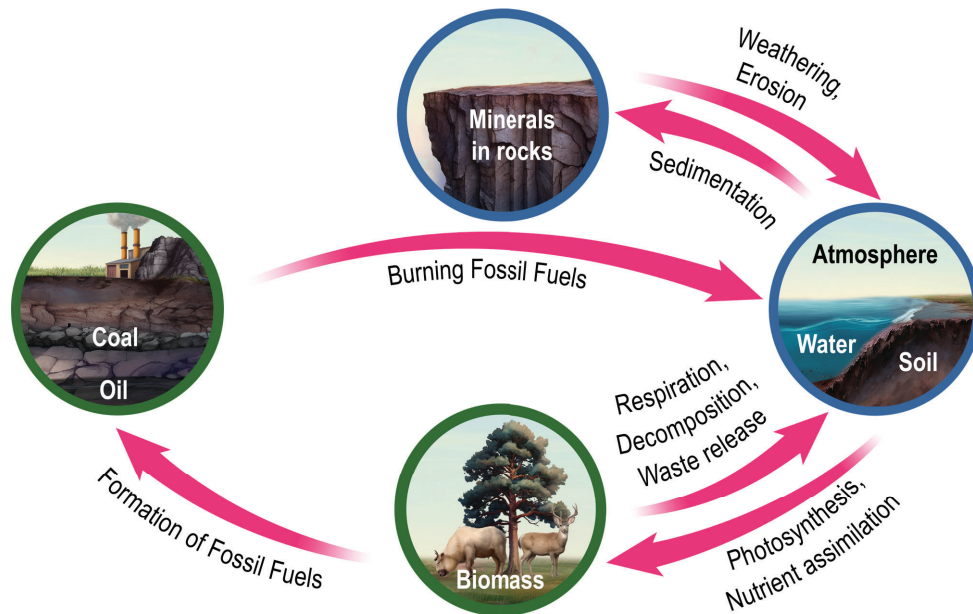


## TOPIC: BIOGEOCHEMICAL CYCLES

### Introduction to Biogeochemical Cycles

- ◆ **Biogeochemical Cycles:** processes recycling nutrients/elements between biotic & abiotic parts of an ecosystem.
  - Includes cycling of water, carbon, nitrogen, & phosphorous.
  - Biological/geological processes move nutrients between different \_\_\_\_\_ (“storage spaces”).



