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.

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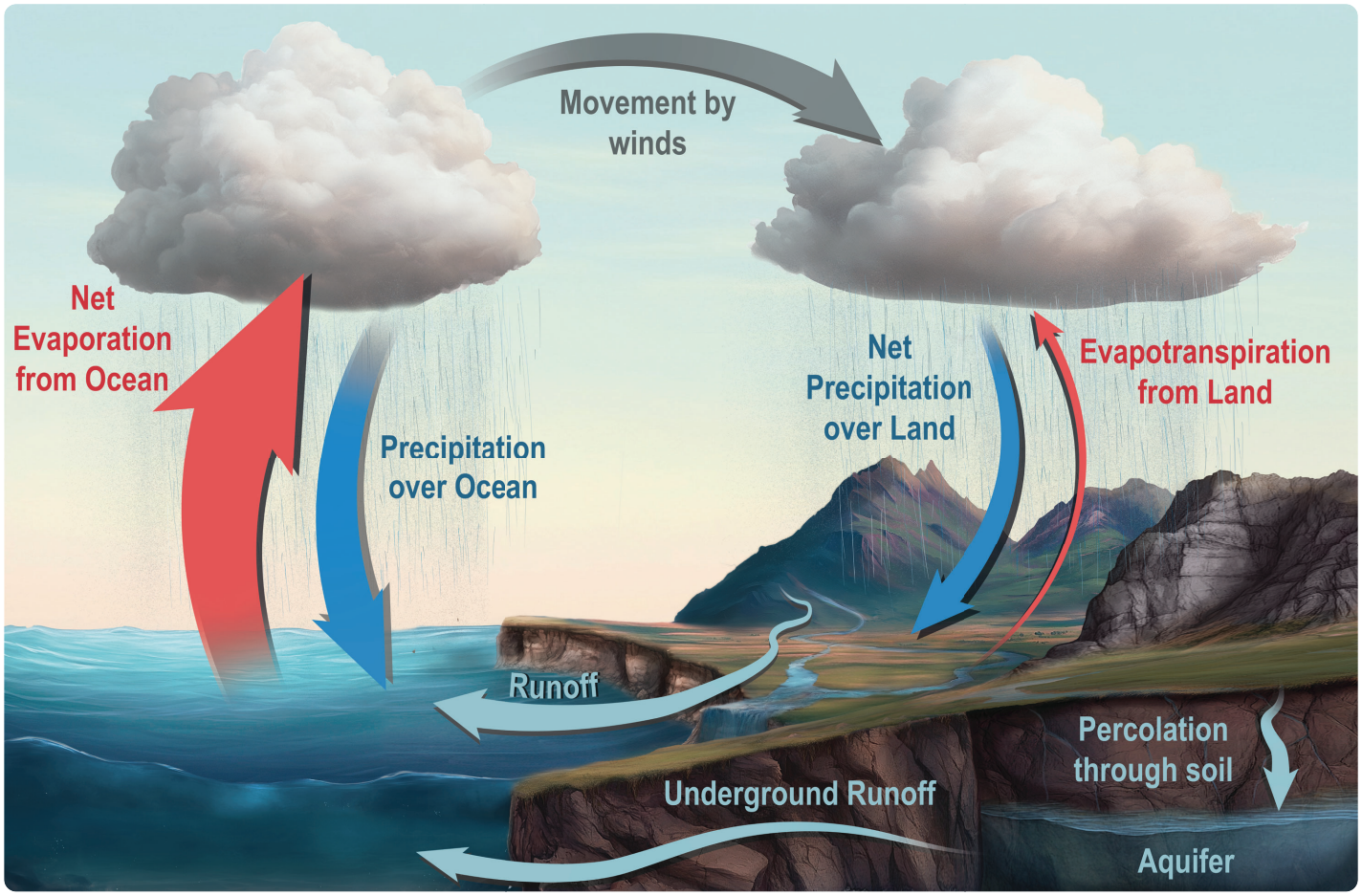
Water Cycle

- 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.



