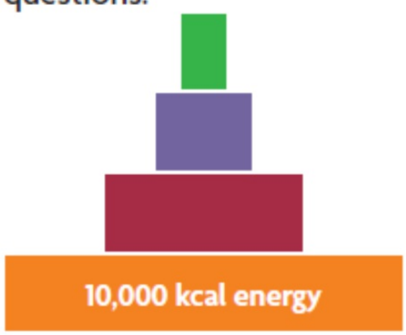
Kickoff (9/17/12):

1. **Get out your curriculum sheets that have the boxes to check for mastery.**
2. **Go to my lab bench and pick up the standard for flow of matter and energy.**
3. **Cut to fit and glue them to the bottom of you curriculum sheet.**
4. **Update your curriculum sheet for the standa that have been taught/mastered.**
5. **Return materials to lab bench and recycle an scrap paper.**

Kickoff (9/18/14):

Predict In a pyramid of numbers, the highest organism has the smallest number of individuals in a community. What might happen if this organism increased its numbers significantly? Explain the effect this increase would have on the other members of the community.

Use the energy pyramid below to answer the following questions.



30. Apply Use the energy pyramid to describe the flow of energy within an ecosystem. Identify which tier represents producers, primary consumers, and so on.

31. Calculate If 90 percent of the energy is lost as heat between trophic levels, approximately how much energy is available to the secondary consumers in this energy pyramid? Show your calculations.

13.6 Pyramid Models

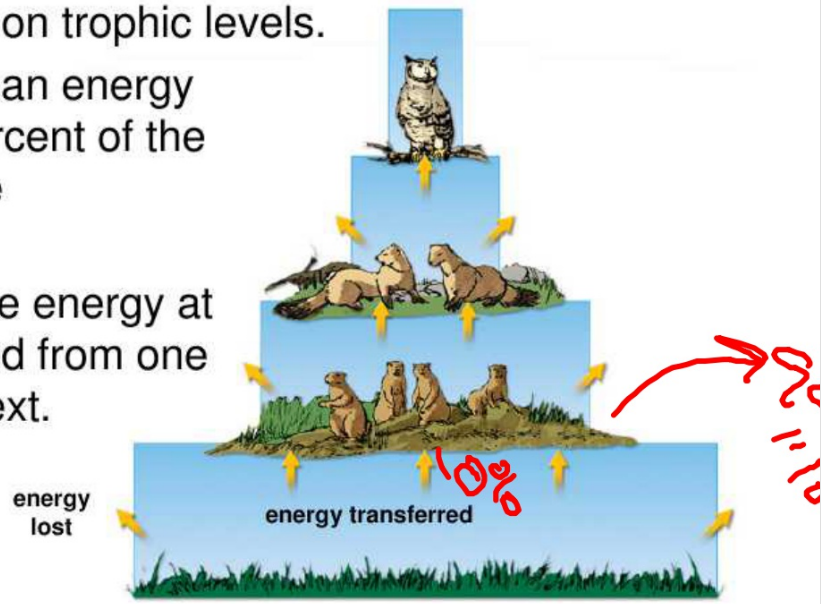
KEY CONCEPT

Pyramids model the distribution of energy and matter in an ecosystem.

13.6 Pyramid Models

An energy pyramid shows the distribution of energy among trophic levels.

- Energy pyramids compare energy used by producers and other organisms on trophic levels.
- Between each tier of an energy pyramid, up to 90 percent of the energy is lost into the atmosphere as heat.
- Only 10 percent of the energy at each tier is transferred from one trophic level to the next.



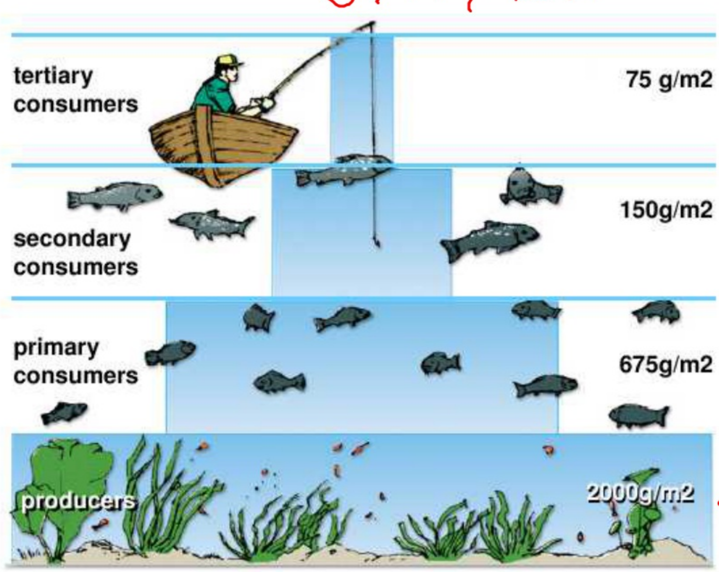
13.6 Pyramid Models

Other pyramid models illustrate an ecosystem's biomass and distribution of organisms.

Biomass – the amount of biological matter in eco

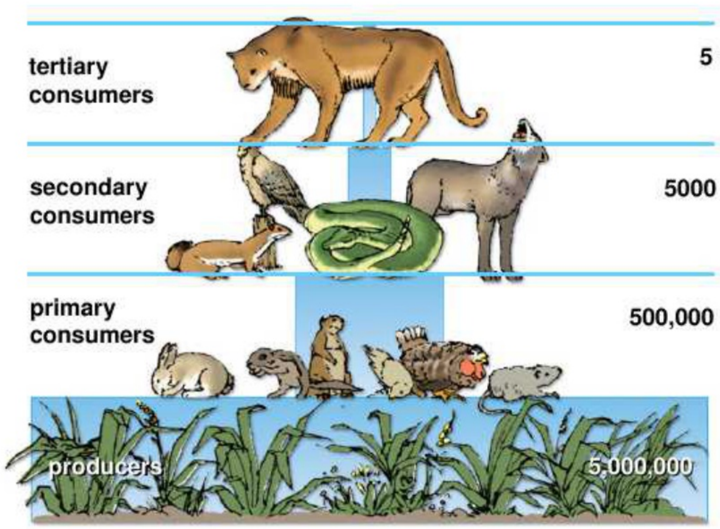
- Biomass is a measure of the total dry mass of organisms in a given area.

g/dry wt



13.6 Pyramid Models

- A pyramid of numbers shows the numbers of individual organisms at each trophic level in an ecosystem.



- A vast number of producers are required to support even a few top level consumers.

Key words

biomass

pyramid of energy (~10% rule)

pyramid of biomass

pyramid of numbers

Key concepts:

→ Energy is cycled

You are what you eat

→ 10% energy flow -

1. How does an **energy pyramid** help to describe energy flow in a food web?

2. What is the difference between a **biomass** pyramid and a pyramid of numbers?

3. **Apply** How would you draw a pyramid of numbers for a dog with fleas? What shape would the pyramid take?

4. **Calculate** If each level in a food chain typically loses 90 percent of the energy it takes in, and the producer level uses 1000 kcal of energy, how much of that energy is left after the third trophic level?

5. **Nutrition** Why is an herbivorous diet more energy efficient than a carnivorous diet? Explain your answer.

Pyramid Activity

Objective: To create an energy pyramid and understand the cycling of energy through an ecosystem.

1. Make a 5-trophic level pyramid with:
15 bushes, 10 beetles, 5 frogs, 3 snakes, 1 hawk

2. Label with:
Autotrophs
Heterotrophs (primary, secondary or tertiary)
Label abiotic factors impacting ecosystem
Include numbers (population, biomass and energy)

3. Do two other biomes of your choice

Kickoff:

1. Explain the relationship between energy and matter it moves through an ecosystem.

2. How does this explain a pyramid of numbers and a pyramid of biomass?

1. The table below lists the average amount of energy (in kilojoules per square meter of land per year) in different organisms that people use for food.

Organism	Energy (KJ/m^2/year)	Ranking
Wheat cereal	3400	
Peanuts	3850	
Rice	5200	
Potatoes	6700	
Carrots	3400	
Apples	6300	
Peaches	3800	
Beet sugar	8300	
Cane sugar	14,650	
Corn	6700	
Milk (cow)	1800	
Chicken	800	
Pork (pig)	800	
Beef (cow)	550	
Fish	8	

13.5 Cycling of Matter

KEY CONCEPT

Matter cycles in and out of an ecosystem.

13.5 Cycling of Matter

Water cycles through the environment.

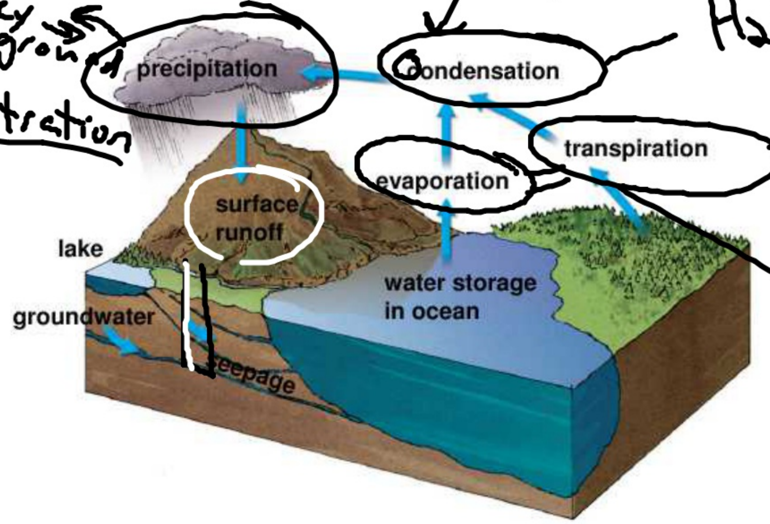
- The hydrologic, or water, cycle is the circular pathway of water on Earth.
- Organisms all have bodies made mostly of water.

water sky → ground

cloud

H_2O gas → liqu

infiltration



→ tree skie (vapo

liquid → vapor

75% Earth has water

98% salty

2% fresh

<1% potable

"drinkable"

13.5 Cycling of Matter

Elements essential for life also cycle through ecosystems.

- A biogeochemical cycle is the movement of a particular chemical through the biological and geological parts of an ecosystem.
- The main processes involved in the Carbon/ oxygen cycle are photosynthesis, ~~and~~ respiration, +

  Combustion

photosynthesis the process by

reactants

inorganic

Photosynthesis

organic

products

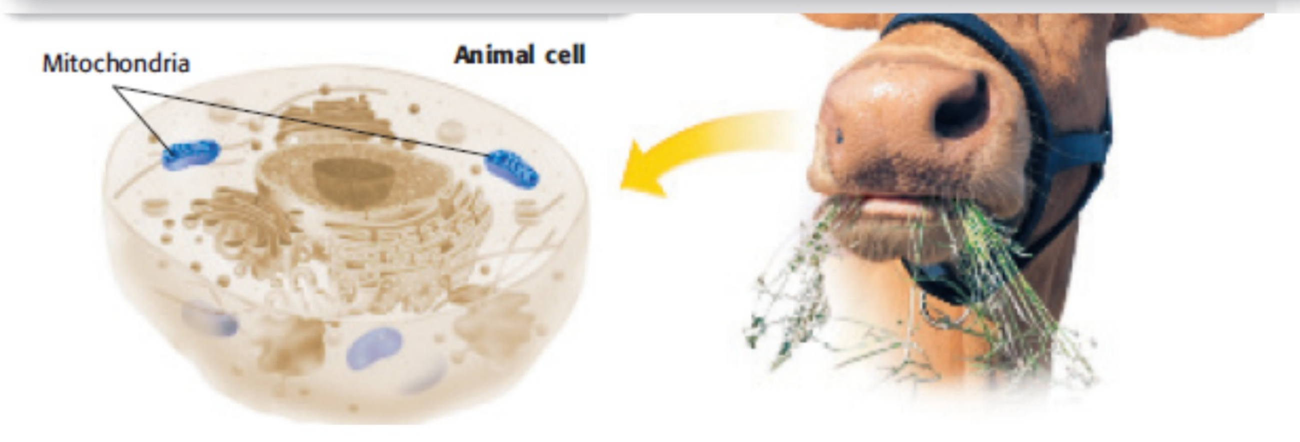
$$6CO_2 + 6H_2O + \text{Light energy} \rightarrow C_6H_{12}O_6 + 6O_2$$