### **EXAMPLE**

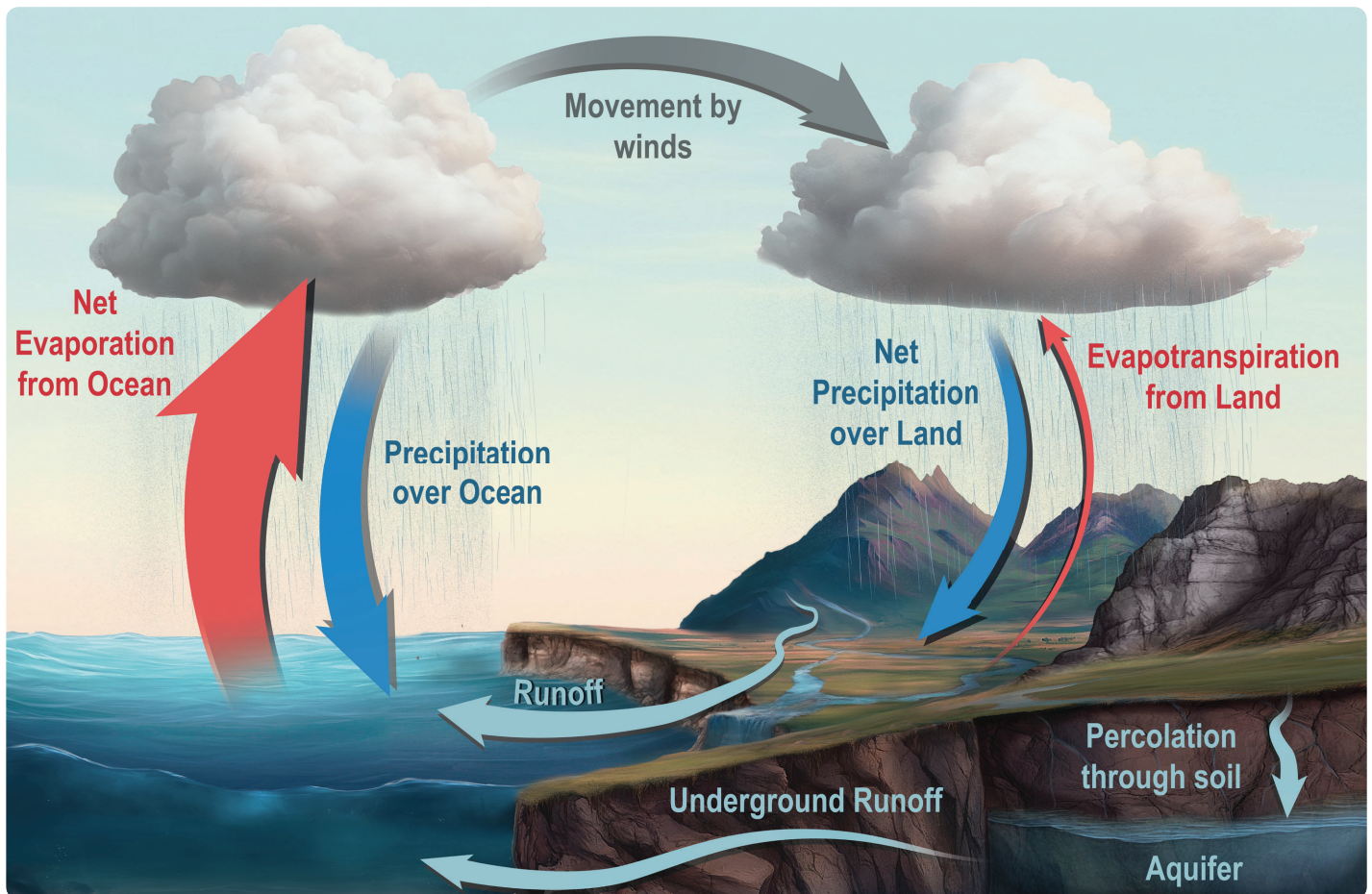
Which of the following is considered a geological process?

- a) Photosynthesis.
- b) Cellular Respiration.
- c) Excretion.
- d) Decomposition.
- e) Weathering.

## TOPIC: BIOGEOCHEMICAL CYCLES

### Water Cycle

- ◆ Over oceans, evaporation rate EXCEEDS precipitation rate, forming rain clouds.
  - Wind moves rain clouds from oceans → land.
- ◆ Water precipitates on land and eventually returns to oceans via surface water & groundwater.

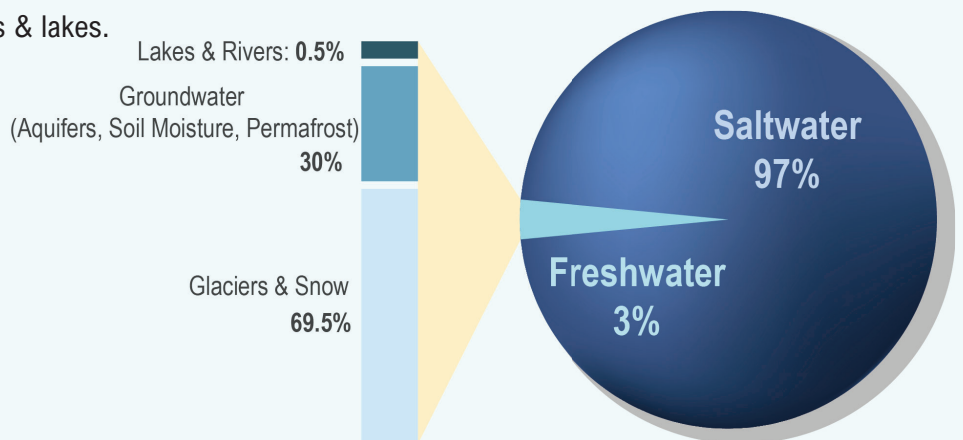


## TOPIC: BIOGEOCHEMICAL CYCLES

### EXAMPLE

Given the information from this graphic & the previous lesson, which of the following processes moves the smallest volume of water?