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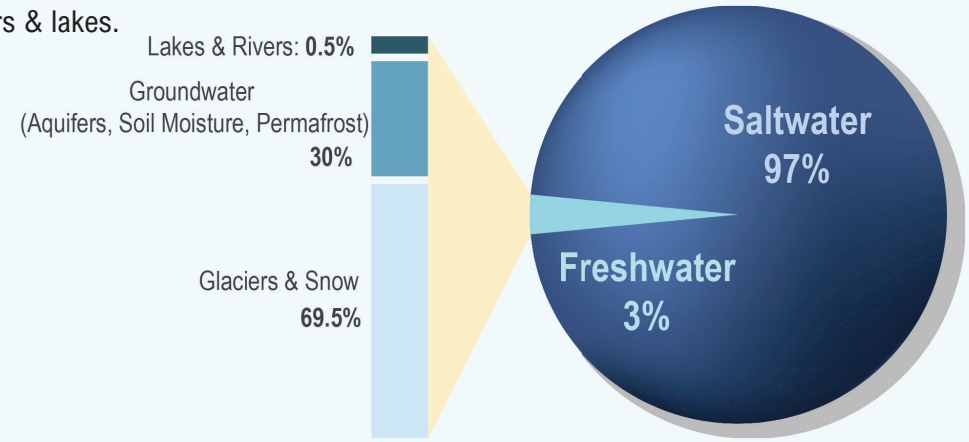
EXAMPLE

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.

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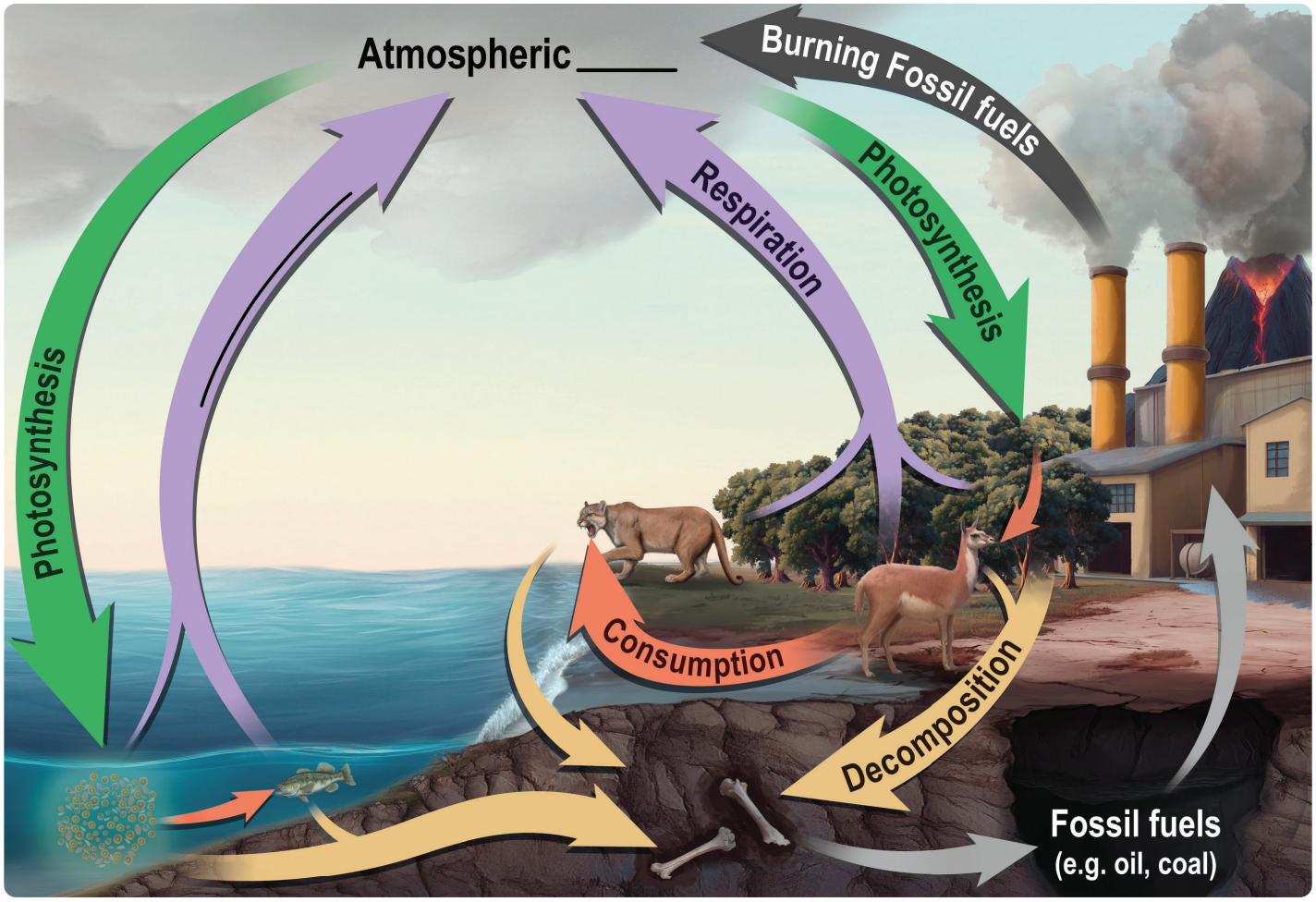
Carbon Cycle

- Carbon in atmospheric 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.