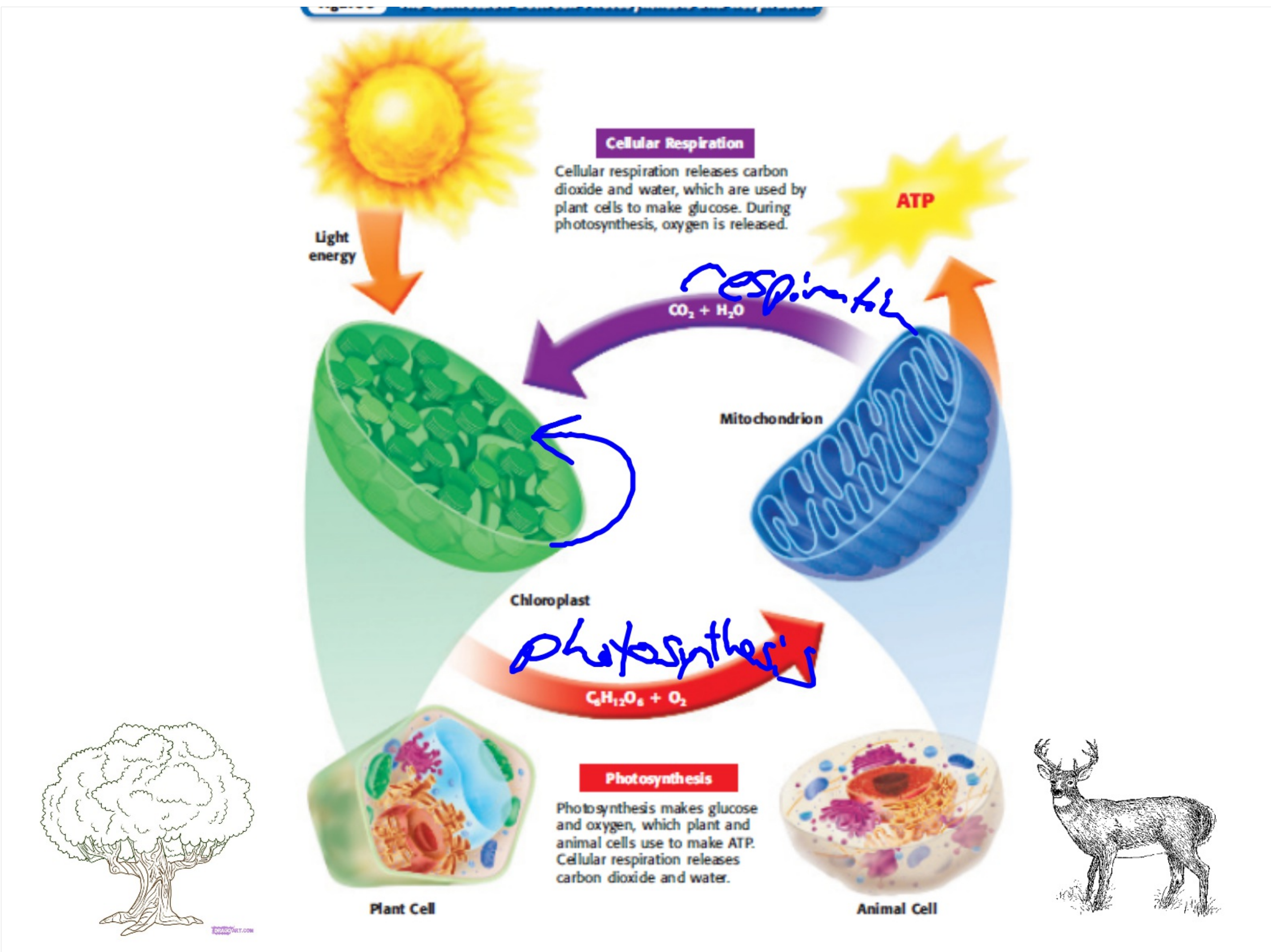
Carbon dioxide Water Glucose Oxygen

takes place in chloroplasts. Chloroplasts are found inside plant cells.

Cellular Respiration

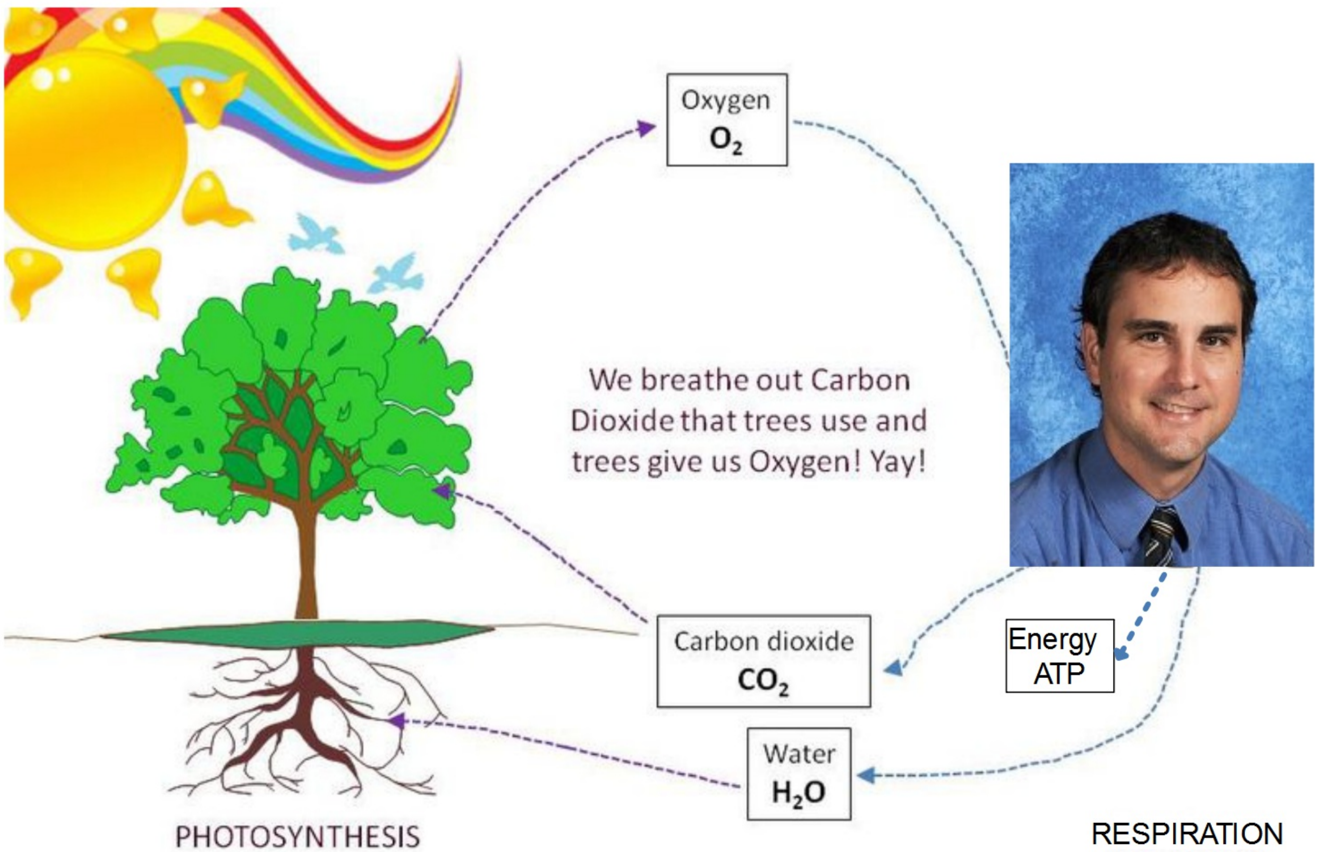
$$\underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Oxygen}}{6O_2} \rightarrow \underset{\text{Carbon dioxide}}{6CO_2} + \underset{\text{Water}}{6H_2O} + \text{energy (ATP)}$$





Cellular Respiration
Cellular respiration releases carbon dioxide and water, which are used by plant cells to make glucose. During photosynthesis, oxygen is released.
Light energy
ATP
respiration
$CO_2 + H_2O$
Mitochondrion
Chloroplast
photosynthesis
$C_6H_{12}O_6 + O_2$
Photosynthesis
Photosynthesis makes glucose and oxygen, which plant and animal cells use to make ATP. Cellular respiration releases carbon dioxide and water.
Plant Cell
Animal Cell

Organic	inorganic
$C_6H_{12}O_6$	CO_2, O_2 CH_4, CO
amino acids (N)	NH_4^+, NO_3, NO_2
Organic Phosphorous	phosphate


Oxygen
O_2
We breathe out Carbon Dioxide that trees use and trees give us Oxygen! Yay!
Carbon dioxide
CO_2
Energy
ATP
Water
H_2O
PHOTOSYNTHESIS
RESPIRATION

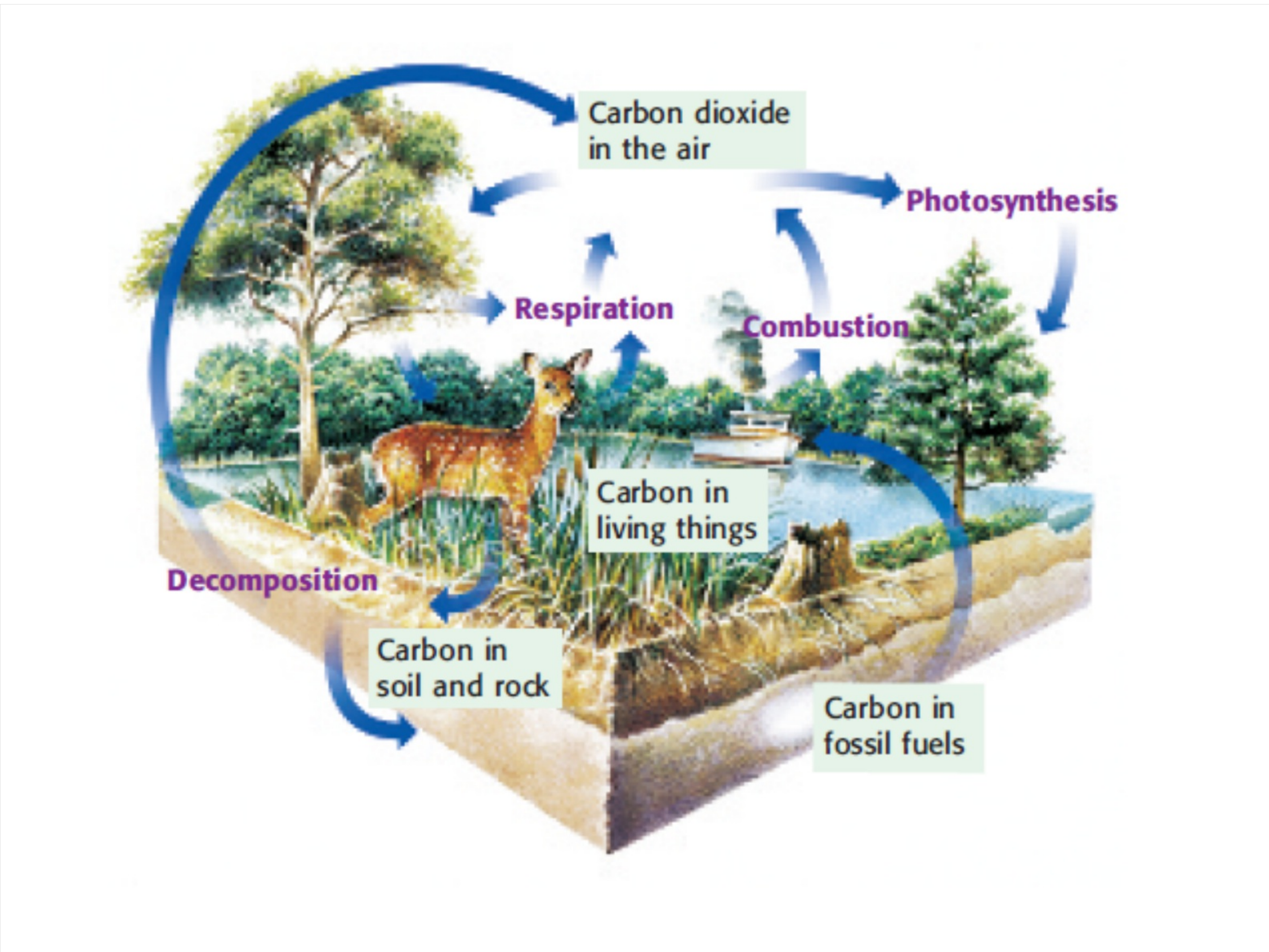
Kickoff (9/21/12):

