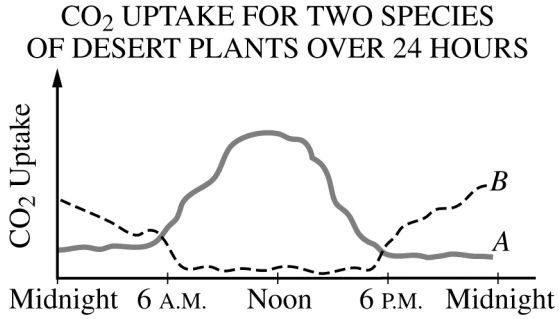
3. Compared with other terrestrial biomes, deserts have extremely low productivity.

   (a) **Discuss** how temperature, soil composition, and annual precipitation limit productivity in deserts.

   (b) **Describe** a four-organism food chain that might characterize a desert community, and **identify** the trophic level of each organism.

   (c) **Describe** the results depicted in the graph. **Explain** one anatomical difference and one physiological difference between species *A* and *B* that account for the CO_2 uptake patterns shown. **Discuss** the evolutionary significance of each difference.



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Question 3

Compared with other terrestrial biomes, deserts have extremely low productivity.

(a) **Discuss** how temperature, soil composition, and annual precipitation limit productivity in deserts. **(3 points maximum)**

Abiotic factor (description)	**How abiotic factor limits productivity (must be linked) (1 point per factor)**
Temperature	
Increase in transpiration/evaporation	Lowers photosynthetic rate
Desiccation	Lowers plant growth
Loss of water from tissues/guard cells	Lowers biomass production
Not optimal temperatures	PS/metabolic enzymes/proteins hindered
Soil composition	
Low organic content/nutrients	Lowers photosynthetic rate/plant growth
Low water retention	Lowers photosynthetic rate/plant growth
Sandy	Poor root anchorage limits plant growth
Compacted soil	Root limitations decrease photosynthesis
Annual precipitation	
Low rainfall	Little water available for photosynthesis
Seasonal rainfall	Lowers plant growth
	Period of high productivity/wildflowers

Clear definition/discussion of productivity: e.g., a measure of the amount of biomass produced by autotrophs/photosynthetic organism/plants…amount of light energy converted to chemical energy by autotrophs per unit time...reduced community productivity **(1 point)**

(b) **Describe** a four-organism food chain that might characterize a desert community, and **identify** the trophic level of each organism. **(2 points)**

- **Written description** of a minimum of 4 organisms (must include a producer/plant) **(1 point)**
- **Clear identification** of 4 distinct trophic levels of the organisms discussed **(1 point)**
  (producer → primary consumer → secondary consumer → tertiary consumer
  or top carnivore or decomposer or scavenger)

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Question 3 (continued)

(c) **Describe** the results depicted in the graph. **Explain** one anatomical difference and one physiological difference between species *A* and *B* that account for the CO_2 uptake patterns shown. **Discuss** the evolutionary significance of each difference. **(6 points maximum)**

Graph interpretation (3 points)

- Describe graph (plant *A* takes up CO_2 during day AND plant *B* takes up CO_2 at night) **(1 point)**
- Species *B* as CAM **(1 point)**
- Species *A* as C_3 or species *A* as C_4 **(1 point)**

Anatomical difference (1 point)

- Species *A* is C_4 with bundle sheath/wreath/Kranz anatomy
- Stomata location (pits/crypts, underside stems) linked to CO_2 uptake
- Stomata density linked to CO_2 uptake
- In species *B*/CAM vacuole/mesophyll of organic acids (malate)

Physiological difference (1 point)

- Species A stomata open during day
- CAM/species *B* stomata open at night/closed during day
- Species *A* uses C_3 pathway; CAM/ species *B* uses C_4 pathway
- C_3 uses Rubisco/ C_4 uses PEP Carboxylase
- Organic acids synthesis for CO_2 storage
- Carbon fixation during day vs. night

Evolutionary significance (2 points)

Discuss the evolutionary significance linked to each difference **(2 points, 1 point per difference)**
e.g., increased evolutionary success due to decrease in water loss in the desert environment
e.g., C_4 pathway circumvents the problem of photorespiration