- a) Evaporation from freshwater rivers & lakes.
- b) Evaporation from oceans.
- c) Evapotranspiration over land.
- d) Precipitation over oceans.



### PRACTICE

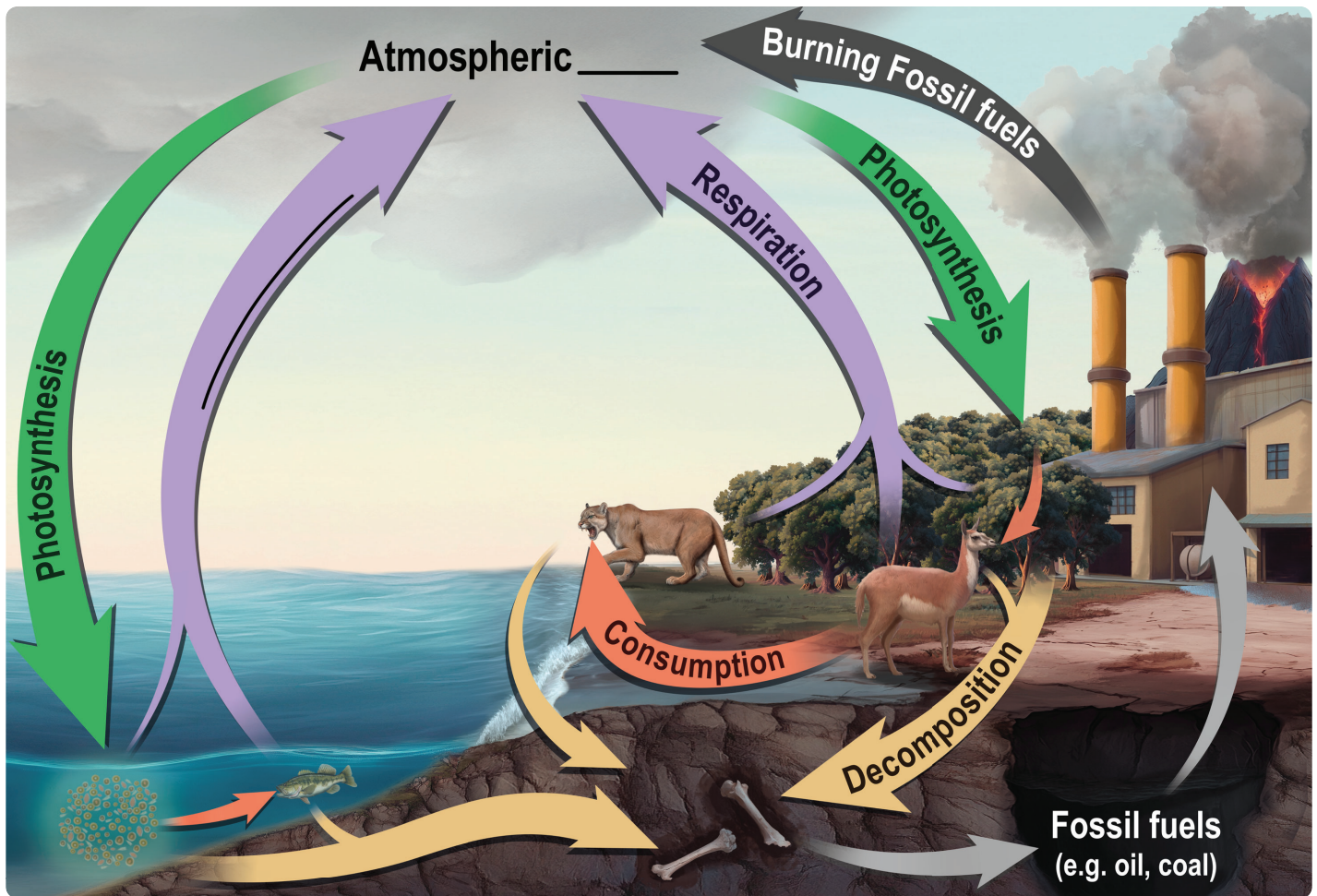
Imagine you're tracking a water molecule frozen in snow on land. Which of the following is a possible path it could take to eventually end up as part of the ocean?

- a) Melting into a stream, ingested by an animal, percolate into the ocean.
- b) Melting into a stream, evaporating into the atmosphere, then runoff into the ocean.
- c) Melting into soil, taken up by a plant, evapotranspiration into the ocean.
- d) Melting into soil, percolating into an aquifer, underground runoff into the ocean.

## TOPIC: BIOGEOCHEMICAL CYCLES

### Carbon Cycle

- ♦ Carbon in atmospheric  $\text{CO}_2$  enters ecosystems via **photosynthesis**.
  - Carbon reservoirs include oceans, biomass, soil, sedimentary rocks, fossil fuels, & the atmosphere.
- ♦ Carbon can be returned to the atmosphere via **respiration** or burning of fossil fuels.





## **TOPIC: BIOGEOCHEMICAL CYCLES**

### **EXAMPLE**

While a change in local conditions (e.g. heavy rainfall, drought etc.) may limit the amount of nitrogen, phosphorus, or water in an ecosystem, this is rarely the case with carbon. Why?

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- a) Plants can produce their own carbon via photosynthesis.
- b) Decomposers can produce their own carbon when they break organic material down.
- c) CO<sub>2</sub> in the air is a constant source of carbon for plants.
- d) Plants can take up carbon from the soil more efficiently than nitrogen, phosphorus, or water.

### **PRACTICE**

Which of the following statements is false?

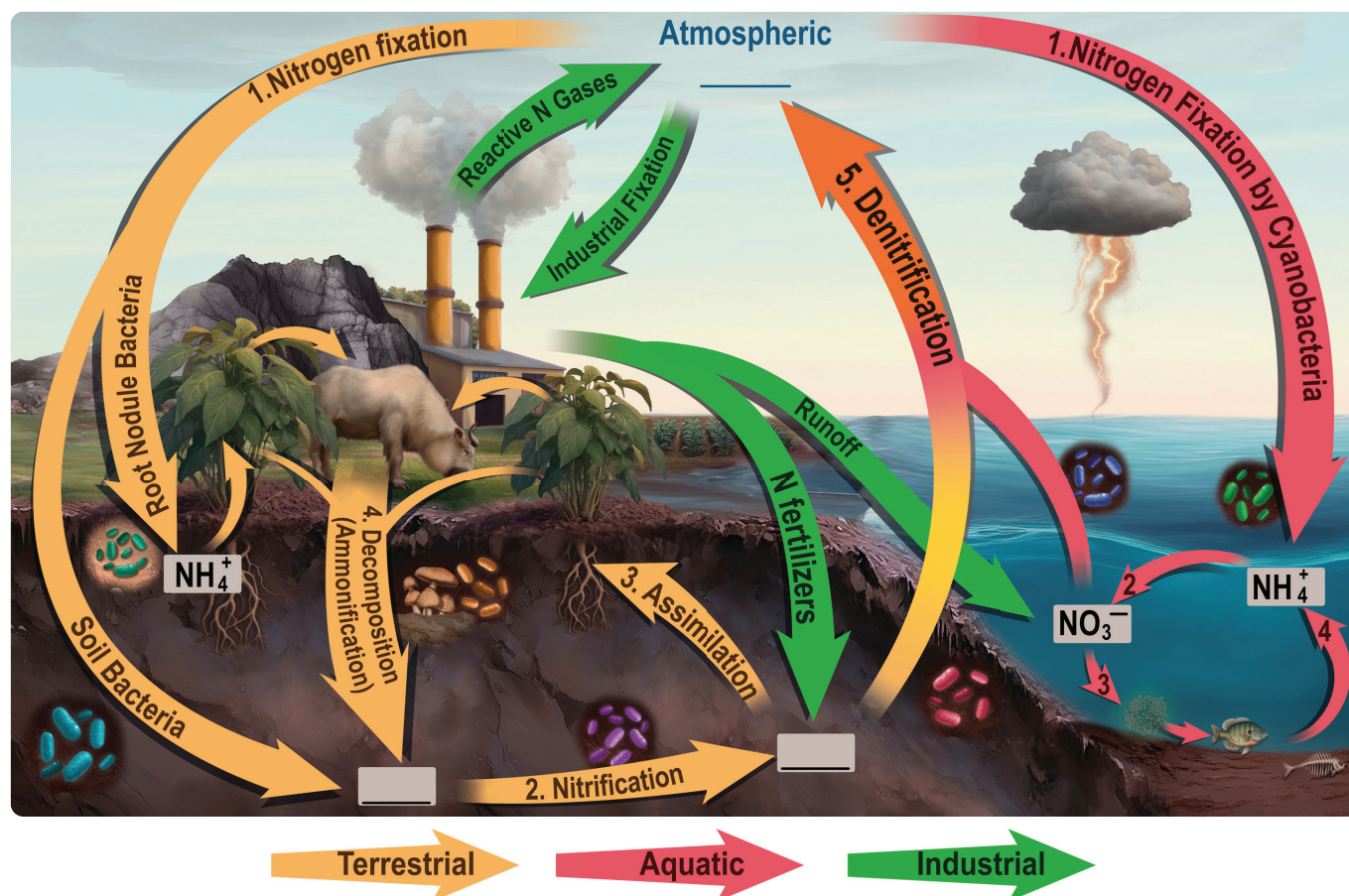
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- a) Biomass is one of the largest carbon reservoirs in the biosphere.
- b) Burning plants increases the amount of atmospheric CO<sub>2</sub>.
- c) The carbon cycle has maintained a constant atmospheric CO<sub>2</sub> concentration over the last million years.
- d) Carbon can be stored in soil, rocks, and ocean water.

## TOPIC: BIOGEOCHEMICAL CYCLES

### Nitrogen Cycle

- ♦ The atmosphere is ~78%  $N_2$  gas; however,  $N_2$  is biologically \_\_\_\_\_ to most organisms.
  - Nitrogen typically enters ecosystems via *nitrogen-fixing* \_\_\_\_\_ in soil & plant roots.
  - Nitrates ( $NO_3^-$ ) & ammonium ( $NH_4^+$ ) are the primary forms of nitrogen that plants can absorb/use.



<b>1. Nitrogen Fixation</b>	$N_2 \rightarrow NH_3 \rightarrow NH_4^+$	Nitrogen-fixing bacteria in soil/plant root nodules bring atmospheric nitrogen ( $N_2$ ) into ecosystems.
<b>2. Nitrification</b>	$NH_3$ or $NH_4^+ \rightarrow NO_2^- \rightarrow NO_3^-$	Nitrifying bacteria convert ammonia or ammonium to nitrate, which plants readily absorb.
<b>3. Assimilation</b>	$NO_3^-$ and $NH_4^+$ absorbed	Plants primarily absorb/use nitrate & ammonium.
<b>4. Ammonification</b>	Organic Nitrogen $\rightarrow NH_3$ or $NH_4^+$	Decomposition process where organic nitrogen from dead organisms & wastes is converted into ammonia or ammonium.
<b>5. Denitrification</b>	$NO_2^-$ & $NO_3^- \rightarrow N_2$	Denitrifying bacteria allow nitrogen gas to return to the atmosphere.

## TOPIC: BIOGEOCHEMICAL CYCLES

### PRACTICE

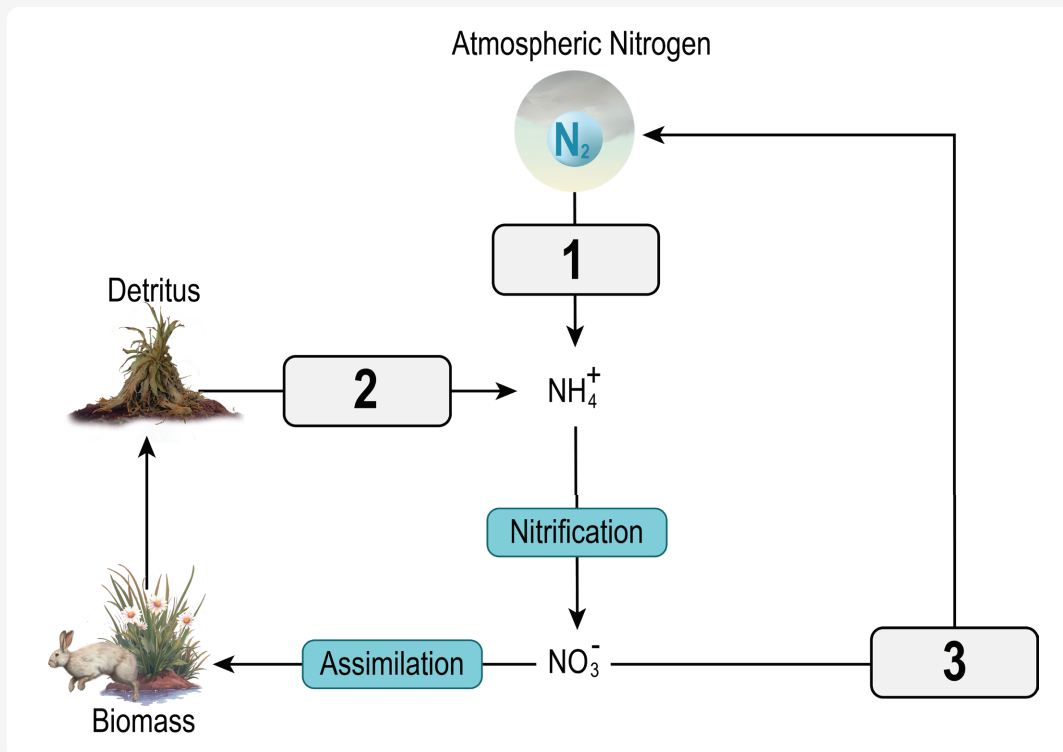
You are tasked with restoring a degraded ecosystem that has experienced a shortage of nitrogen. Which of the following steps could you take?

- a) Introduce nitrogen-fixing bacteria, which convert nitrogen gas to nitrogen-containing compounds.
- b) Introduce denitrifying bacteria, which convert nitrate to nitrogen gas.
- c) Introduce nitrifying bacteria, which convert nitrate to ammonium.
- d) All of the above.

### PRACTICE

Which of the following answers correctly completes the diagram below?

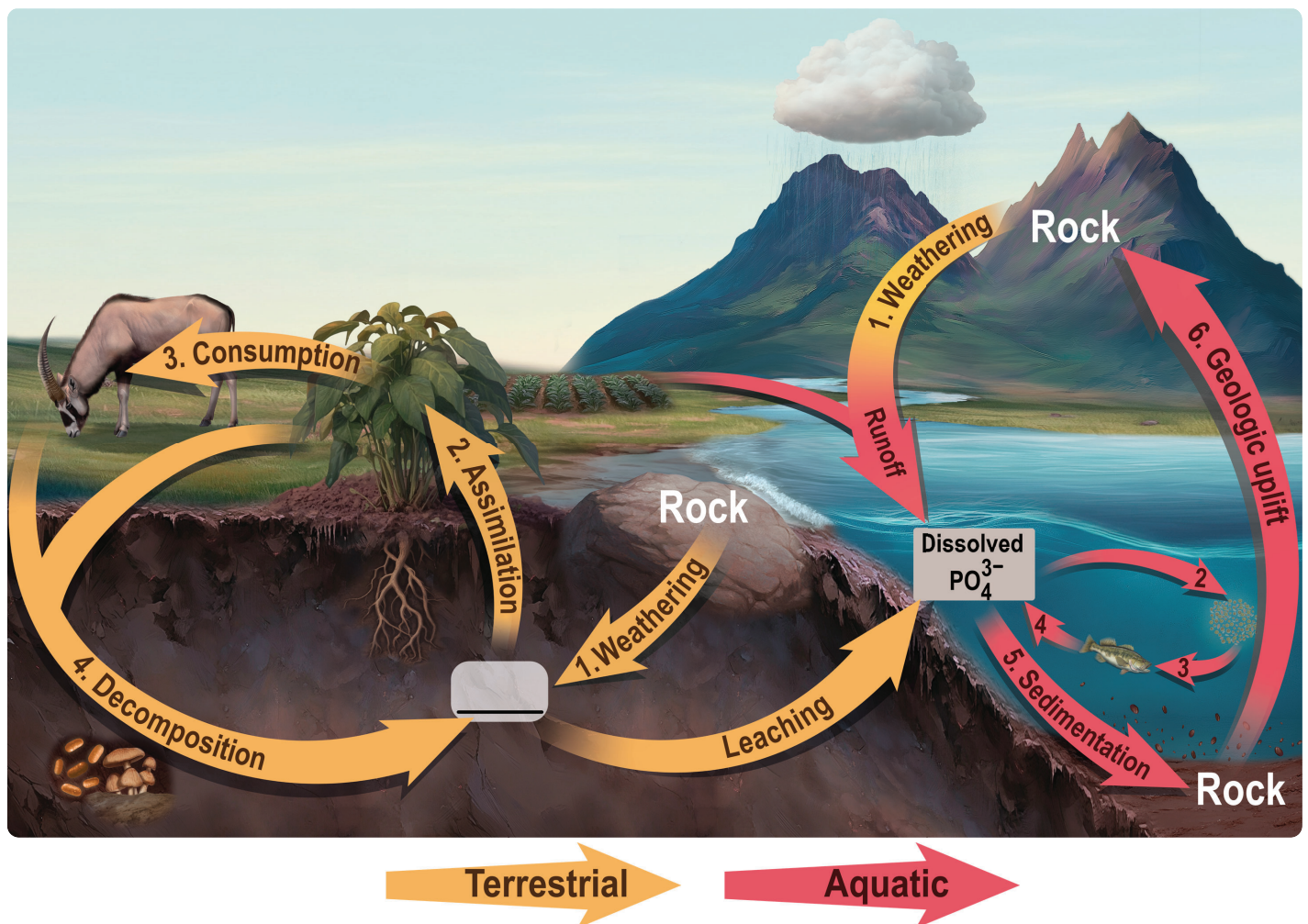
- a) 1 – nitrification, 2 – ammonification, 3 – nitrogen fixation.
- b) 1 – denitrification, 2 – nitrification, 3 – nitrogen fixation.
- c) 1 – nitrogen fixation, 2 – nitrification, 3 – denitrification.
- d) 1 – nitrogen fixation, 2 – ammonification, 3 – denitrification.



## TOPIC: BIOGEOCHEMICAL CYCLES

### Phosphorus Cycle

- ◆ Phosphorous does NOT have an atmospheric component (P cycling is local).
- ◆ The largest reservoir of phosphorus is in sedimentary rock in the form of phosphate ( $\text{PO}_4^{3-}$ ).
  - **Weathering** of rocks causes phosphate to release into soil.
- ◆ Producers uptake phosphorus, then it moves up food chain via consumption; recycled via **decomposition**.
  - Sedimentation of phosphorous incorporates it back into rocks & geologic uplift can re-expose rocks to weather.

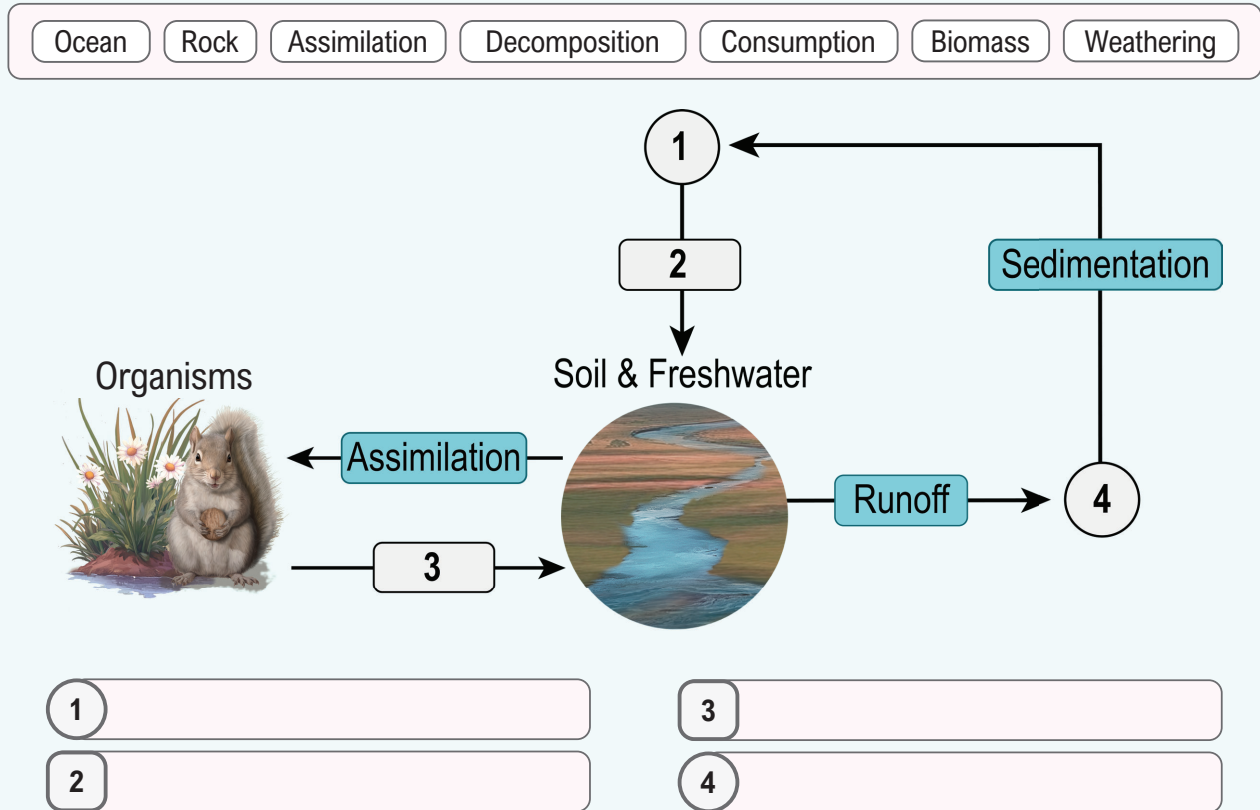




## TOPIC: BIOGEOCHEMICAL CYCLES

### EXAMPLE

Complete the Phosphorous Cycle diagram below by matching the following terms to the correct number (not all answer options will be used).



### PRACTICE

Which of the following statements is true?

- a) Unlike nitrogen, carbon, and water, the atmosphere is not a significant reservoir of phosphorus.
- b) Sedimentary rock is one of the largest reservoirs of phosphorus.
- c) Phosphorus is essential to ecosystems as it's a major component of nucleic acids & ATP.
- d) All of the above are true.