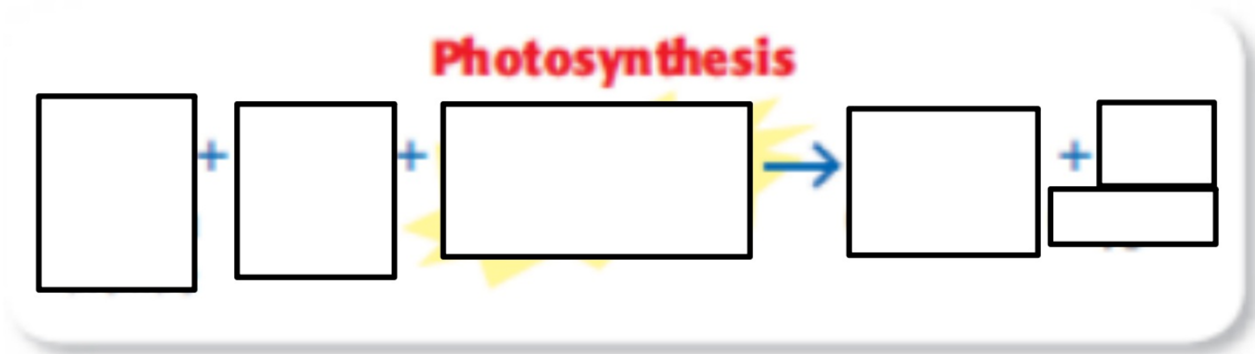
What is one process that remove carbon from the atmosphere? photosynthesis $6CO_2 \rightarrow C_6H_{12}O$

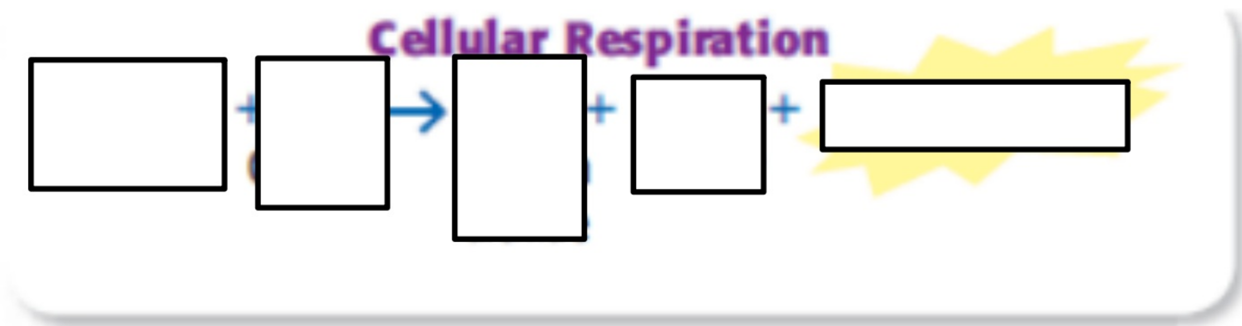
What are three processes that add carbon to the atmosphere?

$C_6H_{12}O_6 \rightarrow CO_2$

- respiration
- combustion
- decomposition


Carbon dioxide
in the air
Photosynthesis
Respiration
Combustion
Carbon in
living things
Decomposition
Carbon in
soil and rock
Carbon in
fossil fuels


Photosynthesis

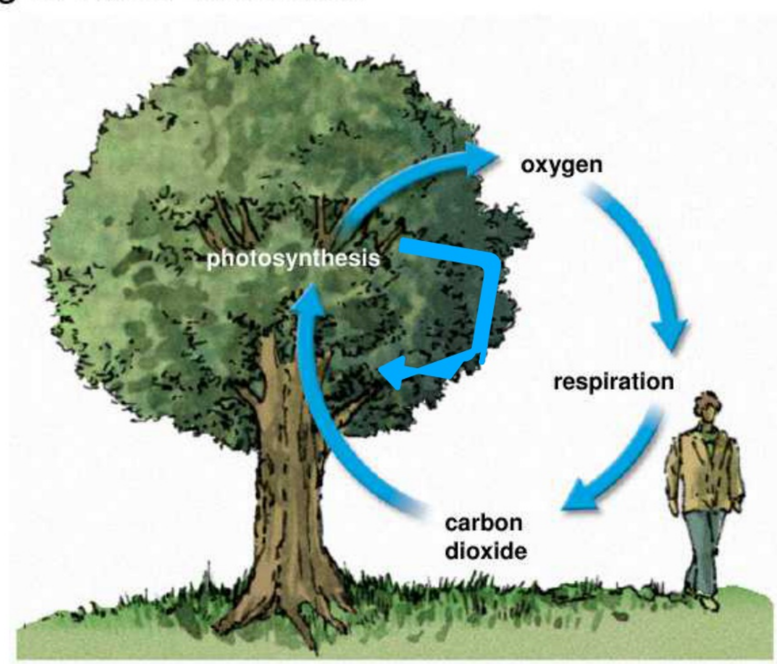

Cellular Respiration

H_2O

Symbol	term
H_2O	water
CO_2	Carbon dioxide
O_2	oxygen
$C_6H_{12}O_6$	glucose (sugar)
ATP	chemical energy adenosine triphosphate

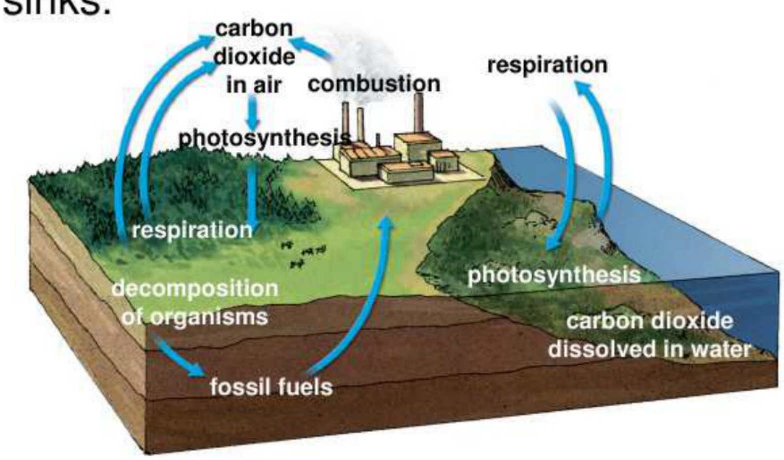
13.5 Cycling of Matter

- Oxygen cycles indirectly through an ecosystem by the cycling of other nutrients.



13.5 Cycling of Matter

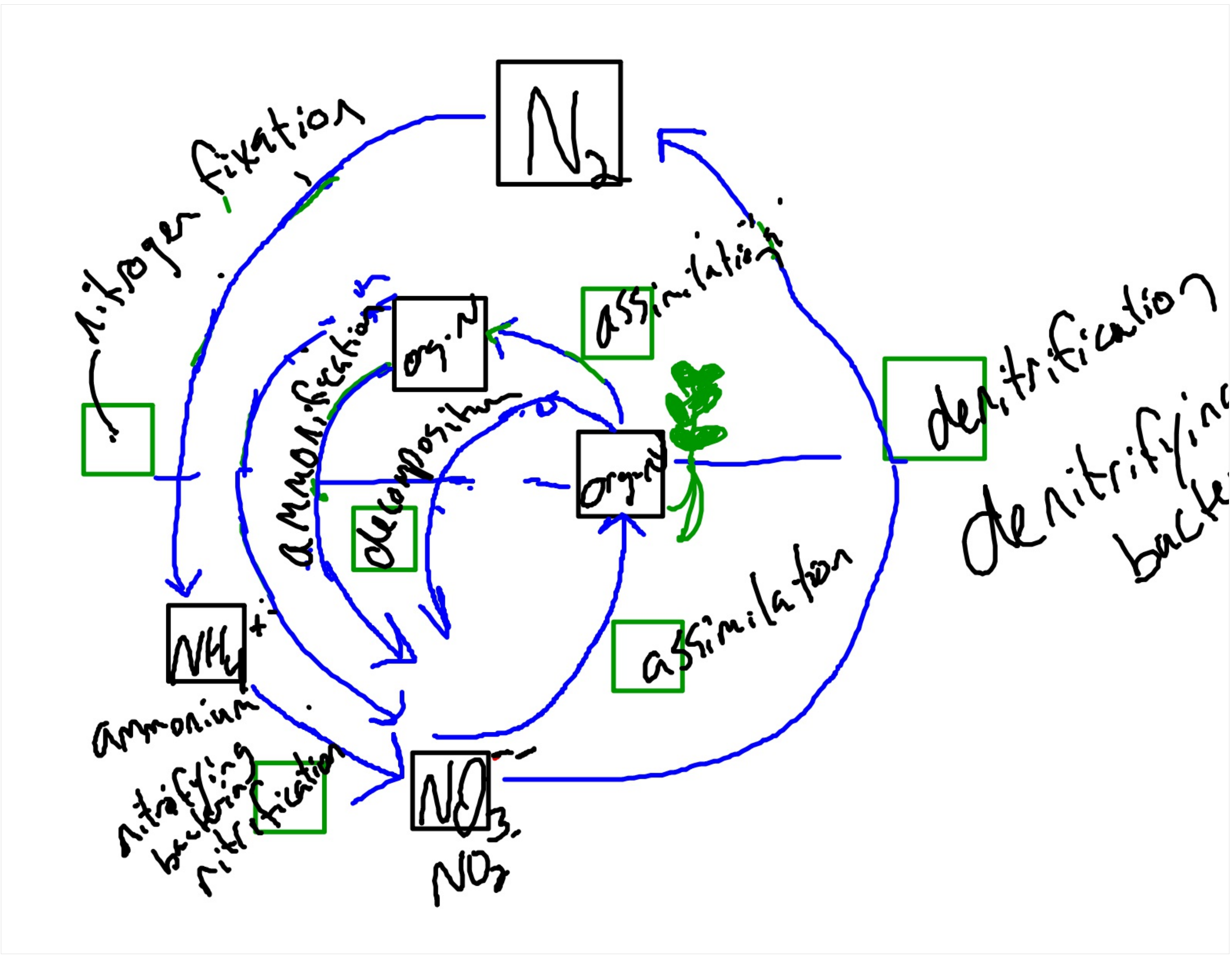
- Carbon is the building block of life.
  - The carbon cycle moves carbon from the atmosphere, through the food web, and returns to the atmosphere.
  - Carbon is emitted by the burning of fossil fuels.
  - Some carbon is stored for long periods of time in areas called carbon sinks.



Kickoff (9/23/14):

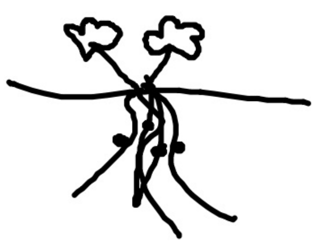
Why is nutrient cycling important through living systems?

Explain how the cycling of carbon is related to N cycling.



N_2
nitrogen fixation
org. N
org. N
ammonification
decomposition
assimilation
assimilation
denitrification
denitrification
denitrifying bacteria
NH_4^+
ammonium
nitrifying bacteria
nitrification
NO_3^-
NO_3

legume - plants that have a Symbiotic relationship with (NFB)




