

AP[®] BIOLOGY
2007 SCORING GUIDELINES (Form B)

Question 4

The energy flow in ecosystems is based on the primary productivity of autotrophs.

(a) **Discuss** the energy flow through an ecosystem and the relative efficiency with which it occurs.

One point for each of the following explanations/identifications (6 points maximum):

- Conversion of light (or inorganic chemical) energy to cellular chemical energy
- Explanation that conversion is the result of photosynthesis or chemoautotrophy
- Concept that energy moves from one trophic level to another
- Understanding that there is a dramatic decrease in the amount of energy transferred from one trophic level to the next
- Energy loss is the result of metabolic activity/heat loss from one trophic level to the next
- Explanation of the concept of primary productivity

(b) **Discuss** the impact of the following on energy flow on a global scale.

- Deforestation
- Global climate change

One point for each of the following explanations/identifications (6 points maximum):

Deforestation (3 points)	Global climate change (3 points)
<p><u>Impact</u></p> <ul style="list-style-type: none"> • Loss of energy • Removal of primary producers • Destruction of habitat decreases food supply • Disruption of ecosystem • Natural succession—NO change in energy flow • Clear-cutting for agriculture increases primary productivity • Clear-cutting for development decreases primary productivity 	<p><u>Definition</u></p> <ul style="list-style-type: none"> • Alternation of climate/global warming or cooling <p><u>Impact</u></p> <ul style="list-style-type: none"> • Increase or decrease in numbers of producers • Increase or decrease in energy • Increase or decrease in metabolism/energy • Changes in respiratory heat depending on the ecosystem • Replacement of productive ecosystems with less productive ones (desertification, tundrification)

4A,

10% efficiency



4. The energy flow in ecosystems is based on the primary productivity of autotrophs.

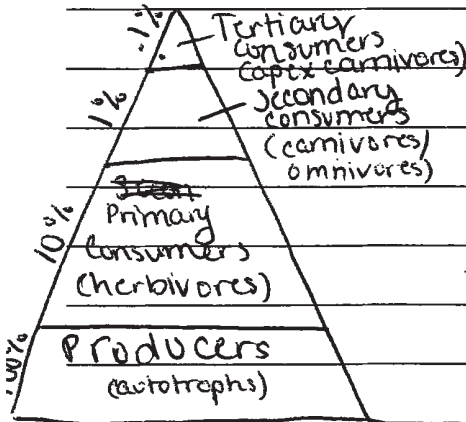
(a) Discuss the energy flow through an ecosystem and the relative efficiency with which it occurs.

(b) Discuss the impact of the following on energy flow on a global scale.

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a) Autotrophs, or primary producers, take energy from sunlight to produce glucose,

which is an energy-storing monosaccharide, by combining 6CO_2 and $6\text{H}_2\text{O}$ molecules through photosynthesis to make $\text{C}_6\text{H}_{12}\text{O}_6$ (glucose) and O_2 . Autotrophs, which are primarily ^{green} plants that capture the sun's light, are then



eaten by herbivores, or primary consumers (see pyramid). These herbivores break down the glucose during cellular respiration to get energy, but unfortunately energy had to be lost as heat while foraging for food and is lost during cellular respiration, so only 10% of the energy provided by the autotrophs is actually used by the primary consumers. Then, other animals that are carnivorous and thus secondary consumers eat the herbivore which only had 10% of the original energy, and they only have a 10% efficiency with the usage of that energy, leaving them with 1%. If there is another tertiary consumer which eats the secondary consumer, this organism only gets .1% of the total

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energy originally fixed into glucose by the autotroph.

b) Worldwide, there is a destruction of the natural environment by industrialized nations, leading to massive deforestation, global warming, and net disruptions of the energy flow. Because trees are autotrophs, they provide a majority of the energy in ecosystems like tropical rainforests (which are particularly susceptible or victimized by deforestation). Many species of primary consumers have gone extinct because of the destruction of their habitat and source of energy in that habitat due to deforestation. And because the primary consumers become extinct, also will the secondary and tertiary consumers who rely on those organisms for food, thus creating a cascade of extinctions. Also, many acres of rainforest are burned, essentially wasting 100% of the energy they stored and contributing CO₂ and ~~useless~~ heat to the atmosphere, causing global warming. As the climates warm, entire ecosystems are disrupted, causing extinctions as previously mentioned and decreasing net global productivity. As the oceans warm, dissolved oxygen will decrease, killing many aquatic animals and

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4A₃

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plants, which provide energy for the rest of the world. With algae, a major producer in many ecosystems, ~~it~~ if it became extinct many bodies of water would be lifeless.

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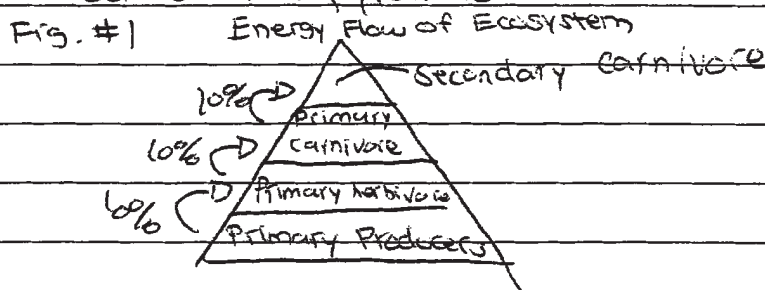
4. The energy flow in ecosystems is based on the primary productivity of autotrophs.