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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?

a) Plants can produce their own carbon via photosynthesis.

b) Decomposers can produce their own carbon when they break organic material down.

c) CO_2 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?

a) Biomass is one of the largest carbon reservoirs in the biosphere.

b) Burning plants increases the amount of atmospheric CO_2.

c) The carbon cycle has maintained a constant atmospheric CO_2 concentration over the last million years.

d) Carbon can be stored in soil, rocks, and ocean water.

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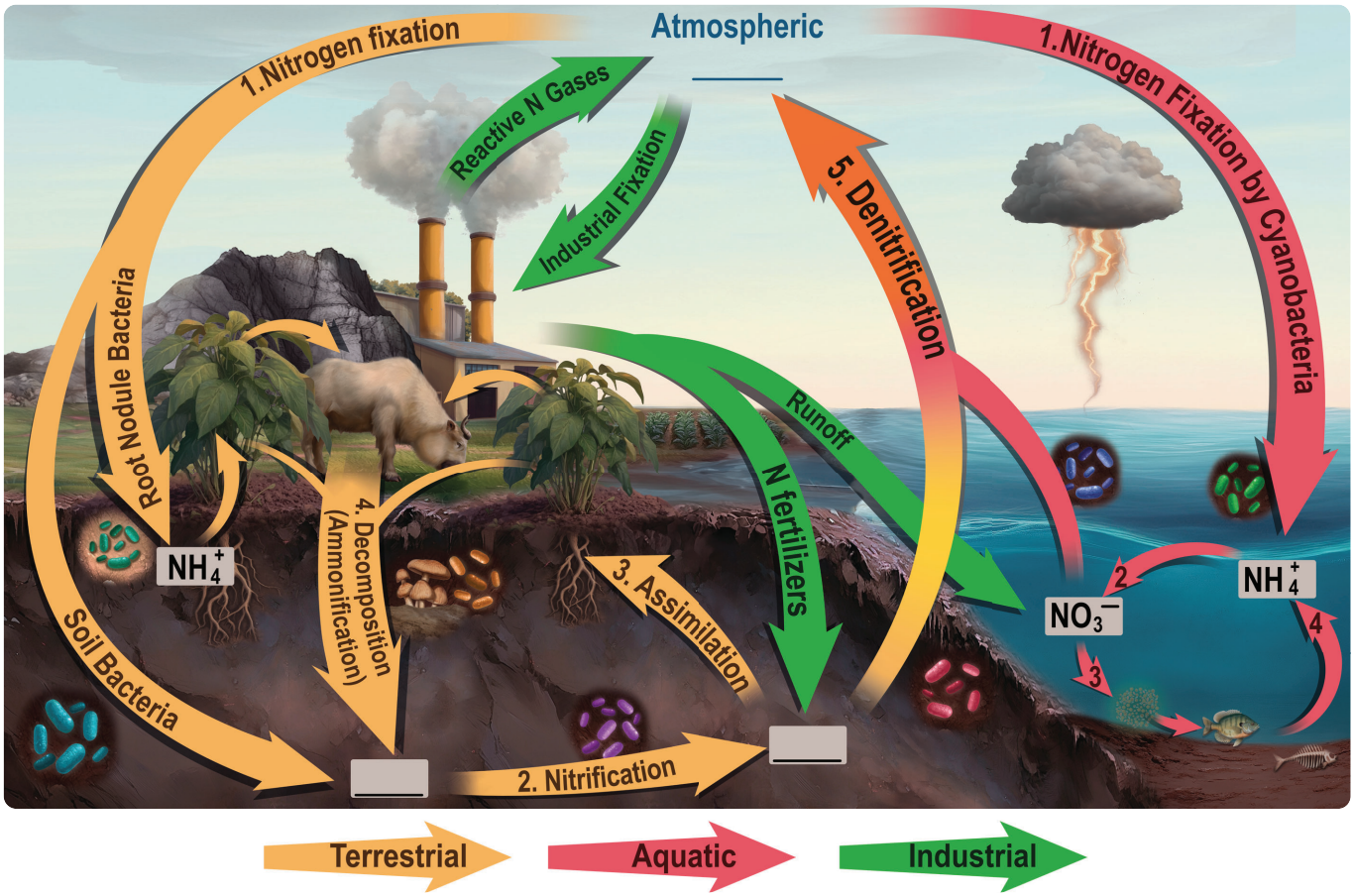
Nitrogen Cycle

◆ 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.



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

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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

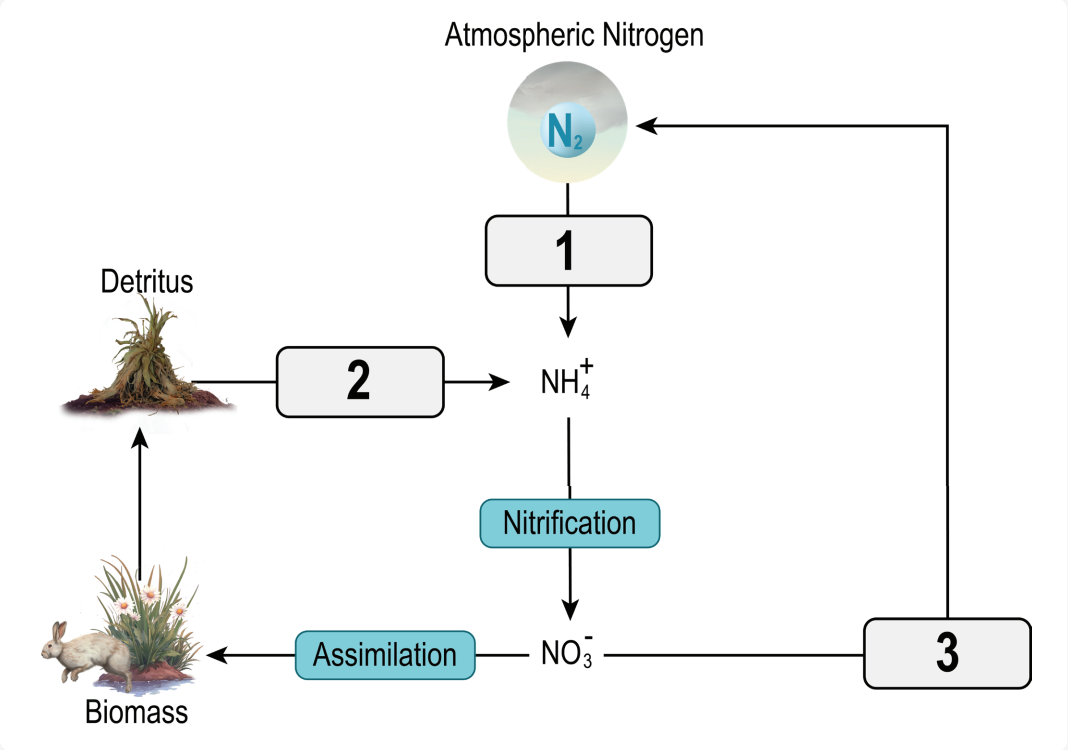
Which of the following answers correctly completes the diagram below?

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.



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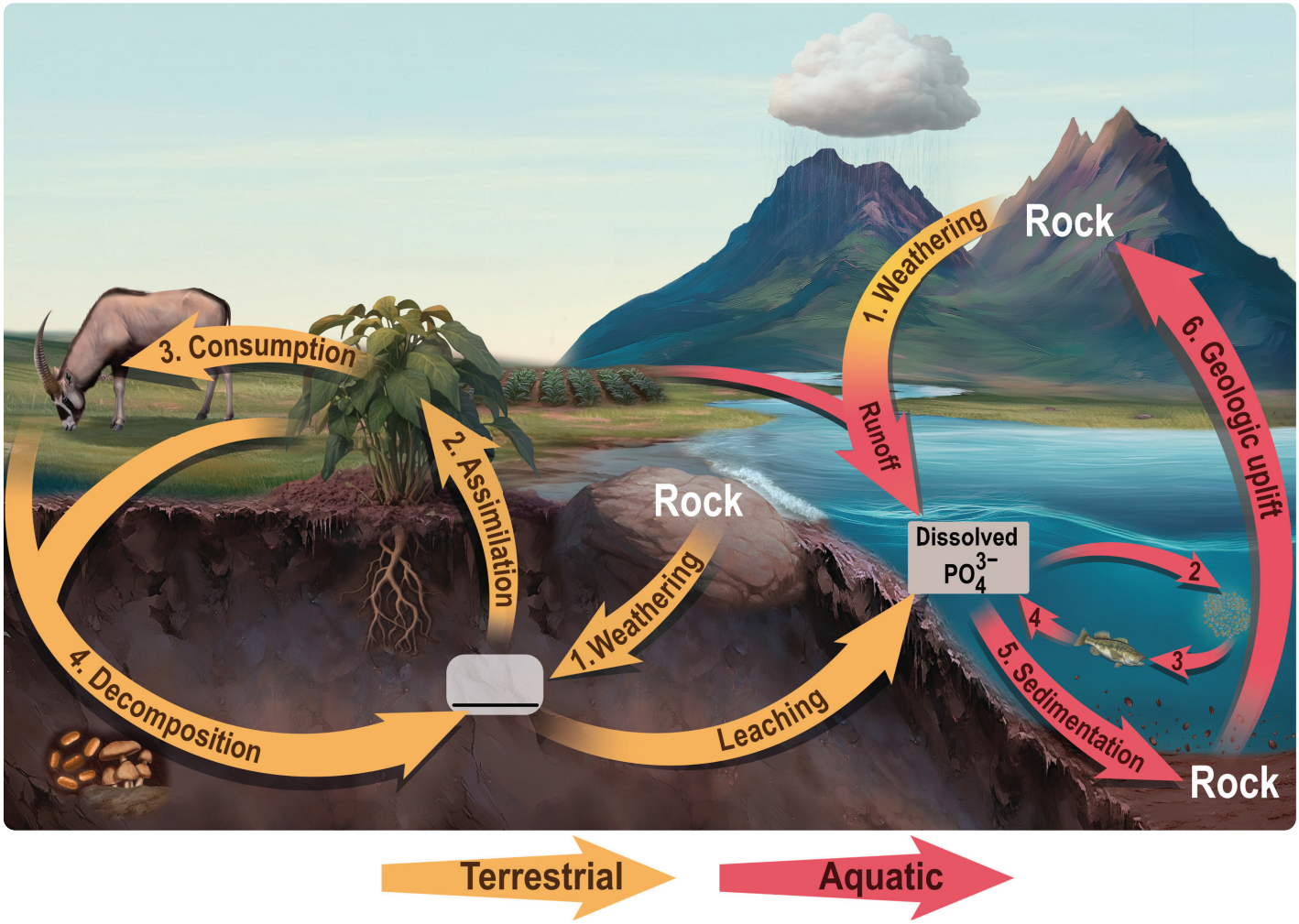
Phosphorus Cycle

- 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 (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.



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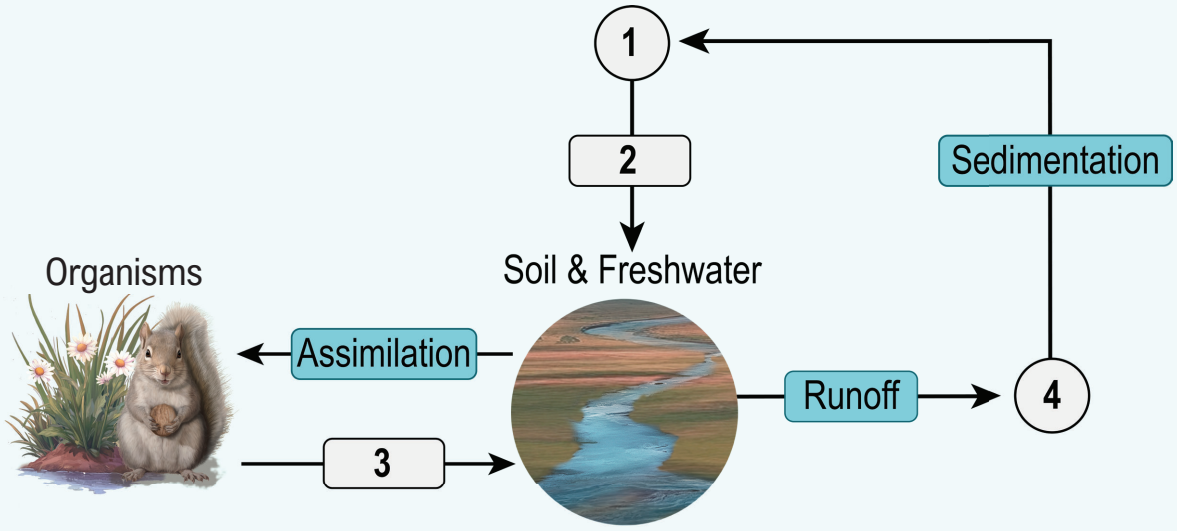
EXAMPLE

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

Ocean | Rock | Assimilation | Decomposition | Consumption | Biomass | Weathering



1 _____ 3 _____

2 _____ 4 _____

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.