ENTRANC
TO
The
MICHIGAN

nitrogen fixation - $N_2 \rightarrow NH_4^+$

assimilation — $NH_4^+, NO_3^-, NO_2^- \rightarrow$ Org-

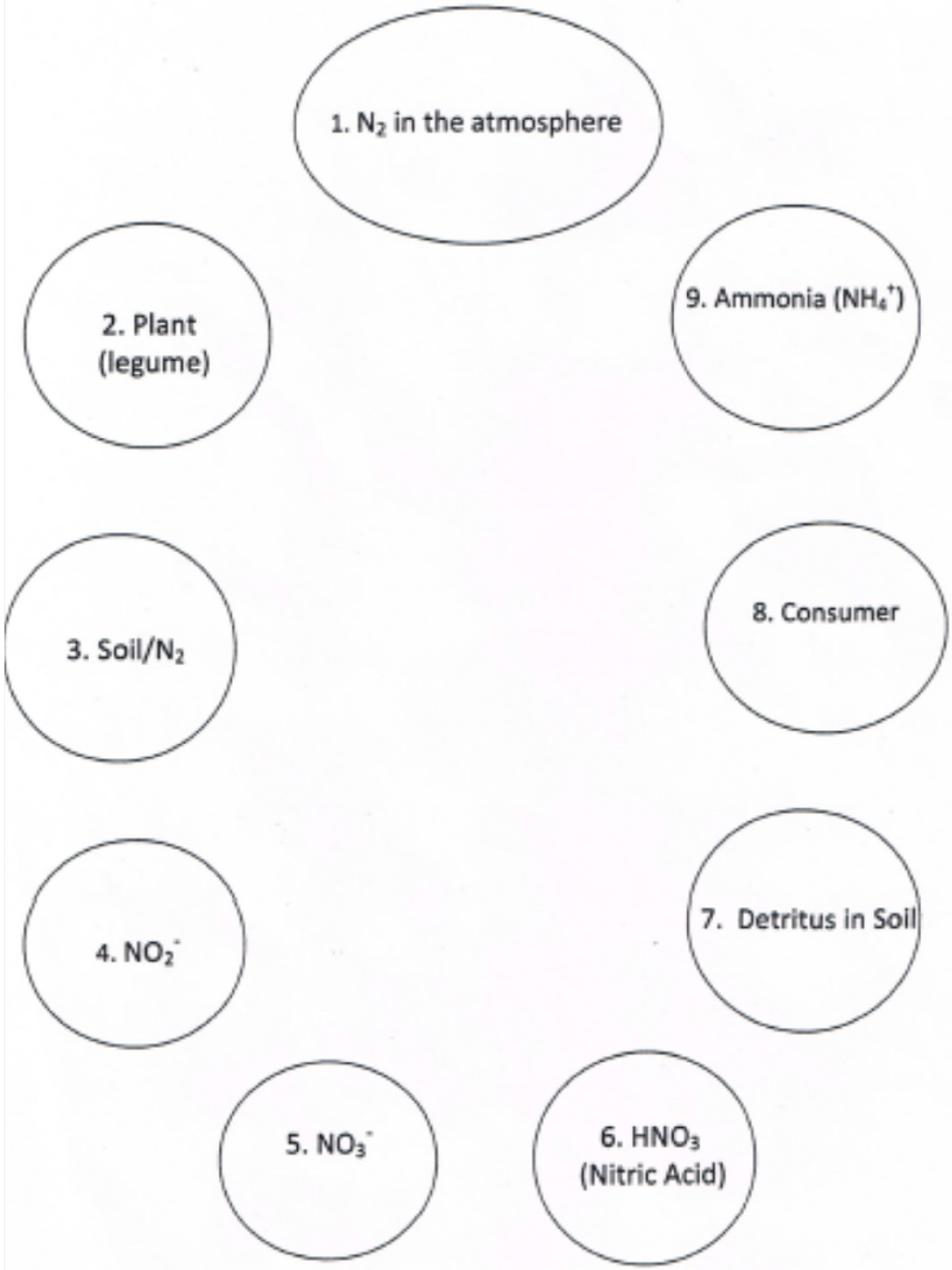
ammonium, nitrate, nitrite

ammonification - Org-N → urea → $\boxed{NH_3 \rightarrow}$
ammonia

nitrification → $NH_4^+ \rightarrow NO_3^-$ (nitrate)

denitrification → $NO_3^- \rightarrow N_2$

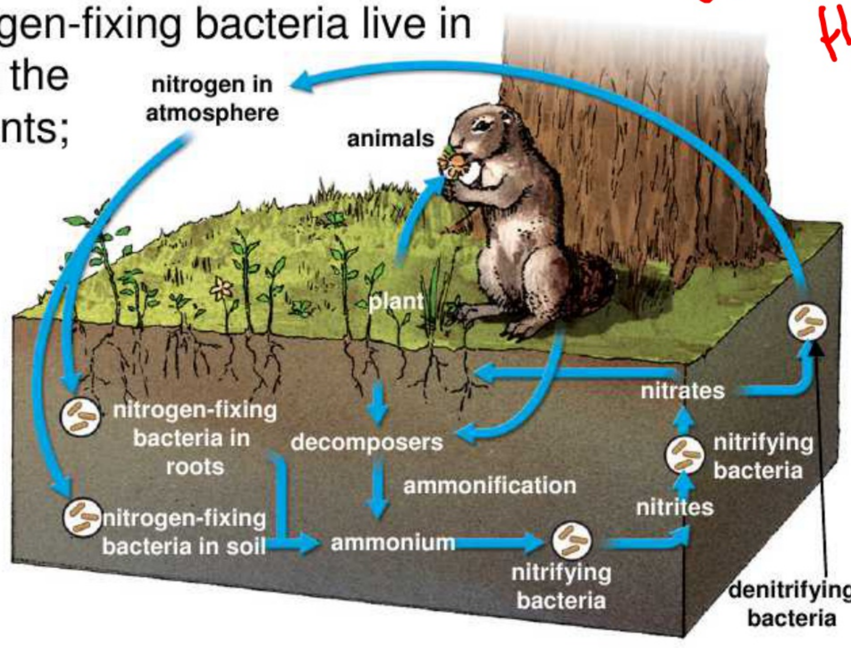
Appendix B: NITROGEN CYCLE GAME BOARD

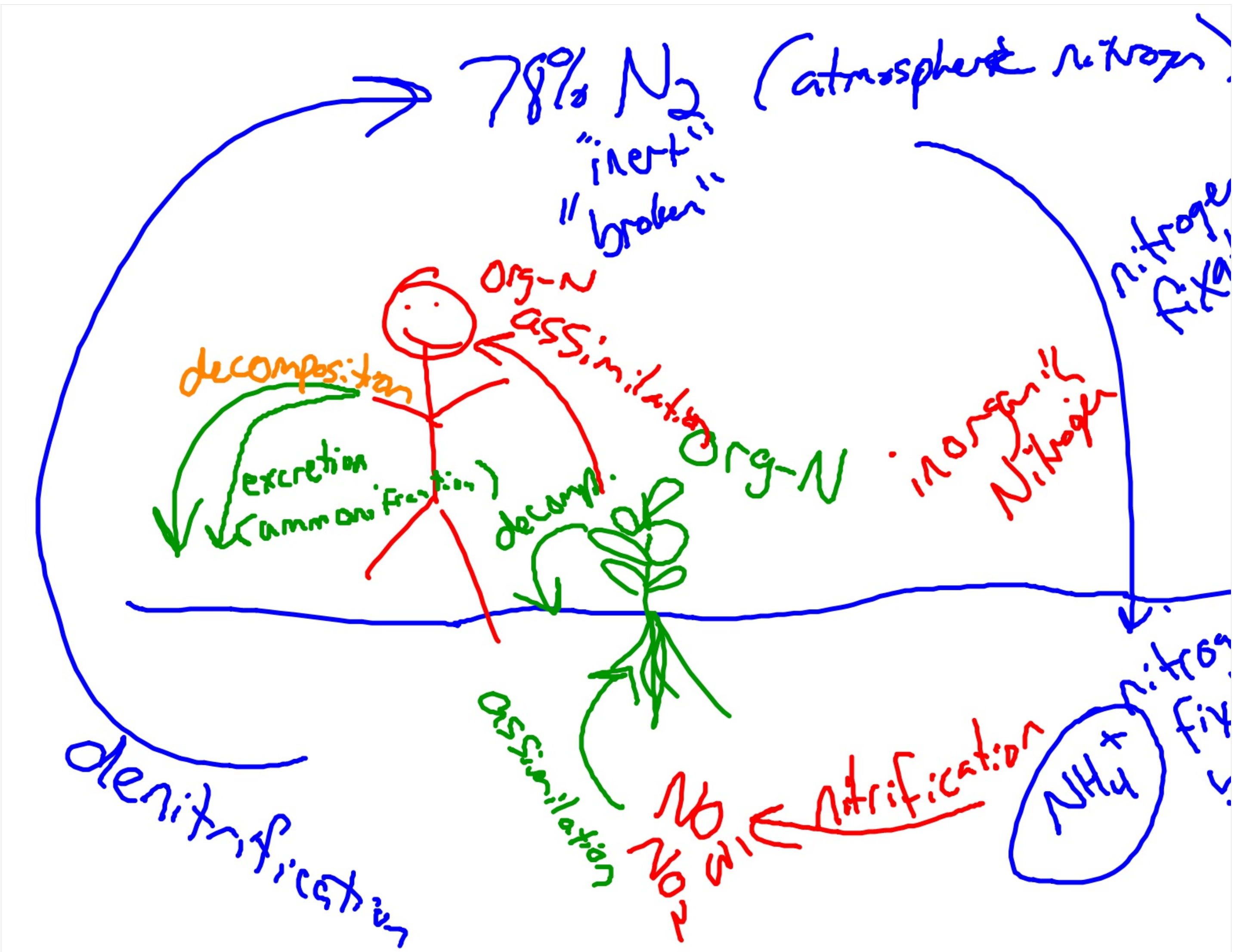


13.5 Cycling of Matter

- The nitrogen cycle mostly takes place underground.
  - Some bacteria convert gaseous nitrogen into ammonia through a process called nitrogen fixation.
  - Some nitrogen-fixing bacteria live in nodules on the roots of plants; others live freely in the soil.

bacteria ru
the sh




78% N_2 (atmospheric nitrogen)
"inert"
"broken"
nitrogen fixation
Org-N
assimilation
decomposition
excretion
(ammonification)
decomp.
Org-N
inorganic Nitrogen
nitrogen fixation
NH_4^+
nitrification
NO_3^-
NO_2^-
assimilation
denitrification

Nitrogen fixation - a process by which nitrogen fixing bacteria conver[t] (N_2) atmospheric nitrogen ~~to~~ a fo[rm] plants can use (NO_3^-, NO_2^-, NH_4^+)

nitrate

ammonium

assimiliation - where ~~plants~~ organism take up inorganic nitrogen (NH_4^+, NO_2^-, NO_3^-) (NH_3)

incorporate it into its own biomass (organic)

(amino acids $\Rightarrow$ proteins DNA)

org-N

Urea $\rightarrow$ NH_3 ammonia

denitrification

nitrification

ammonification

13.5 Cycling of Matter

NH_3

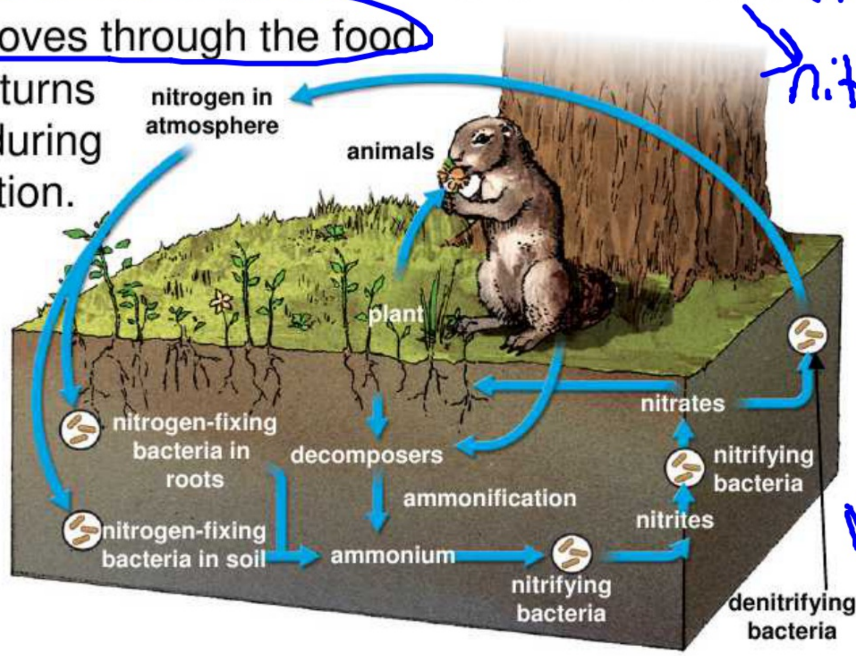
– Ammonia released into the soil is transformed into ammonium. (NH_4^+) - ammonification

– Nitrifying bacteria change the ammonium into nitrate. (NO_3

nitrific

– Nitrogen moves through the food web and returns to the soil during decomposition.

assimilation

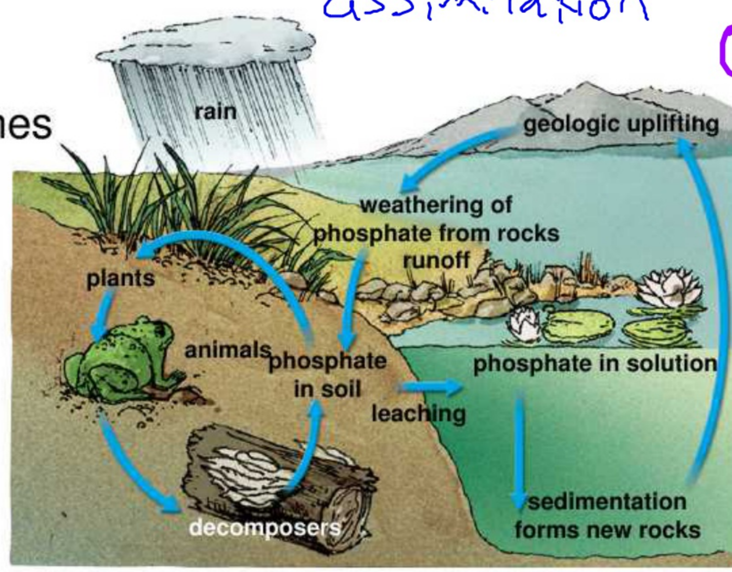


NO_3^-

13.5 Cycling of Matter

phos

- The phosphorus cycle takes place at and below ground level.
  inorganic → PO_4^{3-}
  - Phosphate is released by the weathering of rocks.
  - Phosphorus moves through the food web and returns to the soil during decomposition. Org-P
    assimilation
    org
  - Phosphorus leaches into groundwater from the soil and is locked in sediments.
  - Both mining and agriculture add phosphorus into the environment.