(a) **Discuss** the energy flow through an ecosystem and the relative efficiency with which it occurs.

(b) **Discuss** the impact of the following on energy flow on a global scale.

- Deforestation
- Global climate change

(a) The energy flow through an ecosystem can be demonstrated with a pyramid:



Each level in the pyramid represents a trophic level. The bottom represents the producers, while the top represents the carnivores. A typical ecosystem could have grass as a primary producer, grasshopper as primary herbivore, snake as primary carnivore, and bald eagle as the secondary carnivore. It is important to note that a trophic level only gets 10% of the energy of the next trophic level. Therefore, if the grass starts out with 1,000 units, the grasshopper would get 100, the snake 10 units, and the bald eagle 1. However, it is also important to note that toxins are more concentrated at the top of the ecosystem than at the bottom. That is because the poisons accumulate from the bottom. An example of this is that the bald eagle almost went extinct because of the amount of toxins it ingested. However, with human interference, or artificial selection, the bald eagle did not go extinct.

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(b) Deforestation is disrupting the energy flow of many ecosystems as it is ~~destr~~ destroying many habitats of various trophic levels. Also, with the lack of primary producers, the energy flow of all ecosystems would be reduced. Whether deforestation is caused by abiotic factors ~~such as natural disasters~~, such as non-human induced fires, ~~storms~~^{storms}, or by artificial (human) means, ecological succession will take place. If all the soil is gone by deforestation, it is called primary ecological succession; otherwise, it is only ~~primary~~ secondary succession. Either way, deforestation will globally alter the ecosystems, and thus, the energy flow of the world.

Global climate change, or global warming is caused by the use of CFC's, as it is burning a hole through the ozone layer. This increase of temperature of even 1°C will ~~alter~~ globally affect the energy flow as it is melting the ice caps, resulting in high tides and flooding worldwide. As this will no doubt affect habitats and their primary producers, as with ~~deforestation~~, deforestation, ecological succession will no doubt take place.

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~~(a) In an ecosystem energy flows from an ^{aut}producer to a primary consumer, secondary consumer~~

(a) In an ecosystem, energy flows from the sun in the form of radiant energy to an autotroph which uses it to produce sugars. A consumer (primary) will consume the autotroph. Energy then passes to a secondary consumer and then a tertiary consumer and afterwards ~~energy~~ a decomposer would consume an organism.

~~At~~ With each passing level only 10% of the energy actually makes it to the next level for the next organism.

(b) Deforestation and global climate change

impact the energy flow in that they ~~change~~ ~~the entire~~ give rise to changes in the environment which can influence a variety of factors. Deforestation would directly impact habitat and environment and hence the organisms in them. Climate change would do the same thing

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such as affecting temperature which could affect radiant energy and its availability to plants which in turn has a ripple effect on other levels.

Deforestation could affect the number of organisms that would survive and hence interrupt the energy flow for organisms.

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AP[®] BIOLOGY
2007 SCORING COMMENTARY (Form B)

Question 4

Sample: 4A

Score: 10

In part (a) the student earned 5 points: 1 point for describing the conversion of light to cellular chemical energy (in glucose); 1 point for explaining the role of photosynthesis; 1 point for the concept of energy moving through trophic levels, which was described and diagrammed; 1 point for explaining that energy loss results from metabolic heat; and 1 point for describing the inefficiency of the transfer (10 percent rule).

In part (b) the student received 5 points: 1 point for explaining that deforestation results in a loss of producers; 1 point for explaining that this leads to energy loss; and 1 point for stating that the result is a disruption of the ecosystem. (The internal maximum of 3 points for the deforestation subsection was reached.) With regard to global climate change, the student earned 1 point for defining the change as global warming and 1 point for describing the replacement of a productive ecosystem with a less productive one. An additional point could have been gained if the change in the number of producers had been mentioned.

Sample: 4B

Score: 6

In part (a) the student was awarded 2 points: 1 point for describing the concept of energy moving through trophic levels, using a diagram and a narrative, and 1 point for the inefficiency of the energy transfer (10 percent rule). There was no discussion of photosynthesis, the conversion of radiant energy, or the concept of primary productivity.

In part (b) the student earned 4 points: 1 point for explaining that deforestation results in a loss of producers; 1 point for explaining that this leads to energy loss; and 1 point for stating that the result is disruption of the ecosystem. (All possible points for the deforestation subsection were achieved.) With regard to global climate change, the student earned 1 point for defining the change as global warming. There was no discussion of the replacement of a productive ecosystem, a change in the number of producers, or a resulting change in energy flow. The incorrect reference to CFCs and the ozone hole causing global warming was not penalized.

Sample: 4C

Score: 4

In part (a) the student received 4 points: 1 point for describing the conversion of light to cellular chemical energy (sugars); 1 point for explaining that this conversion is carried out by an autotroph; 1 point for the explanation of the concept of energy moving through trophic levels, using both a diagram and a narrative; and 1 point for the inefficiency of the transfer (10 percent rule). The possible points for metabolic heat loss and explaining the concept of primary productivity were not earned.

In part (b) no points were earned. It contains a vague discussion of “[d]eforestation and global climate change” and an equally vague mention of energy, but no discussion of impact.