are all important in determining the phenotype of individuals.*

3. In picture B you see a man with four pet dogs. Three of the dogs are German Shepherds and one is a Cairn Terrier. These dogs are all descended from wolves as are other dog breeds shown in the picture below:



How could dogs that live with humans become so different from one another and from wolves?

There is genetic variation amongst the wolf ancestors which would result in the breeding of different offsprings. Humans also select for specific traits and characteristics for specific environments through dog breeding practices leading to the different breeds of dogs we see today.

(Qn.3 Wolf & dogs): *We are interested in student understanding of how populations change over time through migration, selection, and reproduction. We are also interested in whether students understand that genetic makeup can influence the phenotype of an individual.*

4. In the background of Picture A, there are three trees 5a, 5b, and 5c that look like one another. Suppose you are a scientist who is asked to determine how closely the trees are related to one another, for example, if they all have the same parents. Name two tests or observations that you could make to decide how closely the trees are related and what evidence you would look for in each one.

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a (i). Suppose you could observe and handle the trees. What would your first test or observation be?

Compare and contrast the physical characteristics of the three trees, comparing the leaves, trunk, root system, shape of the crown of the tree, flowers and fruits if they are present.

a (ii). What evidence would it give you about how closely the trees are related?

There is genetic variation amongst the wolf ancestors which would result in the breeding of different offsprings. Humans also select for specific traits and characteristics for specific environments through dog breeding practices leading to the different breeds of dogs we see today.

(Qn.3 Wolf & dogs): *We are interested in student understanding of how populations change over time through migration, selection, and reproduction. We are also interested in whether students understand that genetic makeup can influence the phenotype of an individual.*

b (i). Suppose you could not handle the trees but were given samples of tree wood, bark, and leaves. What tests or observations would you make on the tree samples?

Extract genetic material from each tree and run tests in the laboratory to see if they are similar.

b (ii). What evidence would these tests or observations give you about how closely the trees are related?

If the genetic material are similar, then it would mean the trees are the same species.

(Qn.4 Trees): *We are interested in student understanding of how populations are linked phylogenetically. We are also interested in whether students understand that genetic makeup, life cycle stage and environmental variability are all important in determining the phenotype of individuals. Visible (morphological) answers and invisible (biochemical, DNA) answers are both correct.*

Initials

5. Look at picture A. What do you think will happen to the lawn and to the forested area if humans abandoned this park completely?

Lawn:
Other species will start to grow in the lawn. The lawn will lose its manicured look as weeds and other plant species including the seeds from the trees in the background start to grow in the lawn area.

Forested area:
Other species will start to grow in the forested area. Grass seeds from the lawn will be germinate in the forested area as will other plant species.. If left long enough the two locations will resemble each other in species diversity if the environmental conditions are consistent between both locations.

(Qn.5 Succession): *We are interested in student understanding of how populations change over time, what limits the growth of populations and encourages diversity.*