P-cycling


org-P
assimilation
org-P
PO_4^{3-}
rocks (P)
weathering
PO_4^{3-}
assimilation

Kickoff:

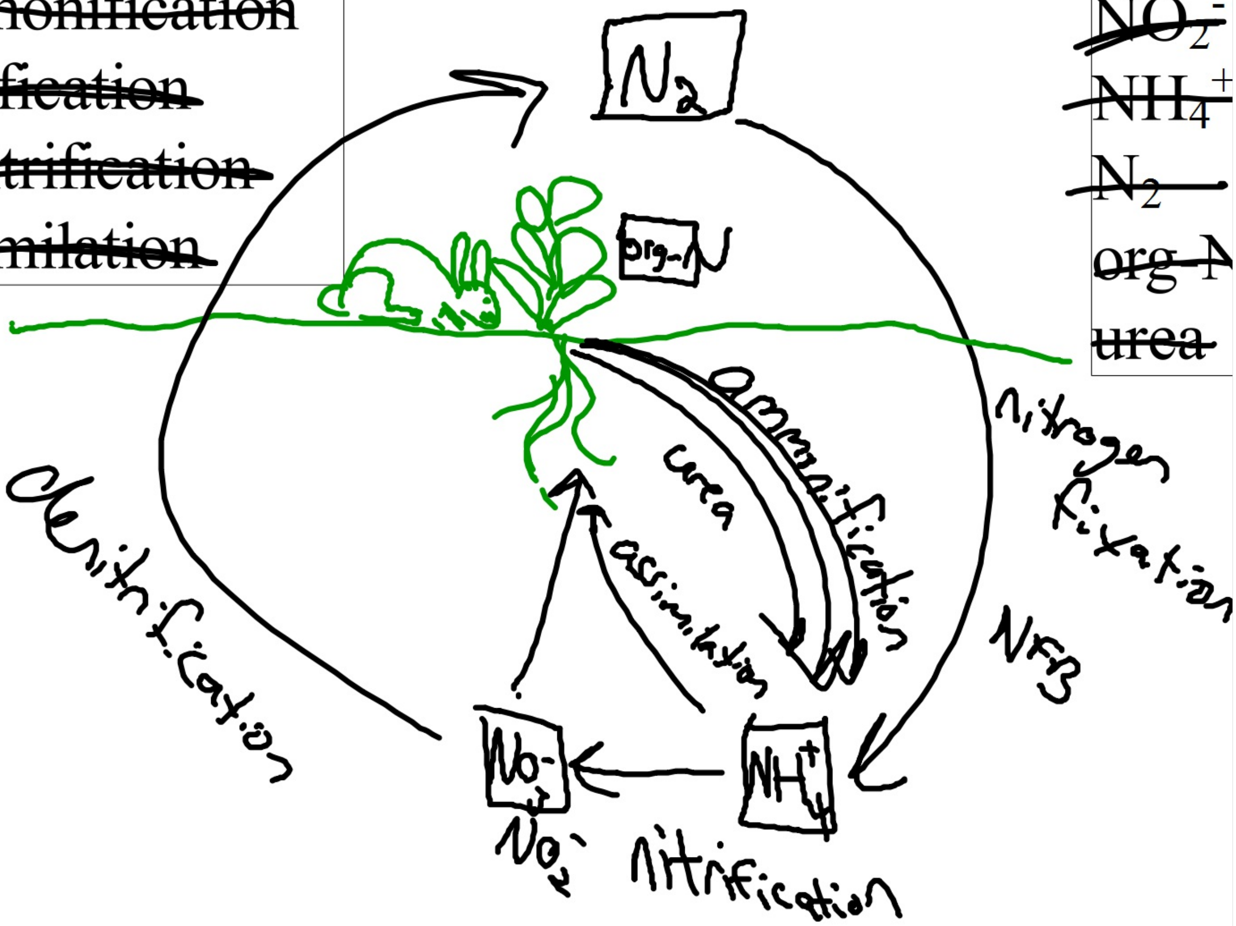
In 1934, Alfred Redfield analyzed thousands of marine organisms and discovered that the relative ratio of carbon to nitrogen to phosphorous was relatively constant at 106:16:1. This was referred to as the Redfield ratio.

1. Which of the nutrients is most limiting in the Redfield ratio??
   a) Predict what it would look like if N:P >20.
   b) What if N:P < 10?

2. What are two ways that nitrate can be moved through the nitrogen cycle?

~~nitrogen fixation~~
~~ammonification~~
~~nitrification~~
~~denitrification~~
~~assimilation~~

~~NO_3^-~~
~~NO_2^-~~
~~NH_4^+~~
~~N_2~~
~~org N~~
~~urea~~



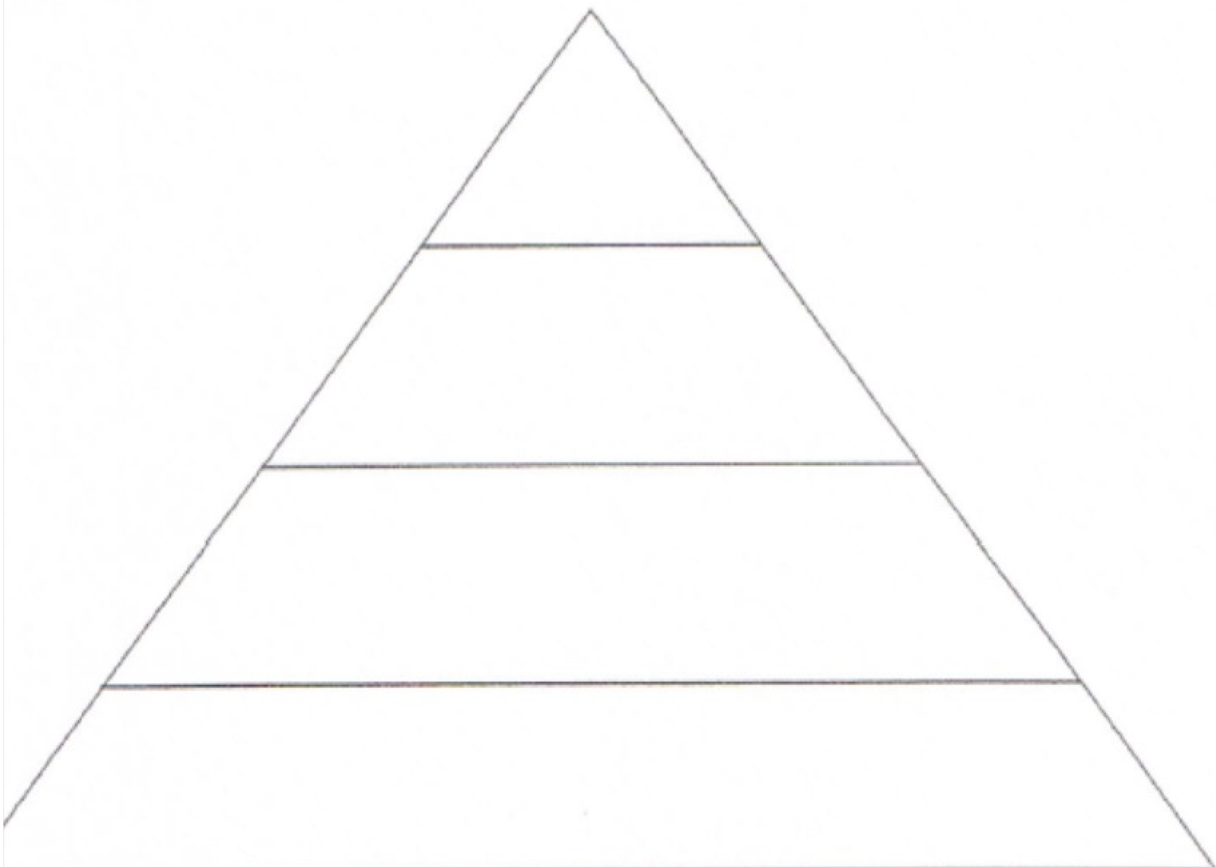
ure of the total dry mass of organisms in a given area is calle

_______________.

onsumer incorporates the biomass of a producer into its own bi

f energy is lost as _______________________ and ___________

four tiers of the energy pyramid with the correct trophic level
onsumers, secondary consumers, tertiary consumers).

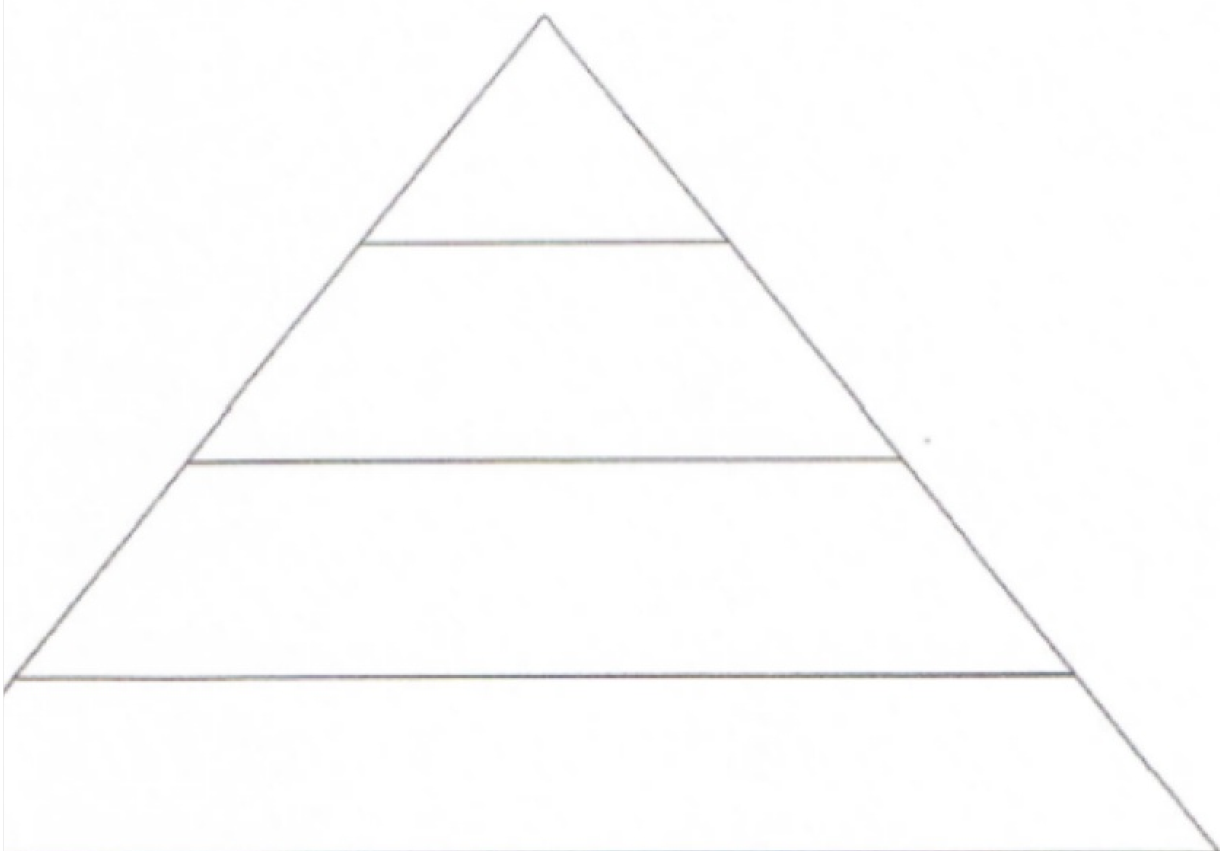


: Other pyramid models illustrate an ecosystem's biomass and of organisms.

iption of each pyramid model.

	Description
y pyramid	
ss pyramid	
id of numbers	

energy pyramid of your meal last night.



