(a) Calculate the number of acres required to produce 1,000 gallons of oil in one year from

(i) microalgae

(ii) soybeans

(b) Describe TWO environmental advantages that biodiesel production from microalgae offers over biodiesel production from the other crops listed in the table.

(c) Explain why burning biodiesel fuel has a different impact on atmospheric CO_2 concentrations than does burning fossil fuels.

(d) Discuss TWO benefits, other than those related to atmospheric impacts, of increased reliance on biodiesel fuels over the next 50 years.

(e) Describe TWO economic or societal problems associated with producing fuel from corn.

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3. For decades, forest fires in the United States have been suppressed. In 2003 legislation was passed under the Healthy Forests Initiative (HFI) in response to the record-breaking wildfires that had occurred in the early 2000s. Some environmental and conservation groups fear that negative impacts could result if timber companies are encouraged to harvest medium- and large-size trees in federally owned forests while clearing away the smaller trees and underbrush.

   (a) Identify TWO characteristics of forests that develop when fires are suppressed, and explain why the practice of fire suppression does not reduce, but actually increases, the risk of intense and extensive forest fires.

   (b) The effects of the HFI are expected to extend beyond fire reduction. Excluding fire reduction, describe ONE positive and ONE negative effect likely to result from the implementation of the provisions of the HFI.

   (c) Describe TWO ecosystem services provided for humans by forests. Explain how clear-cutting would affect each ecosystem service you describe.

   (d) Identify a specific type of plant community or biome (other than a forest) that is naturally maintained by fire. Explain how the fire maintains the community or biome.

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Question 3

(a) Identify TWO characteristics of forests that develop when fires are suppressed, and explain why the practice of fire suppression does not reduce, but actually increases, the risk of intense and extensive forest fires.

(Three points can be earned: 1 point for each correct characteristic, and 1 point for a correct explanation. Only the first two characteristics given are scored.)

Characteristics of Forests
• Accumulation of combustible materials (layer of leaf litter and debris on forest floor, dead trees, etc.) • Increase in understory growth (grasses, shrubs, brush, ladder trees) • Larger trees develop • Even-aged stands develop • Tree density increases • Fire-intolerant species increase in number in the understory • Fire-tolerant species that need fire to germinate seeds decrease in population • Increased canopy coverage eliminates understory growth • Increase or decrease in the rate of nutrient cycling (e.g., release of nutrients of litter, lack of nutrient-rich ash) • No loss of nutrients to burning in intense fires • Increased susceptibility to disease/parasites

Explanations for Increased Fire Risk
Adds to fuel load [intensity] • Increased leaf litter • Increased density of large trees • Increased size of trees • Increase in brush and small trees • Species composition change Adds to spreading of fire [extent] • Increased density of trees • Increased density of understory growth • Ladder trees leading to crown fires

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Question 3 (continued)

(b) The effects of the HFI are expected to extend beyond fire reduction. Excluding fire reduction, describe ONE positive and ONE negative effect likely to result from the implementation of the provisions of the HFI.

(Two points can be earned: 1 point for a correct positive effect and description; 1 point for a correct negative effect and description.)

Positive Effect and Description	Negative Effect and Description
Increased removal of medium and large trees/small tree brush removal will: • lead to economic growth in the lumber industry Increased removal of medium and large trees will: • allow understory to develop into larger trees, potentially enhancing forest habitat • make additional timber available to use (must indicate usage) • result in thinned trees resistant to pests and disease/impede spread of diseases and pests • enhance economic value of the surrounding areas (housing, lower insurance) • lower the cost of timber • result in a change of aesthetics (with explanation)	The removal of medium and large trees/small tree brush removal will: • reduce available habitat for other organisms in the forest biome • allow timber companies to cut in areas remote from forest communities not threatened by forest fires • cause a reduction in biodiversity (must include a specific example: reduction in nest sites, decrease in seed trees, etc.) • increase soil erosion • increase logging practices (e.g., roads providing access to new areas) • reduce public input • result in a change in aesthetics (with explanation)

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Question 3 (continued)

(c) Describe TWO ecosystem services provided for humans by forests. Explain how clear-cutting would affect each ecosystem service you describe.

(Four points can be earned: 1 point for each correct ecosystem service, and 1 point for each correct link that describes the impact of clear-cutting. Only the first two characteristics given are scored.)

Ecosystem Service	Impact of Clear-Cutting
Carbon that is removed from the atmosphere by trees helps to limit the magnitude of the atmospheric greenhouse effect.	• Some carbon will be released to the atmosphere or will not be removed
Forests provide oxygen (via photosynthesis).	• Some loss of oxygen, without which we cannot live
Forests provide food products for human consumption (deer, nuts, fungi).	• Can change available browsing places and sighting of animals due to species composition change, increasing their availability for humans (e.g., deer)
Forests provide habitat for many species, some of which provide food and goods for humans, some of which cause harm.	• Loss of habitat (biodiversity)
Forests provide wood (e.g., construction material, paper)	• Increase in the short-term availability of wood, but potential long-term loss of availability
Forests provide wood for fuel.	• Increase in the short-term availability of wood, but potential long-term loss of availability
Many products, such as glue, rubber, and medicines, are produced with forest products.	• Increase in the short-term availability of these products, but potential long-term loss of availability
Forests influence the local microclimate affecting humans (change in temperature, shade, UV, wind breaks).	• Change in the microclimate
Forests have aesthetic value (hiking, camping, photography, tourism, etc.).	• Decreases in natural beauty
Forests improve the quality of soil and water used by humans. (Soil and water must be linked to a specific human use.)	• Increases in erosion and runoff and decreases in groundwater recharge, changing water quality

Question 3 (continued)

Ecosystem Service	Impact of Clear-Cutting
Forests maintain watershed integrity (e.g., flood control with specific human application).	• Decreases in watershed integrity

(d) Identify a specific type of plant community or biome (other than a forest) that is naturally maintained by fire. Explain how the fire maintains the community or biome.

(Two points can be earned; 1 point for identification of biome; 1 point for correct explanation of how fire maintains biome.)

Grasslands (savannah, steppe, veldt, pampas, prairie, marquis, garrigue—regional descriptions should include mention of grasslands):

- Fire destroys invasive plant species (e.g., other grasses and trees) that compete for resources with native grasses.
- Fire removes cover and allows sunlight penetration.
- Fire helps the seeds of native grasses to germinate.
- Fires enhance cycling of nutrients back into the soil.

Chaparral (Mediterranean scrubland, Mediterranean shrubland—regional descriptions should include mention of location):

- Fire removes brush, reducing competition for resources.
- Fire helps plants that require fire or lack of brush cover to germinate.
- Species that vigorously stump sprout quickly regenerate themselves.
- Fires enhance cycling of nutrients back into the soil.

Note: Any forest biome earns no credit.