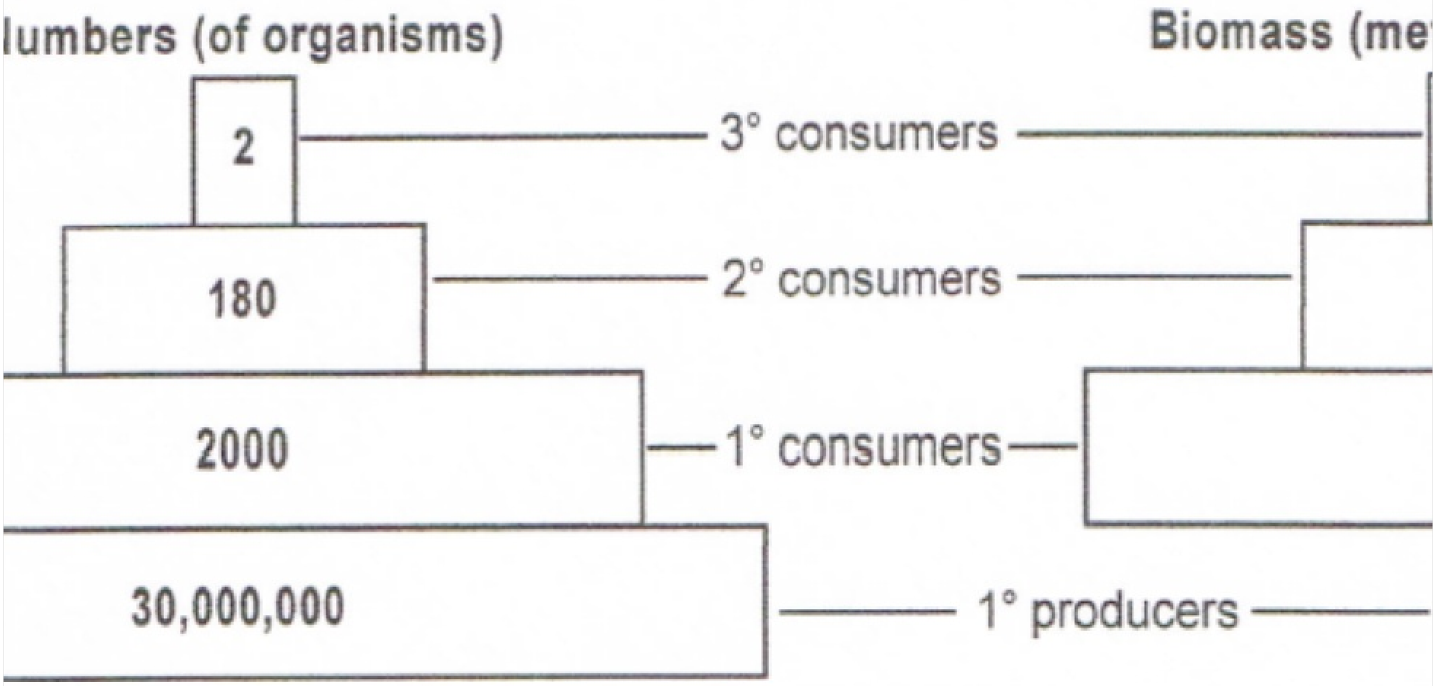
diverse and productive ecosystems on Earth is the coral reef.
ile coral reefs occupy less than one percent of the ocean floor
e fish we consume and are home to more than a third of all r

REEF FOOD WEB

gure 13.11 on page 410, even a simplified coral reef food web
nd zooxanthellae—symbiotic algae that live within coral poly
converting sunlight into energy that is then taken up, in part,
as sponges, corals, fish, sea turtles, and zooplankton. These
ien consumed by secondary (2°) consumers, which are in turn
ers (3°), and so on. There are multiple levels, and the variable
e them on more than one level. For example, a tiger shark th
ight in that instance be a quaternary (4°) consumer if the grou
rimp that ate some phytoplankton. A few days later, the tiger
is a primary consumer, thereby making itself a secondary con

L PYRAMIDS

shifting nature of this complex food web, some coral reef ecologists : al species but on families or groups of organisms to determine the tr eef. For example, scientists might assign all consumers into three gr lary, and tertiary. After extensive field work to gather data, the scienti t pyramids of biomass or numbers that make it easier to "see" the ecos 'e.



pyramid represents a hierarchy of feeding relationships in whi rganisms at the base support smaller numbers or masses of or often drawn in a general, symbolic way. For example, if the py vere drawn proportionally starting from the top level as shown evel could end up being larger than your school. And if it were evel as shown, the top level would be microscopic.

pyramid may also be skewed by the amount of time in which data wa spans of the organisms. In the biomass pyramid shown, the producer l cause at any given moment the mass of phytoplankton is small. Becau oduce very quickly, their biomass over time is enough to sustain the analogous to the mass of food in your kitchen. On any given day it is your family's mass, but over the course of a year—not to mention you of food is many times larger than the human biomass in your kitchen

ht
f
g
in
aiian
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at
a
they
else
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n

Biomass of Fish in the Two Groups of Hawaiian Islands (metric

	Island	**1° Consumers**	**2° Consumers**	**3° Consun**
NWHI	French Frigate Shoals	0.6	0.3	1.7
	Gardner	1.6	1	1.3
	Kure	0.6	0.4	0.3
	Laysan	0.7	0.2	1.2
	Lisianski	0.7	0.2	1.8
	Maro	0.7	0.3	0.7
	Neckar	0.4	0.3	0.7
	Nihoa	1.6	0.6	0.6
	Pearl & Hermes	0.3	0.6	3.8
MHI	Hawai'i	0.4	0.2	0.1
	Kauai	0.2	0.2	0
	Maui	0.5	0.4	0.1
	Molokai	0.3	0.2	0
	Oahu	0.3	0.3	0

wing questions on a separate piece of paper.

ıe structure of the two island groups' ecosystems. First, calc
ss in each trophic level for each island group. Then use thes
ramids on graph paper. Draw the pyramids so that the levels
(Hint: Draw the smallest level first.)

e pyramids reveal about the differences between the island g
?

few humans live in the NWHI, what might be responsible for
nass between the two island groups?

e biomass of 2° consumers support a much larger 3° consume
nsider the life spans of organisms in these levels, as well as
top level consumers.

Water cycles through the environment.

ith a description of each process that describes how water moves th
hydrologic cycle.

	Description
ion	
on	
ion	
tion	

: Elements essential for life also cycle through ecosyst

following sentences with the proper terms.

nimals, and most other organisms need ________________

________________.

is released as a waste product by plants during the proces

__________. Animals takes in this oxygen and release it

__________ during the process of ________________.

rbon cycle, plants use energy from the Sun to convert ____

air into organic material that becomes a part of the plant's s ased to the atmosphere as carbon dioxide when you breathe during

f ________________ or through the ________________ of dead

______, or the burning of fossil fuels, also adds carbon dioxide to the

gen fixation?

____

____

that occur during the phosphorus cycle.

____

____

____

____

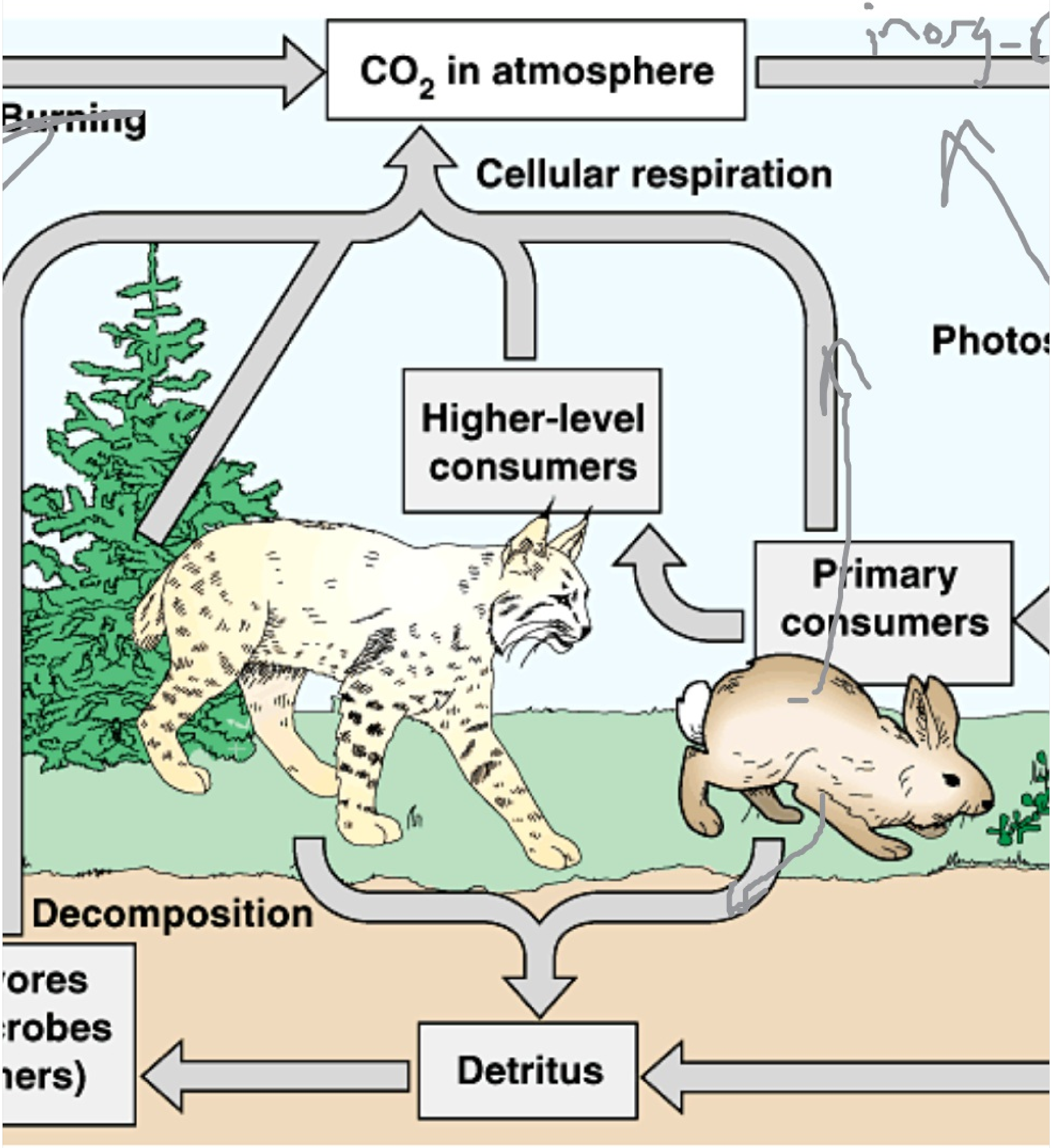
ologic cycle (evaporation, condensation, precipitation, runoff, ranspiration, infiltration):	Carbon cycle (photosynthesis, respiration, combustion, decomposition)
jen cycle (nitrogen fixation, denitrification, nitrification, ammonification, assimilation)	Phosphorus cycle:

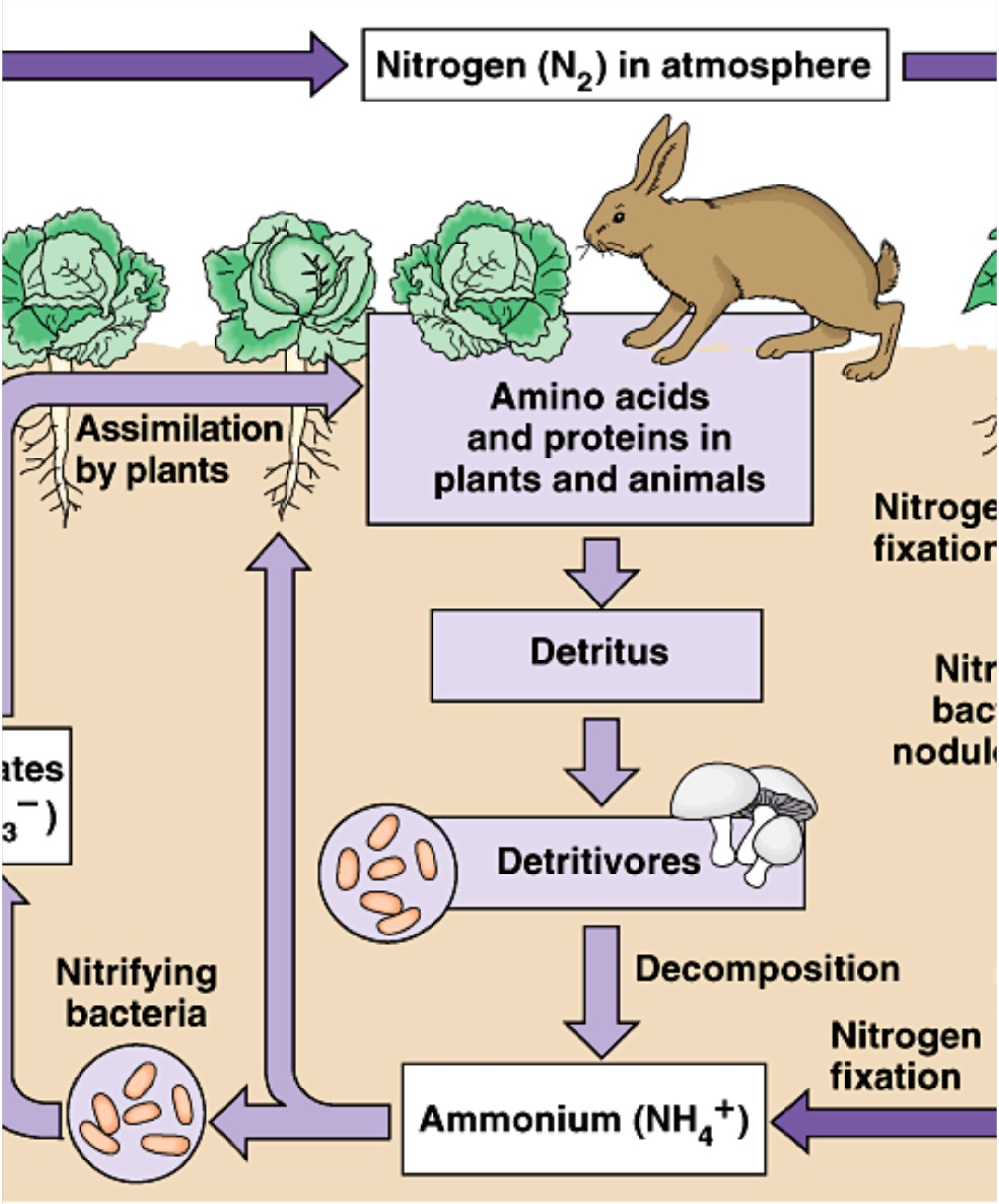
SECTION 3.5

CYCLING OF MATTER

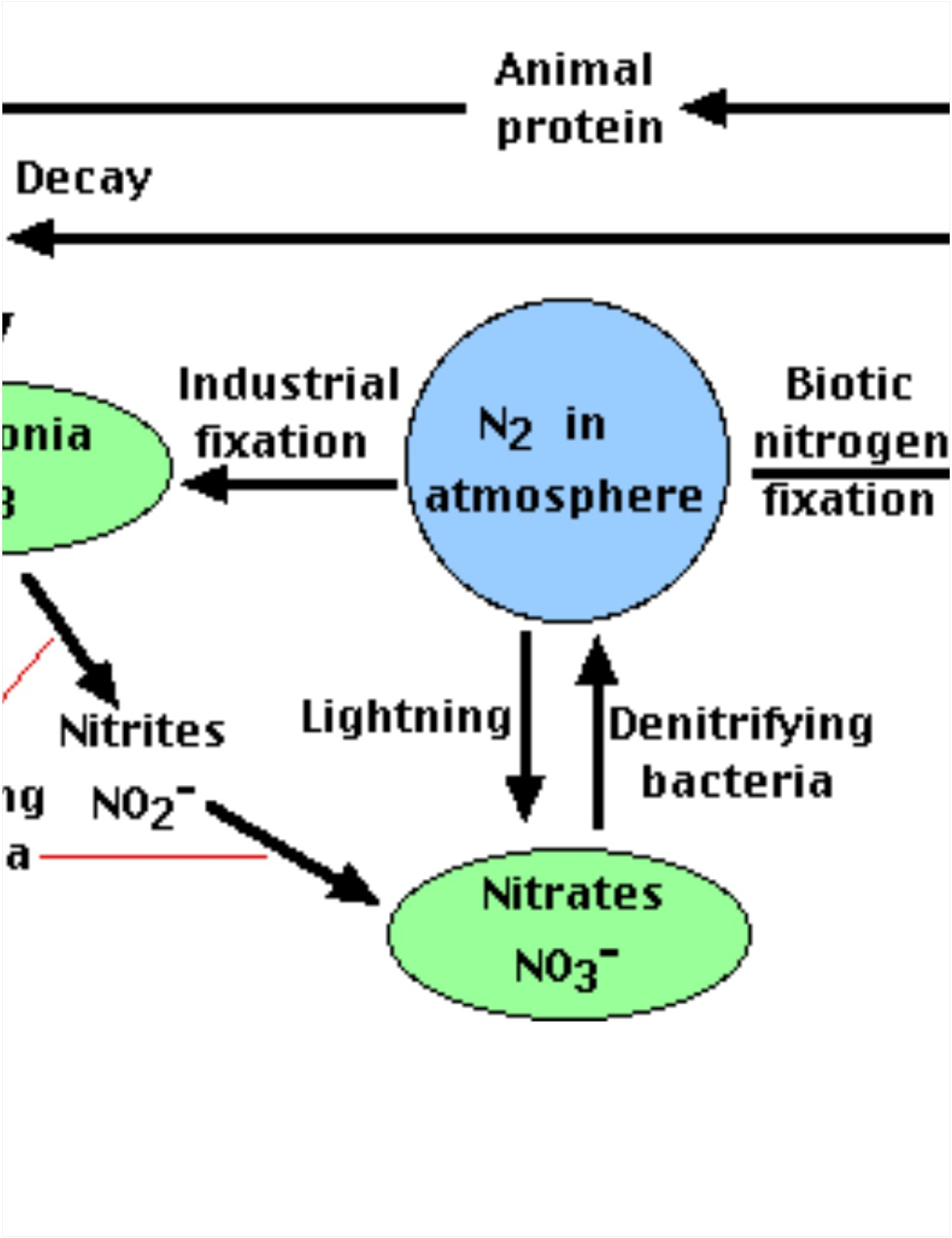
Biogeochemical Cycles: In each box, illustrate the following cycles including each of the terms in parentheses.

drologic cycle (evaporation, condensation, precipitation, runoff, transpiration, infiltration):	Carbon cycle (photosynthesis, respiration, combustion, decomposition)
ogen cycle (nitrogen fixation, denitrification, nitrification, ammonification, assimilation)	Phosphorus cycle:

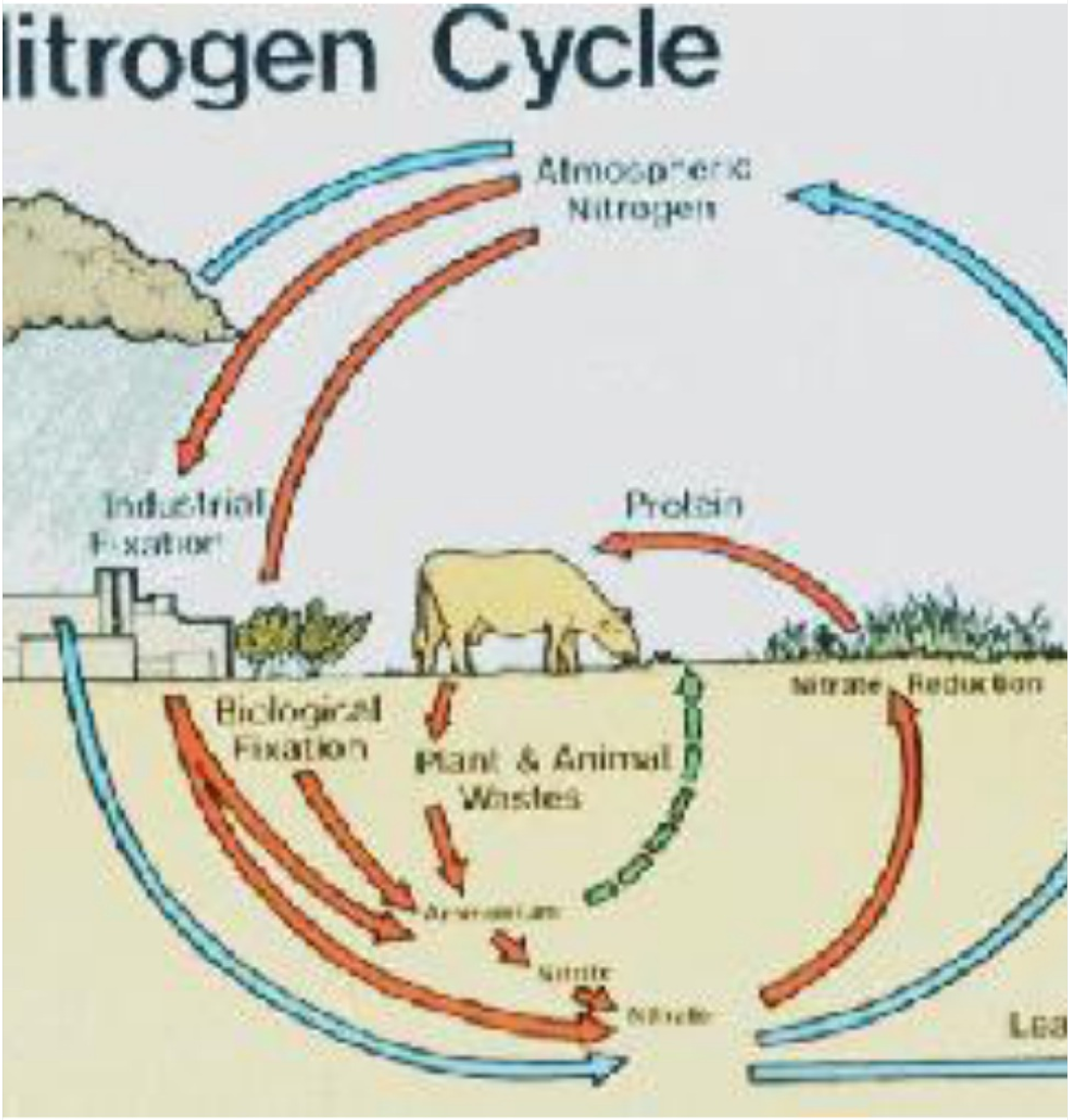

inorg-C
CO_2 in atmosphere
Burning
Cellular respiration
Photos
Higher-level consumers
Primary consumers
Decomposition
vores
crobes
ners)
Detritus



Nitrogen (N_2) in atmosphere
Amino acids and proteins in plants and animals
Assimilation by plants
Nitroge
fixation
Detritus
Nitr
bac
nodul
ates
$_3^-$)
Detritivores
Nitrifying bacteria
Decomposition
Nitrogen fixation
Ammonium (NH_4^+)



Animal
protein
Decay
Industrial
fixation
onia
N2 in
atmosphere
Biotic
nitrogen
fixation
Nitrites
NO2-
Lightning
Denitrifying
bacteria
Nitrates
NO3-



itrogen Cycle
Atmospheric
Nitrogen
Industrial
Fixation
Protein
Biological
Fixation
Plant & Animal
Wastes
Nitrate
Nitrite
Nitrate Reduction

ammonification

tion

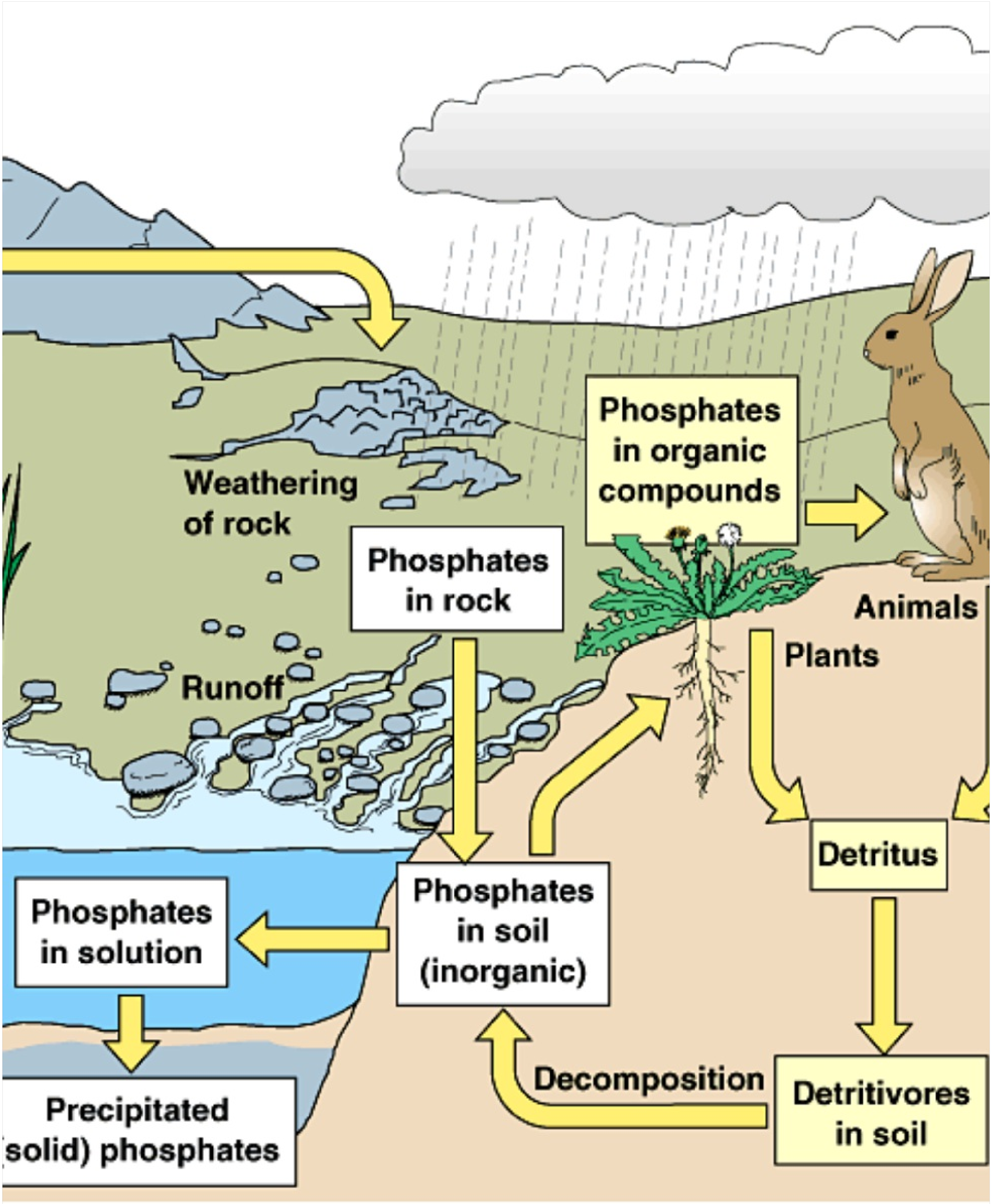
Nitrification

assimilation

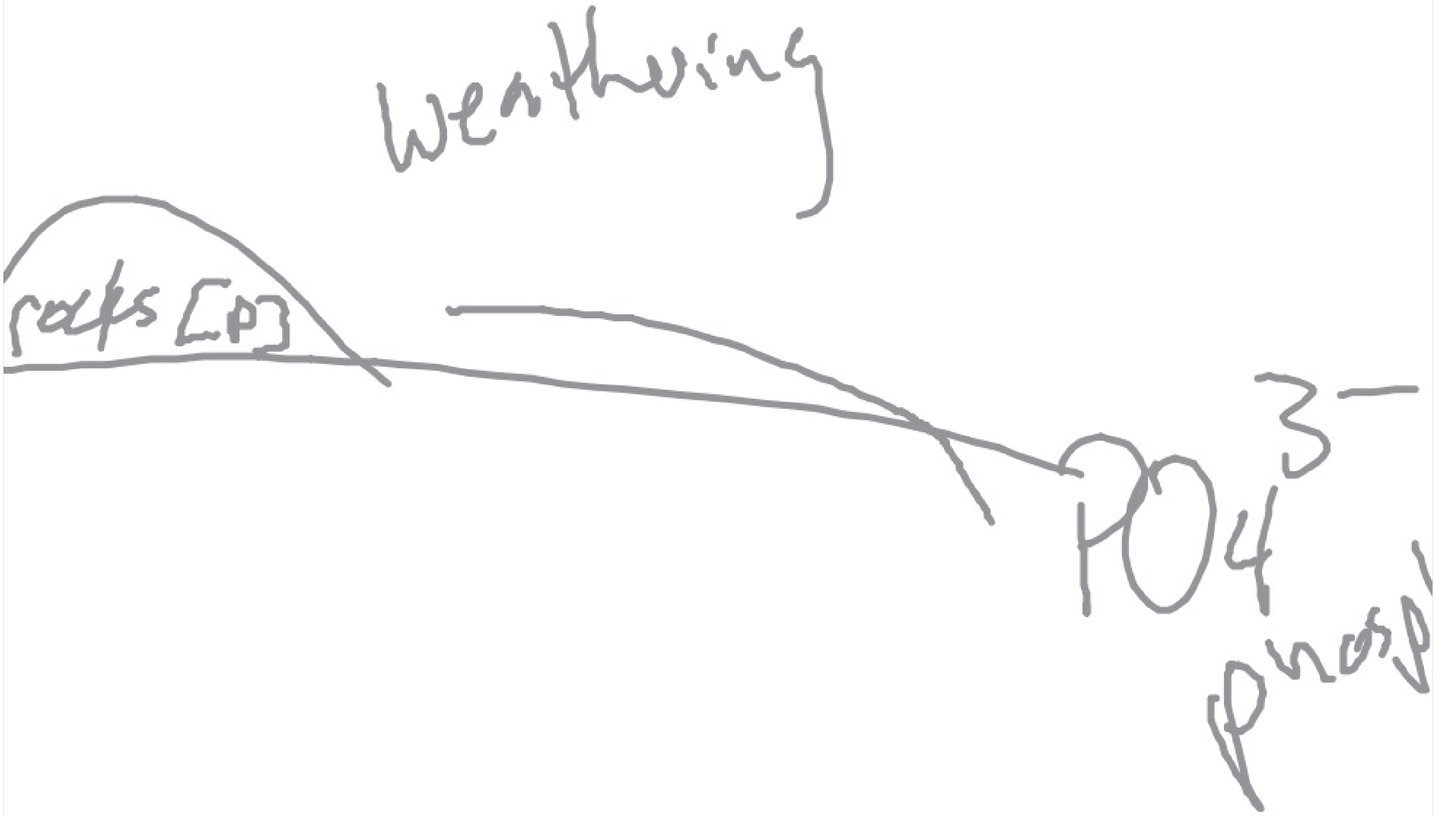
$\rightarrow NH_4^+ \xrightarrow{\text{Nitrification}} NO_3^- \xrightarrow{\text{assimilation}} O$

NO_2^-

nitrification



Weathering of rock
Phosphates in rock
Phosphates in organic compounds
Animals
Plants
Runoff
Detritus
Phosphates in solution
Phosphates in soil (inorganic)
Precipitated (solid) phosphates
Decomposition
Detritivores in soil


weathering
rocks [P]
PO_4^{3-}
phosp

Kickoff: **1.** Group yourselves and sit according to the chart below

Front of class

1	2	3	4	5	6	7	8

Group 1 sit here   Group 2 sit here

6	5	4	3	2	1	10	9

Group 3 sit here   Group 4 sit here

7	8	9	10	1	2	3	4

Group 5 sit here   Group 6 sit here

2	1	10	9	8	7	6	5

Group 7 sit here   Group 8 sit here   Group 9 sit here

Group 10 sit here
(back tables)

2. Once in your group, discuss whether climate change could affect allergies.

Making Connections

Question: Is there a relationship between global climate change (carbon cycle) and seasonal allergies

Objective: To analyze research and develop an evidence-based argument examining the relationship between climate change and allergies.

SPI 2.4 Predict how various types of human activities affect the environment.
SPI 3.4 Predict how changes in a biogeochemical cycle can affect an ecosyste
SPI Inq.5 Defend a conclusion based on scientific evidence.

AH-CHOO!
A Case Study on Climate Change and Allergies

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Scenario

You work for ScienceSpeak, a public relations firm that educates the public about scientific issues. Your company has won a contract with the World Health Organization (WHO) to supply materials for their new multimedia public health campaign about climate change. The WHO is specifically interested in the relationship between climate change and the increasing prevalence of allergies and asthma worldwide.

Your boss calls a meeting to discuss the contract. She gives you a set of Data Tables prepared for you by tw expert scientists that summarize recent evidence on the effects of increasing carbon dioxide and temperatu on allergenic plants. Your job is to design and produce a communication product such as a brochure, poste ~~web page, or television program~~ that informs the public about potential links between climate change and allergies.

1. Assign two data data tables for analysis to each group member, and summarize on your student Planning sheet. Share with group members and rank the top two most important ones that help you make your point.

2. Analyze your data (consider your source). What do we know, what do we want to know? How can we find out? Is there bias?

3. For each data table, consider the following:
 - The strength of the scientific evidence—e.g.: How were the data collected? Are there sufficient data to support a strong claim? How consistent is a response across plant species? Across geographical areas?

 - The relevance of the data to your target audience—e.g.: Where does your audience live? What plant species might they encounter? What sort of professional or recreational activities are your audience members engaged in?

4. Use the rubric on the back of your planning sheet, to self assess and peer review the product.

Data Tables

Table 1. Observational Data. Change in start of pollen season in Europe from 1969-2003. "—" = No data.

	Average change in start of pollen season			
Country	*Oak*	*Birch*	*Ragweed*	*Grass*
Austria	—	17 days earlier	—	—
Belgium	—	23 days earlier	—	—
Denmark	—	13 days earlier	—	—
France	12 days earlier	6 days earlier	No change	No change
Italy	8 days earlier	—	—	6 days earlier
The Netherlands	18 days earlier	10 days earlier	—	6 days earlier
Switzerland	21 days earlier	20 days earlier	20 days earlier	14 days earlier
United Kingdom	19 days earlier	—	—	—

Sources: Corden and Millington, 1999; Emberlin et al., 2002; Frenguelli, 2002; Rasmussen, 2002; Van Vliet et al., 2002; Clot, 2003; Thibaudon et al., 2005.

Table 2: Observational Data. Duration of pollen season (17 pollen types) in Europe (450 stations), 1974-2002.

*Flowering Season**	*Average Change in Duration of Pollen Season*
Winter	8 days shorter
Early spring	3 days longer
Mid-spring	3 days longer
Late spring	4 days longer
Summer	2 days longer
Autumn	4 days longer

* Trees typically flower from winter to mid-spring. Grasses can flower all year in some areas, but usually peak from late spring to summer. Most allergenic herbs flower from summer to autumn.

Source: Jaeger, 2001 (cited in World Health Organization, 2003).

Table 3: Observational Data. Change in amount of airborne pollen in Europe, 1969–2003. "—" = No data.

	Average change in amount of pollen		
Country	***Oak***	***Birch***	***Grass***
Austria	—	4.5 × more	2.4 × more
Belgium	2.7 × more	2.3 × more	No change
Denmark	—	4.1 × more	—
France	2.3 × more	5.3 × more	—
Germany	No change	No change	No change
The Netherlands	4.7 × more	2.4 × more	No change
Switzerland	2.6 × more	2.4 × more	1.1 × more
United Kingdom	4.8 × more	4.7 × more	No change

Sources: Frei and Leuschner, 2000; Rasmussen, 2002; Spieksma et al., 2003; Bortenschlager and Bortenschlager, 2005; Thibaudon et al., 20

Table 4: Experimental Data. Effect of increased carbon dioxide (CO_2) and temperature on pollen production in common ragweed. Half of the ragweed plants in each experiment were treated either with the predicted amount of CO_2 that will be in the atmosphere in 50 years, or the predicted temperature that will occur in 50 years.

Location	*Growing Technique*	*Treatment*	*Observed Change in Pollen Production in Treated Plants*
Maryland, USA	Environmental chambers	High CO_2	1.9 × more pollen than control plants
Illinois, USA	Greenhouses	High CO_2	1.6 × more pollen than control plants
Oklahoma, USA	Outdoor field	High temperature	1.8 × more pollen than control plants

Sources: Ziska and Caulfield, 2000; Wan et al., 2002; Wayne et al., 2002.

Table 5: Experimental Data. Effect of carbon dioxide on concentration of protein allergens in ragweed pollen. Plants were grown environmental chambers.

Concentration of CO_2 (µmol/mol)	*Concentration of Allergen From Ragweed Plants (ELISA/mg pollen)*
280 (pre-industrial levels)	93
370 (current levels)	103
600 (projected future levels)	178

Source: Singer et al., 2005.

Table 6: Observational Data. Effect of temperature on concentration of protein allergens in birch pollen. Plants were grown in outdoo gardens in northern Finland.

Location	*Concentration of Allergen From Birch Trees (% Antibody Bound to Protein)*
Hill, 270 m above sea level.	103
River valley, 90 m above sea level. (Daily mean temperatures 1.0–2.5°C warmer than Hill location).	130

Source: Ahlholm et al., 1998.

Planning Worksheet—Meeting 1

Data set	*Summary statement*	*Rank (1 = most important)*	*Reason for ranking of top two statements*
Table 1			*1.*
Table 2			
Table 3			
Table 4			*2.*
Table 5			
Table 6			

Peer Review Form

Reviewer name:				
Group name:		Intended audience:		
Type of presentation (circle one): Brochure Poster Web page Television program Other:				
Criteria Student-defined				
Introduction				
1. The main message is clear, factual, scientifically accurate, and catchy.				
Body				
2. The product summarizes all six data tables.				
3. Appropriate types of figures (e.g., graphs, maps, etc.) are used to highlight the most important data. The figures are detailed and creative.				
Conclusions				
4. Appropriate conclusions are made based on the available data.				
General Criteria				
5. The text/spoken word is easy to read/hear.				
6. The product is organized logically.				
7. The format and language are appropriate to the target audience.				
8. The product is an appropriate length.				
9. There are no errors in spelling and/or grammar.				
TOTAL				

List three specific things you liked about the draft communication product: 1. 2. 3.
List three specific suggestions for improving the draft communication product: 1. 2. 3.
General comments: