

# AP ENVIRONMENTAL SCIENCE (APES) SUMMER ASSIGNMENT 2026-27

John C. Kimball High School

Mrs. Botelho

Hey new APES friends!

The **purpose** of this summer assignment is to help us skip through Unit 1 (Ecosystems) as fast as possible and prepare us for Unit 2 (Biodiversity). Since you have seen a lot of this in previous classes, this will hopefully be a lot of review.

- Feel free to work together if you would like. I encourage it! Science is collaborative and a lot of this class will be as well. **BUT**, when I say work together, I don't mean split up the sections and "share" information to speed it up. **Really**, you can work together, but each person is responsible for their own learning. A lot of the info in this assignment will NOT be covered in class in August but you will still be tested on it.
- Ask for help if you need it! Ask a friend in the class, ask me, ask ChatGPT for help. Using your resources is fine but remember if it doesn't get stuck into YOUR BRAIN you are wasting your time. Just getting the assignment done to get the points won't help for our class or the AP exam.
- I will be checking my email over summer, but my responses may not be instantaneous.
- The summer assignment is due on **Tuesday August 4, 2025**.

**Checklist (see notes on each assignment on the backside of this page)**

1. Flinn Lab Safety Contract (study to prep for test, fill out signatures and allergies)
2. Unit 1 Smedes Video Notes
3. Current Event #1 and Current Event #2

*"Saving our planet, lifting people out of poverty, advancing economic growth... these are one and the same fight. We must connect the dots between climate change, water scarcity, energy shortages, global health, food security, and women's empowerment. Solutions to one problem must be solutions for all."* -Ban Ki-moon

*"You cannot get through a single day without having an impact on the world around you. What you do makes a difference, and you have to decide what kind of difference you want to make."* -Jane Goodall

Onward,

Mrs. Botelho  
jbotelho@tusd.net

### 1. Flinn Lab Safety

- Read the contract (attached), study it, sign it, prep for a quiz. You may have taken this one a few times so we will review and take the quiz in the first few days of class.

### 2. Video Notes for Unit 1

- Jordan Dischinger-Smedes (Mr. Smedes) is an APES teacher who has a GREAT set of resources you should be using this year. You will be going through his videos on Unit 1 and filling in cloze notes (attached) made by another educator, Carolyn Kelleher Mendonca.
- The links to the video playlists will be posted in Teams as part of the summer assignment and are listed on the links page of these instructions.
- We will use this as a way to speed through the first two units and save some time. So, make sure these get done or you will be at a disadvantage.

### 3. Current Events

In environmental science, it is important to know about current issues in the news. One of my goals is to familiarize you with environmental issues that are important to our community, country, and world. We will be reading and discussing a variety of current events throughout the school year as well. Over the course of the summer, find **2** recent articles related to environmental science.

All articles should be current (during the past year) and taken from a reliable source. The sources may be scientific publications, popular magazines, newspapers etc. Try the NY times (especially Tuesday), Washington Post, National Geographic, Discover Magazine, Natural History Magazine, etc. I do not care if you use a paper or online copy of your article as long as it is properly cited.

Each of the three articles should relate to a different topic chosen from the following list. As the year progresses you will be able to cover all of the topics!

|                     |                   |                  |              |                             |
|---------------------|-------------------|------------------|--------------|-----------------------------|
| Environmental Law   | Ecosystems        | Climate          | Evolution    | Preserving our biodiversity |
| Water pollution     | Population growth | Cities and waste | Geology      | Renewable Energy            |
| Nonrenewable energy | Food/agriculture  | Air pollution    | Human Health | Forest or Rangeland         |

**Article Analysis Directions:** Include all of the following components and clearly identify each component with headings. Each analysis should be either typed or very neatly written in blue or black ink. Each article should be on its own paper.

- Title of the Article
- Summary: **brief** summary that tells me what the article is about.
- Analysis:
  - a. Points of view – does the article have more than one side/pov? If so, what are they?
  - b. Bias – Is this article biased in any way? In your opinion, does the author give a positive, negative, or neutral view of the environmental science topic?
  - c. Controversy: Is there any controversy surrounding this article? If so, briefly explain it.
  - d. Your perspective: State your perspective on this news article based on your personal knowledge of the topic and your reading of the article.
  - e. Effect on you: How does this topic relate to you or affect you?
- Attach the article – either a physical copy of the article or a working web address must be included.

School Name \_\_\_\_\_

Teacher \_\_\_\_\_

**PURPOSE**

Science is a hands-on laboratory class. You will be doing many laboratory activities which require the use of hazardous chemicals. Safety in the science classroom is the #1 priority for students, teachers, and parents. To ensure a safe science classroom, a list of rules has been developed and provided to you in this student safety contract. These rules must be followed at all times. Two copies of the contract are provided. One copy must be signed by both you and a parent or guardian before you can participate in the laboratory. The second copy is to be kept in your science notebook as a constant reminder of the safety rules.

**GENERAL RULES**

1. Conduct yourself in a responsible manner at all times in the laboratory.
2. Follow all written and verbal instructions carefully. If you do not understand a direction or part of a procedure, ask the instructor before proceeding.
3. Never work alone. No student may work in the laboratory without an instructor present.
4. When first entering a science room, do not touch any equipment, chemicals, or other materials in the laboratory area until you are instructed to do so.
5. Do not eat food, drink beverages, or chew gum in the laboratory. Do not use laboratory glassware as containers for food or beverages.
6. Perform only those experiments authorized by the instructor. Never do anything in the laboratory that is not called for in the laboratory procedures or by your instructor. Carefully follow all instructions, both written and oral. Unauthorized experiments are prohibited.
7. Be prepared for your work in the laboratory. Read all procedures thoroughly before entering the laboratory.
8. Never fool around in the laboratory. Horseplay, practical jokes, and pranks are dangerous and prohibited.
9. Observe good housekeeping practices. Work areas should be kept clean and tidy at all times. Bring only your laboratory instructions, worksheets, and/or reports to the work area. Other materials (books, purses, backpacks, etc.) should be stored in the classroom area.
10. Keep aisles clear. Push your chair under the desk when not in use.
11. Know the locations and operating procedures, where appropriate, for all safety equipment including first aid kit, eyewash station, safety shower, fire extinguisher, and fire blanket. Know where the fire alarm and exits are located.
12. Always work in a well-ventilated area. Use the fume hood when working with volatile substances or poisonous vapors. Never place your head into the fume hood.
13. Be alert and proceed with caution at all times in the laboratory. Notify the instructor immediately of any unsafe conditions you observe.
14. Dispose of all chemical waste properly. Never mix chemicals in sink drains. Sinks are to be used only for water and those solutions designated by the instructor. Solid chemicals, metals, matches, filter paper, and all other insoluble materials are to be disposed of in the proper waste containers, not in the sink. Check the label of all waste containers twice before adding your chemical waste to the container.
15. Labels and equipment instructions must be read carefully before use. Set up and use the prescribed apparatus as directed in the laboratory instructions or by your instructor.
16. Keep hands away from face, eyes, mouth and body while using chemicals or preserved specimens. Wash your hands with soap and water after performing all experiments. Clean all work surfaces and apparatus at the end of the experiment. Return all equipment clean and in working order to the proper storage area.
17. Experiments must be personally monitored at all times. You will be assigned a laboratory station at which to work. Do not wander around the room, distract other students, or interfere with the laboratory experiments of others.
18. Students are never permitted in the science storage rooms or preparation areas unless given specific permission by their instructor.
19. Know what to do if there is a fire drill during a laboratory period; containers must be closed, gas valves turned off, fume hoods turned off, and any electrical equipment turned off.
20. Handle all living organisms used in a laboratory activity in a humane manner. Preserved biological materials are to be treated with respect and disposed of properly.

21. When using knives and other sharp instruments, always carry with tips and points pointing down and away. Always cut away from your body. Never try to catch falling sharp instruments. Grasp sharp instruments only by the handles.
22. If you have a medical condition (e.g., allergies, pregnancy, etc.), check with your physician prior to working in lab.

**CLOTHING**

23. Any time chemicals, heat, or glassware are used, students will wear laboratory goggles. There will be no exceptions to this rule!
24. Contact lenses may be worn provided adequate face and eye protection is provided by specially marked, non-vented safety goggles. The instructor should know which students are wearing contact lenses in the event of eye exposure to hazardous chemicals.
25. Dress properly for lab activities. Long hair, dangling jewelry, and loose or baggy clothing are hazardous. Long hair must be tied back and dangling jewelry and loose or baggy clothing must be secured. Shoes must completely cover the foot. No sandals allowed.
26. Lab aprons have been provided for your use and should be worn during laboratory activities.

**ACCIDENTS AND INJURIES**

27. Report any accident (spill, breakage, etc.) or injury (cut, burn, etc.) to the instructor immediately, no matter how trivial it may appear.
28. If you or your lab partner are hurt, immediately yell out "Code one, Code one" to get the instructor's attention.
29. If a chemical splashes in your eye(s) or on your skin, immediately flush with running water from the eyewash station or safety shower for at least 20 minutes. Notify the instructor immediately.
30. When mercury thermometers are broken, mercury must not be touched. Notify the instructor immediately.

**HANDLING CHEMICALS**

31. All chemicals in the laboratory are to be considered dangerous. Do not touch, taste, or smell any chemicals unless specifically instructed to do so. The proper technique for wafting chemical vapors will be demonstrated to you.
32. Check the label on chemical bottles twice before removing any of the contents. Take only as much chemical as you need.

33. Never return unused chemicals to their original containers.
34. Never use mouth suction to fill a pipet. Use a rubber bulb or pipet pump.
35. When transferring reagents from one container to another, hold the containers away from your body.
36. Acids must be handled with extreme care. You will be shown the proper method for diluting strong acids. Always add acid to water, swirl or stir the solution and be careful of the heat produced, particularly with sulfuric acid.
37. Handle flammable hazardous liquids over a pan to contain spills. Never dispense flammable liquids anywhere near an open flame or source of heat.
38. Never remove chemicals or other materials from the laboratory area.
39. Take great care when transporting acids and other chemicals from one part of the laboratory to another. Hold them securely and walk carefully.

## HANDLING GLASSWARE AND EQUIPMENT

40. Carry glass tubing, especially long pieces, in a vertical position to minimize the likelihood of breakage and injury.
41. Never handle broken glass with your bare hands. Use a brush and dustpan to clean up broken glass. Place broken or waste glassware in the designated glass disposal container.
42. Inserting and removing glass tubing from rubber stoppers can be dangerous. Always lubricate glassware (tubing, thistle tubes, thermometers, etc.) before attempting to insert it in a stopper. Always protect your hands with towels or cotton gloves when inserting glass tubing into, or removing it from, a rubber stopper. If a piece of glassware becomes "frozen" in a stopper, take it to your instructor for removal.
43. Fill wash bottles only with distilled water and use only as intended, e.g., rinsing glassware and equipment, or adding water to a container.
44. When removing an electrical plug from its socket, grasp the plug, not the electrical cord. Hands must be completely dry before touching an electrical switch, plug, or outlet.
45. Examine glassware before each use. Never use chipped or cracked glassware. Never use dirty glassware.
46. Report damaged electrical equipment immediately. Look for things such as frayed cords, exposed wires, and loose connections. Do not use damaged electrical equipment.
47. If you do not understand how to use a piece of equipment, ask the instructor for help.
48. Do not immerse hot glassware in cold water; it may shatter.

## HEATING SUBSTANCES

49. Exercise extreme caution when using a gas burner. Take care that hair, clothing and hands are a safe distance from the flame at all times. Do not put any substance into the flame unless specifically instructed to do so. Never reach over an exposed flame. Light gas (or alcohol) burners only as instructed by the teacher.
50. Never leave a lit burner unattended. Never leave anything that is being heated or is visibly reacting unattended. Always turn the burner or hot plate off when not in use.
51. You will be instructed in the proper method of heating and boiling liquids in test tubes. Do not point the open end of a test tube being heated at yourself or anyone else.
52. Heated metals and glass remain very hot for a long time. They should be set aside to cool and picked up with caution. Use tongs or heat-protective gloves if necessary.
53. Never look into a container that is being heated.
54. Do not place hot apparatus directly on the laboratory desk. Always use an insulating pad. Allow plenty of time for hot apparatus to cool before touching it.
55. When bending glass, allow time for the glass to cool before further handling. Hot and cold glass have the same visual appearance. Determine if an object is hot by bringing the back of your hand close to it prior to grasping it.

## QUESTIONS

56. Do you wear contact lenses?  
☐ YES ☐ NO
  57. Are you color blind?  
☐ YES ☐ NO
  58. Do you have allergies?  
☐ YES ☐ NO
- If so, list specific allergies \_\_\_\_\_

## AGREEMENT

I, \_\_\_\_\_ (student's name) have read and agree to follow all of the safety rules set forth in this contract. I realize that I must obey these rules to ensure my own safety, and that of my fellow students and instructors. I will cooperate to the fullest extent with my instructor and fellow students to maintain a safe lab environment. I will also closely follow the oral and written instructions provided by the instructor. I am aware that any violation of this safety contract that results in unsafe conduct in the laboratory or misbehavior on my part, may result in being removed from the laboratory, detention, receiving a failing grade, and/or dismissal from the course.

Student Signature \_\_\_\_\_

Date \_\_\_\_\_

Dear Parent or Guardian:

We feel that you should be informed regarding the school's effort to create and maintain a safe science classroom/laboratory environment.

With the cooperation of the instructors, parents, and students, a safety instruction program can eliminate, prevent, and correct possible hazards.

You should be aware of the safety instructions your son/daughter will receive before engaging in any laboratory work. Please read the list of safety rules above. No student will be permitted to perform laboratory activities unless this contract is signed by both the student and parent/guardian and is on file with the teacher.

Your signature on this contract indicates that you have read this Student Safety Contract, are aware of the measures taken to ensure the safety of your son/daughter in the science laboratory, and will instruct your son/daughter to uphold his/her agreement to follow these rules and procedures in the laboratory.

Parent/Guardian Signature \_\_\_\_\_

Date \_\_\_\_\_

## Video Links Unit 1:

Unit 1.1 - Ecosystems: <https://youtu.be/-IMCElvN0lk?si=iqe4UjEaggZt9nww>

Unit 1.2 – Terrestrial Biomes: <https://youtu.be/DliF5uQmtn0?si=DL8n0aHMT054h9aQ>

Unit 1.3 – Aquatic Biomes: [https://youtu.be/wpYZW\\_pV1u4?si=XekfW\\_Hw8KlqYwcG](https://youtu.be/wpYZW_pV1u4?si=XekfW_Hw8KlqYwcG)

Unit 1.4 – Carbon Cycle: <https://youtu.be/pFrFOnw8TFs?si=f9sWGlki59WjTwpZ>

Unit 1.5 – Nitrogen Cycle: <https://youtu.be/hGJkzTPcX2A?si=5VHZVaAq4x0YsxUz>

Unit 1.6 – Phosphorous Cycle: [https://youtu.be/AmnVAp0aGdc?si=QfFQVGMJg\\_aKz9D3](https://youtu.be/AmnVAp0aGdc?si=QfFQVGMJg_aKz9D3)

Unit 1.7 – Hydrologic (Water) Cycle: <https://youtu.be/IsKLNzKK2T8?si=qJLAZ8zqtSYQJrD7>

Unit 1.8 – Primary Productivity: <https://youtu.be/tRXp-WPnjxE?si=BhBPwHaMVR-zZMrY>

Unit 1.9 and 1.10 – Trophic Levels and the 10% Rule: [https://youtu.be/tFvphrq\\_xsc?si=hOZicnSzvoK7sGpe](https://youtu.be/tFvphrq_xsc?si=hOZicnSzvoK7sGpe)

Unit 1.11 – Food Webs and Chains: <https://youtu.be/SCKJJSsKqQY?si=HAXvG-g3SQG9Twsf>

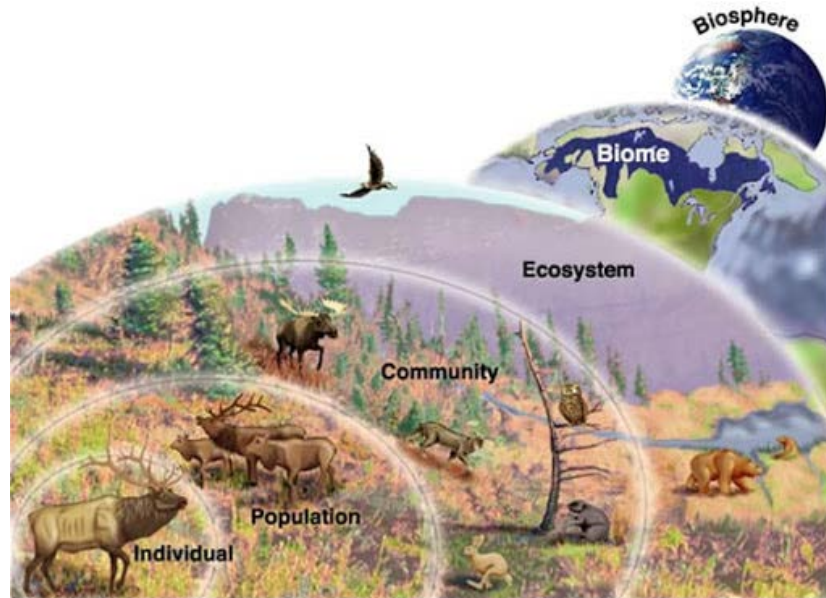
## 1.1 Ecosystems

### Ecosystem Basics

- Individual = \_\_\_\_\_
- Pop. = \_\_\_\_\_ of individuals of same \_\_\_\_\_ (elk herd)
- Community = \_\_\_\_\_ in an area
- Ecosystem = \_\_\_\_\_ (plants, animals, rocks, soil, water, air)

 Biome = large area with similar \_\_\_\_\_ conditions that determine \_\_\_\_\_ there

Ex: (tropical rainforest)



### Organism Interactions

- \_\_\_\_\_: organisms fighting over a resource like food or shelter; limits pop. size
- \_\_\_\_\_: one organism using another for energy source (hunters, parasites, even herbivores)
- \_\_\_\_\_: relationship that benefits both organisms (coral reef)
- \_\_\_\_\_: relationship that benefits one organism & doesn't impact the other (birds nest in trees)

| Type of interaction | Species 1 | Species 2 |
|---------------------|-----------|-----------|
| Competition         | -         | -         |
| Predation           | +         | -         |
| Mutualism           | +         | +         |
| Commensalism        | +         | 0         |

### Predation (+/-)

- \_\_\_\_\_: (plant eaters) eat plants for energy (giraffe & tree)

- \_\_\_\_\_: (carnivores) kill and eat prey for energy (leopard & giraffe)
- \_\_\_\_\_: use a host organism for energy, often without killing the host & often living inside host
  - Ex: mosquitoes, tapeworms, sea lamprey
- \_\_\_\_\_: lay eggs inside a host organism; eggs hatch & larvae eat host for energy
  - Ex: parasitic wasps, bot fly

Symbiosis sym = together |  
bio = living | osis =  
condition

### What is coral?

Corals are made up from colonies of tiny organisms called polyps

Polyps are related to sea anemones and jellyfish

Tentacles to capture microscopic organisms in the water

Coral polyps are translucent, they receive colour from algae such as **dinoflagellates** that live on them in a **symbiotic relationship**

Algae use nitrogen, phosphorus and other **metabolic waste from the coral** to generate energy from the sun via **photosynthesis**

► Ocean acidification affects hard coral's ability to absorb **calcium carbonate** and build carbon skeletons

Polyps connect to one another through their **calcium skeletons**, creating colonies and reefs

Oxygen and other **organic products of photosynthesis** help the coral to grow

- Under environmental stress, such as a change in temperature, corals will expel algae
- Loss of algae causes coral bleaching, making them vulnerable to disease
- Bleached coral will eventually die if they don't regain algae

Source : NOAA/NationalGeographic/Oceana.org/teachoceanscience.net

AFP



Any \_\_\_\_\_  
between two organisms of \_\_\_\_\_

- Mutualism (+/+), commensalism (+/0), and parasitism (+/-) are all symbiotic relationships
- \_\_\_\_\_: Organisms of diff. species living close together in a way that benefits both
  - \_\_\_\_\_ (animals) provide reef structure & CO<sub>2</sub> for **algae**; algae provide sugars for coral to use as energy
  - \_\_\_\_\_ = composite organism of fungi living with algae; algae provide sugars (energy) & fungi provides nutrients

### Competition



\_\_\_\_\_ since there are fewer resources available & fewer organisms can survive

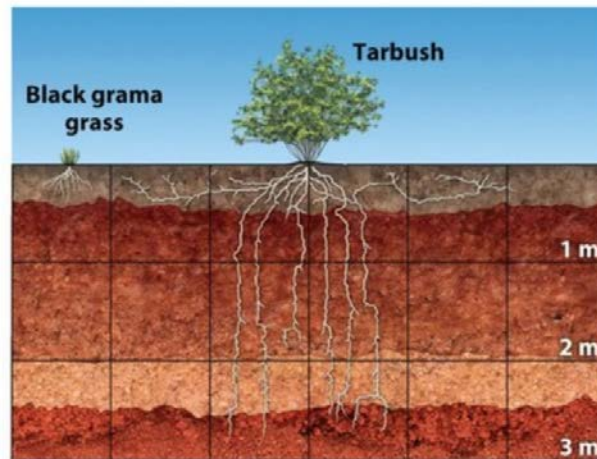
- \_\_\_\_\_: different species using the same resource in diff. ways to **reduce competition**
  - \_\_\_\_\_: using resource

@ different times, such as wolves & coyotes hunting @ different times (night vs. day)

- \_\_\_\_\_: using diff. areas of a shared habitat (diff. length roots)
- \_\_\_\_\_: using diff. resources based on diff. evolved body features



(a) Temporal resource partitioning

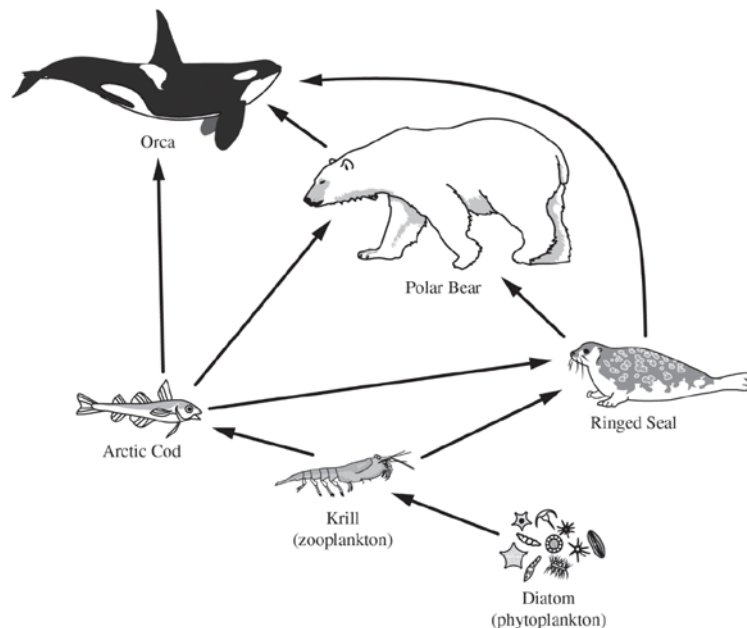


(b) Spatial resource partitioning



(c) Morphological resource partitioning

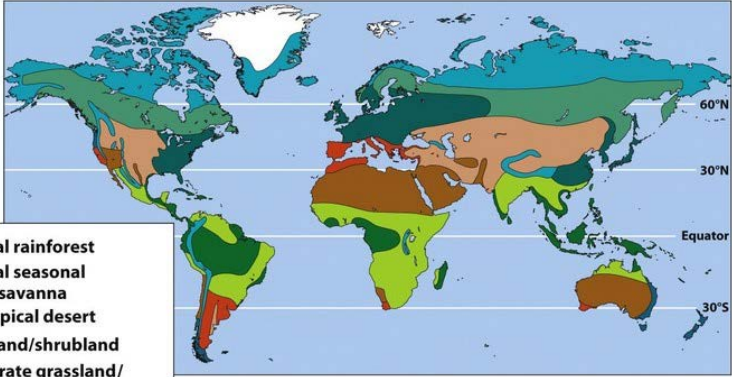
### Practice FRQ 1.1



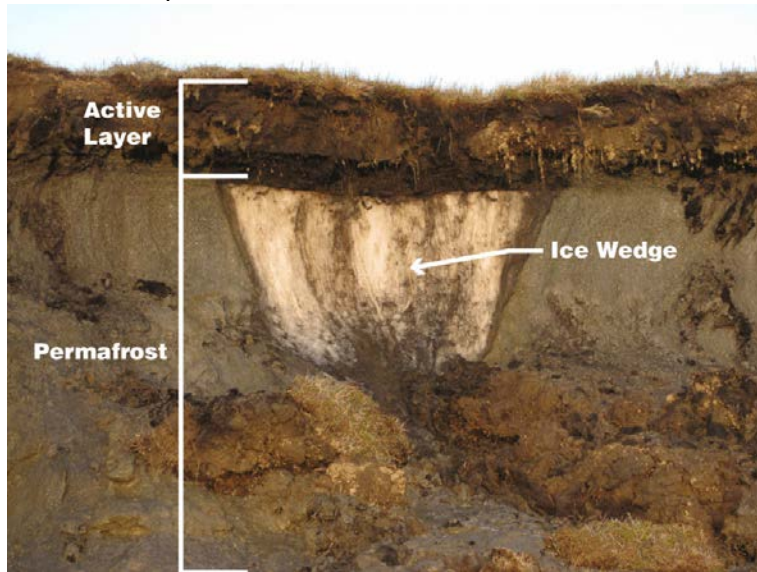
|  |                                                                               |
|--|-------------------------------------------------------------------------------|
|  | <p><b>Identify</b> two organisms that compete for a shared food resource.</p> |
|--|-------------------------------------------------------------------------------|

|  |                                                                                                                         |
|--|-------------------------------------------------------------------------------------------------------------------------|
|  | <p><b>Describe</b> how resource partitioning could reduce the competition between the two organisms you identified.</p> |
|--|-------------------------------------------------------------------------------------------------------------------------|

## 1.2 Terrestrial (Land) Biomes

|                              |                                                                                                                                                                                                                                                                                                                                                                                                                |
|------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Biome</b>                 | <p>_____ : an area that shares a combination of avg, yearly temp. &amp; precipitation (climate)</p> <p> The community of org. (plants &amp; animals) in a biome are _____ to live in that biome</p> <p>Ex: camels &amp; cacti have _____ for _____; shrubs &amp; wildflowers _____ to recover quickly from _____ in _____</p> |
| <b>Biome Characteristics</b> | <p> _____ (distance from eq) determines _____ which is why biomes exist in predictable pattern on earth</p> <p>Biome chart can also predict where on earth biomes are found</p> <p>Biomes are defined by annual _____</p>                 |
| <b>Nutrient Availability</b> | <p>Plants need _____ to grow, so _____ determines which plants can survive in a biome</p> <p> Ex: frozen soils of _____ don't allow _____ in _____ to be broken down by decomposers</p> <p>- Low soil _____</p>                                                                                                             |

- Low water \_\_\_\_\_
- Few plants survive here

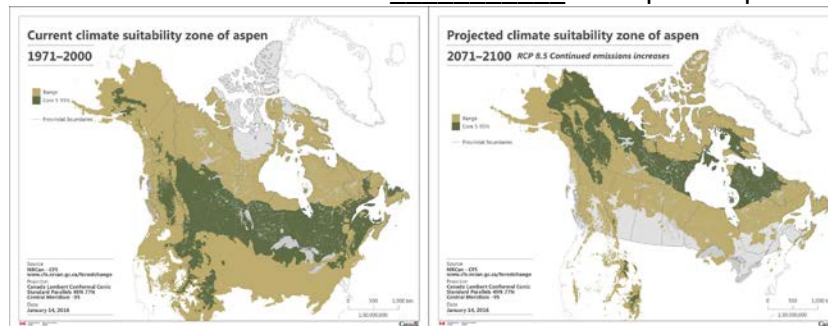


## Shifting Biomes

 Biomes \_\_\_\_\_ in location on earth as climate changes



Ex: warming climate will shift boreal forests further \_\_\_\_\_ as tundra permafrost soil melts & lower latitudes become too \_\_\_\_\_ for aspen & spruce

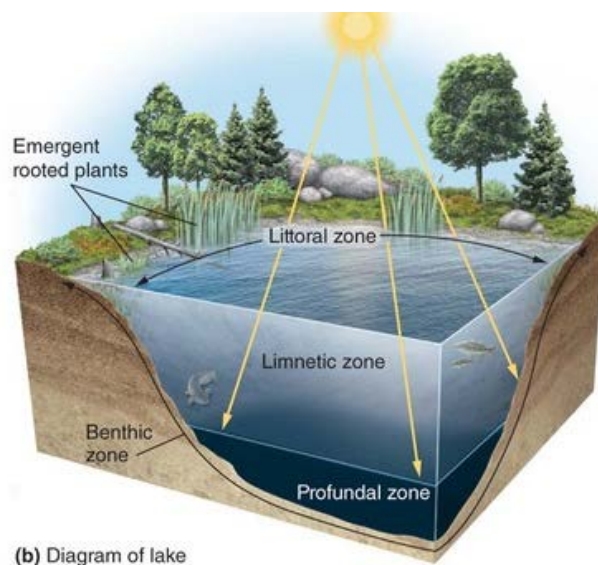


## Practice FRQ 1.2

**Identify** one characteristic of a biome and **explain** how that characteristic determines the community of organisms found in the biome.

1.3 Aquatic Biomes

|                                          |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Characteristics of Aquatic Biomes</b> | <p>_____</p> <p>How much salt there is in a body of water, determines _____ can survive &amp; usability for _____</p> <p>(Fresh water vs. estuary vs. ocean)</p> <p>_____</p> <p>Influences how much _____ can penetrate and reach plants below the surface for _____</p> <p>_____</p> <p>Determines which _____, how much _____ into water</p> <p>_____.</p> <p>_____ water holds _____ so it can support _____ aq. organisms</p>                                                                              |
| <b>Freshwater: Rivers &amp; Lakes</b>    | <p>_____ have _____ due to flow mixing water &amp; air, also carry nutrient-rich _____ (deltas &amp; flood plains = fertile soil)</p> <p>_____ = standing bodies of fresh H<sub>2</sub>O (key drinking H<sub>2</sub>O source)</p> <p>_____ : shallow water w/emergent plants</p> <p>_____ : where light can reach (photosynth)</p> <p>No rooted plants, only phytoplankton</p> <p>_____ : too deep for sunlight (no photos.)</p> <p>_____ : murky bottom where inverts (bugs) live, nutrient-rich sediments</p> |



## Freshwater: Wetlands

\_\_\_\_\_ : area with soil \_\_\_\_\_  
 \_\_\_\_\_ in water for at least part of the year,  
 but shallow enough for \_\_\_\_\_ plants

🌿 Plants living here have to be \_\_\_\_\_ to  
 living with roots \_\_\_\_\_ in standing water  
 (cattails, lily pads, reeds)

### Benefit\$ of Wetland\$

\_\_\_\_\_ during storms, lessening  
 floods

\_\_\_\_\_ by absorbing rainfall into  
 soil

Roots of wetland plants \_\_\_\_\_ from  
 water draining through

High productivity (plant growth) due to lots of  
 \_\_\_\_\_ (dead organic matter) in sediments



(a)

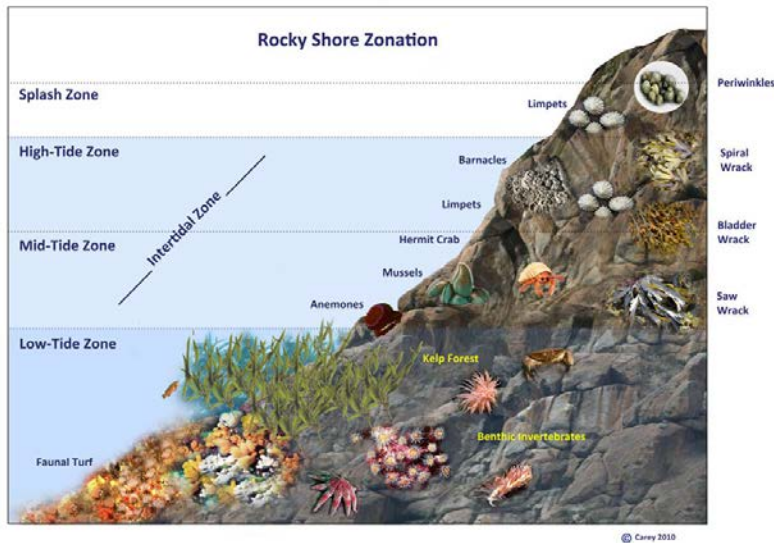


(b)



(c)

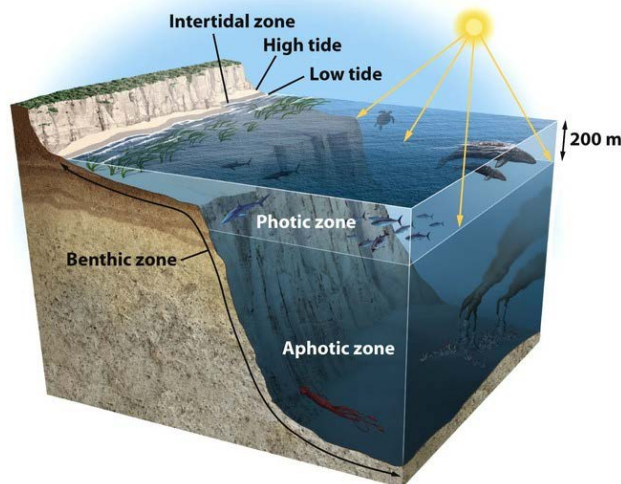
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|-------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Estuaries</b>        | <p>areas where _____ into the ocean</p> <p> Mix of _____ water (species adapt to this ex: _____ trees)</p> <p> High _____ (plant growth) due to nutrients in sediments deposited in estuaries by river</p> <p>_____:</p> <ul style="list-style-type: none"> <li>● Estuary hab. along coast in _____</li> <li>● _____ for many fish &amp; shellfish species</li> </ul> <p>_____:</p> <ul style="list-style-type: none"> <li>● Estuary hab. along coast of _____</li> <li>● Mangrove trees with long, stilt roots _____ &amp; _____ for many species of fish &amp; shellfish</li> </ul> |
| <b>Coral Reef</b>       | <ul style="list-style-type: none"> <li>● _____ shallow waters beyond the shoreline; most _____ marine (ocean) biome on earth</li> <li>● _____ relationship between _____ (animals) &amp; _____ (plants)</li> <li>● Coral take _____ out of ocean to create calcium carbonate _____ (the reef) &amp; also provide CO<sub>2</sub> to the _____</li> <li>● Algae _____ &amp; provide _____ (energy) to the coral through _____</li> </ul> <p> Both species rely on the other:</p> <ul style="list-style-type: none"> <li>- Coral couldn't survive without _____ from algae.</li> <li>- Algae need the _____ of the reef &amp; CO<sub>2</sub> from the coral</li> </ul>  |
| <b>Intertidal Zones</b> | <ul style="list-style-type: none"> <li>● Narrow band of coastline between _____</li> <li>● Organisms must be _____ to survive _____ &amp; _____ during low tide<br/>Ex: Barnacles, sea stars, crabs that can attach themselves to rocks</li> <li>● Shells &amp; tough outer skin can prevent drying out (_____) during low tides</li> </ul> <p> Diff. organisms are _____ to live in diff. Zones</p> <p>Ex: Spiral wrack (type of seaweed) curls up &amp; secretes mucus to retain water during low tide</p>                                                                                                                                                         |



### Open Ocean

- Low \_\_\_\_\_/area as only \_\_\_\_\_ & \_\_\_\_\_ can survive in most of ocean  
 🌍 So \_\_\_\_\_ though, that algae & phytoplankton of ocean \_\_\_\_\_ a lot of earth's \_\_\_\_\_ & \_\_\_\_\_ a lot of atmospheric \_\_\_\_\_
- \_\_\_\_\_ = area where sunlight can reach (photosynthesis)
- \_\_\_\_\_ (abyssal) = area too deep for sunlight

### Practice FRQ 1.3



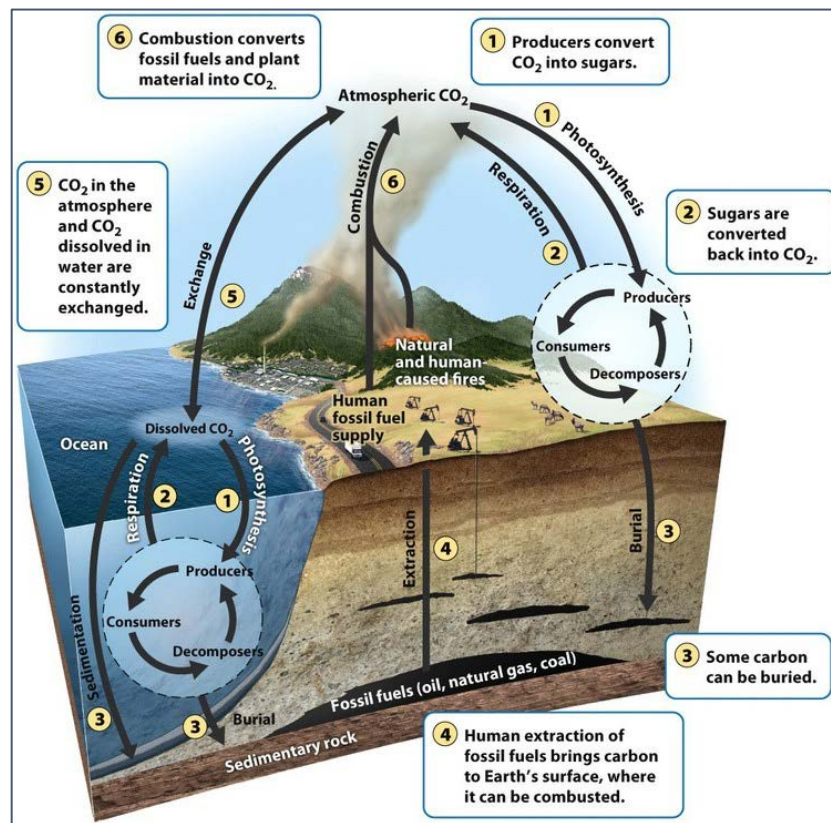
**Identify** an organism found in an aquatic biome and **explain**

|  |                                                              |
|--|--------------------------------------------------------------|
|  | how that organism is uniquely adapted to live in that biome. |
|--|--------------------------------------------------------------|

## 1.4 The Carbon Cycle

### Carbon Cycle Overview

- Movement of molecules that contain Carbon (\_\_\_\_\_, \_\_\_\_\_, \_\_\_\_\_) between \_\_\_\_\_ and \_\_\_\_\_
- 🌳 Some steps are very quick (\_\_\_\_\_); some are very slow (\_\_\_\_\_ & \_\_\_\_\_)
- 🌳 Leads to \_\_\_\_\_ in which reservoirs or sinks are storing carbon
- Atmosphere is key C reservoir; \_\_\_\_\_ levels of C in atm. Leads to \_\_\_\_\_
- \_\_\_\_\_: a carbon \_\_\_\_\_ that \_\_\_\_\_ more carbon than it \_\_\_\_\_
  - \_\_\_\_\_ (algae & sediments), \_\_\_\_\_, \_\_\_\_\_
- \_\_\_\_\_: processes that \_\_\_\_\_ C to \_\_\_\_\_
  - Fossil fuel (oil, coal, nat gas) \_\_\_\_\_
  - \_\_\_\_\_ (cow burps & farts =  $\text{CH}_4$ )
  - \_\_\_\_\_, releases  $\text{CO}_2$  from trees



### Photosynthesis & Cellular Respiration

- Plants, algae, phytoplankton

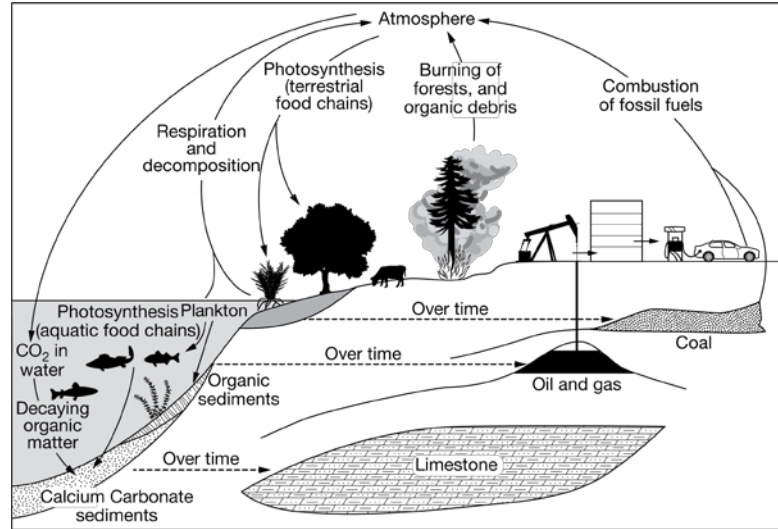
|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                       |
|---------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                             | <ul style="list-style-type: none"> <li>● Removes CO<sub>2</sub> from the atmosphere &amp; converts it to glucose</li> <li>● Glucose = biological form of C &amp; stored (chemical) energy in form of sugar</li> <li>● _____</li> </ul> <hr/> <ul style="list-style-type: none"> <li>● Done by plants &amp; animals to release stored energy</li> <li>● Uses O<sub>2</sub> to break glucose down &amp; release energy</li> <li>● Releases CO<sub>2</sub> into atmosphere</li> <li>● _____ (adds CO<sub>2</sub> to atm.)</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
| <b>Ocean &amp; Atmosphere</b>               | <ul style="list-style-type: none"> <li>● _____: CO<sub>2</sub> moves directly between _____ &amp; the _____ by _____ into &amp; out of ocean water at the surface<br/><br/>  Happens very _____ &amp; in _____, balancing levels of CO<sub>2</sub> between atm. &amp; ocean</li> <li>● B/c of direct exchange, _____ atm. CO<sub>2</sub> also _____ ocean CO<sub>2</sub>, leading to _____</li> <li>● _____: take CO<sub>2</sub> out of the ocean &amp; atm. through _____ <ul style="list-style-type: none"> <li>○ _____ <b>reef &amp; marine org. with</b> _____ also take CO<sub>2</sub> out of the ocean to make _____</li> </ul> </li> <li>● _____: when marine org. die, their bodies sink to ocean floor where they're broken down into sediments that contain C <ul style="list-style-type: none"> <li>○ _____: over, long, periods of time, pressure of water compresses C-containing sediments on ocean floor into sedimentary stone (limestone, sandstone) - long-term C reservoir</li> </ul> </li> </ul> |
| <b>Burial, Extraction, &amp; Combustion</b> | <ul style="list-style-type: none"> <li>● _____: slow, geological process that stores C in underground sinks like sedimentary rock or fossil fuels</li> <li>● _____ (bits of rock, soil, organic matter) compressed into sed. rock, or FF, by pressure from overlying rock layers or water</li> <li>● _____: coal, oil, and Nat. gas are formed</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

from fossilized remains of org. Matter. Ex: dead ferns (coal) or marine algae & plankton (oil)

- \_\_\_\_\_: digging up or mining FFs & burning them as energy source; releases CO<sub>2</sub> into atm.

 \_\_\_\_\_ (formation of FFs) takes far \_\_\_\_\_ than **extraction & combustion**, which means they \_\_\_\_\_ of CO<sub>2</sub> in atmosphere

#### Practice FRQ 1.4

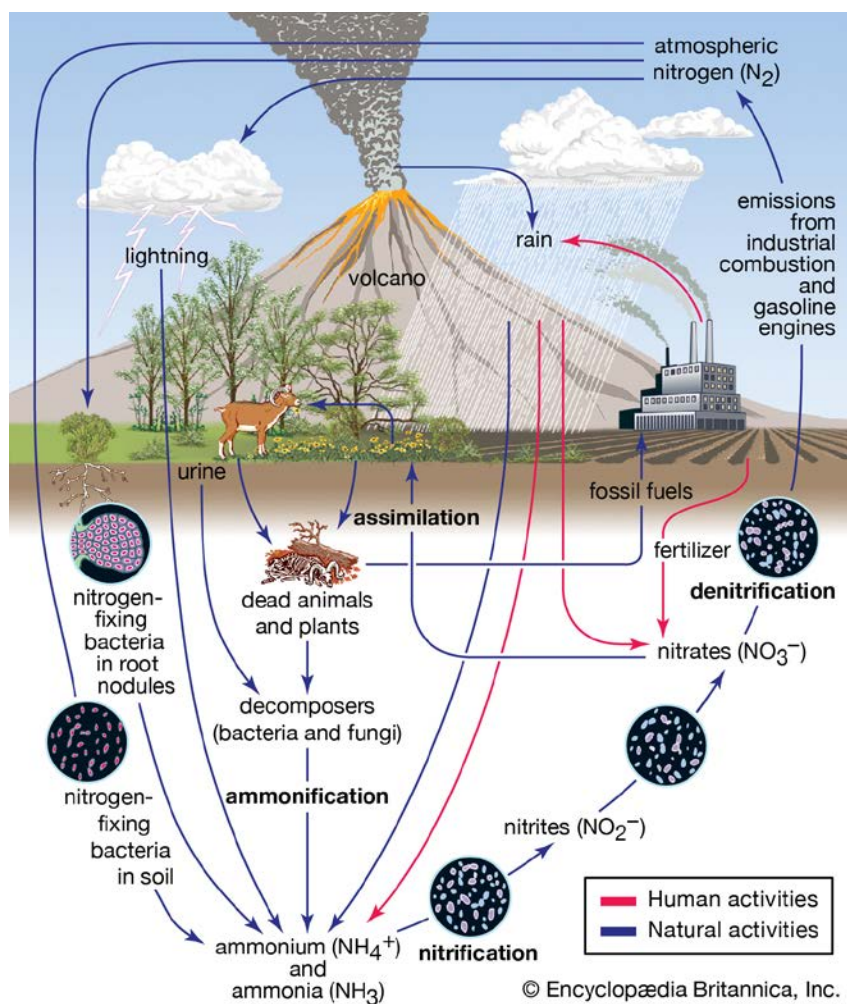


**Identify** ONE process in the diagram that happens quickly and ONE process that happens slowly.

**Explain** how the rate at which fossil fuels are transferred into the atmosphere, as shown in the diagram, has altered the carbon cycle during the past 250 years.

## 1.5 The Nitrogen Cycle

|                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Nitrogen Cycle Overview</b> | <p>Mvmnt of _____ between<br/>_____ &amp; _____</p> <p>Sources release N into atmosphere; sinks take N out of the atmosphere in increasing amounts</p> <p><b>N _____ hold N for relatively _____ period of time compared to C cycle</b></p> <p>- <b>Ex:</b> _____<br/>_____ = _____ <b>N reservoir</b></p> <p>N in atm. exists mostly as _____ gas, not _____ by plants or animals</p> <p><b>N = critical plant &amp; animal _____</b></p> <p>All living things need N for _____ &amp; amino acids to make _____</p> |
| <b>Nitrogen Fixation</b>       | <p><b>Process of N<sub>2</sub> gas being _____ into _____ (useable by plants)</b><br/>_____ or _____</p> <p>_____ <b>fixation:</b> certain bacteria that live in the _____, or in _____ relationship with plant<br/>_____ convert _____</p> <p>_____ live in root nodules of _____ (peas, beans) &amp; _____ for them in return for _____ from the plant</p> <p>_____ : humans _____ to convert _____ gas into _____</p> <p>Nitrates are added to _____ like _____ &amp; used in _____</p>                           |



### Other N Cycle Steps

\_\_\_\_\_ : plants & animals \_\_\_\_\_  
 \_\_\_\_\_ and \_\_\_\_\_ it into their  
 body

Plant roots take in \_\_\_\_\_ from soil; animals  
 assimilate N by \_\_\_\_\_ plants or other animals

\_\_\_\_\_ : soil bacteria, microbes &  
 decomposers \_\_\_\_\_ back into  
 \_\_\_\_\_ and returning it to \_\_\_\_\_

\_\_\_\_\_ : conversion of \_\_\_\_\_ into  
 \_\_\_\_\_ & then \_\_\_\_\_ by soil bacteria

\_\_\_\_\_ : conversion of soil N \_\_\_\_\_  
 into \_\_\_\_\_ gas which returns to  
 atmosphere

### Human Impacts on N Cycle

\_\_\_\_\_ :  $N_2O$  (nitrous oxide) =  
 \_\_\_\_\_ which warm earth's climate

Produced by \_\_\_\_\_ of nitrate in agricultural  
 soils (especially when waterlogged / over watered)

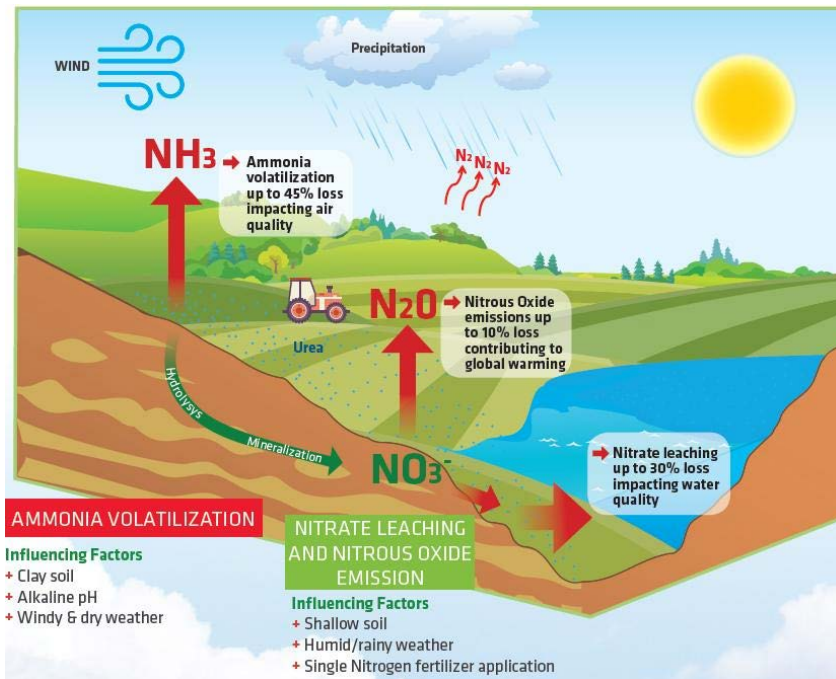
\_\_\_\_\_ : excess \_\_\_\_\_ use  
can lead to \_\_\_\_\_ gas entering atm.

$\text{NH}_3$  gas in atm = \_\_\_\_\_ (rain) and  
\_\_\_\_\_ in humans & animals

It also means \_\_\_\_\_ for crops to use for  
growth (lost \_\_\_\_\_)

\_\_\_\_\_ : synthetic fertilizer use leads  
to nitrates ( $\text{NO}_3$ ) \_\_\_\_\_, or being carried out of soil by  
water

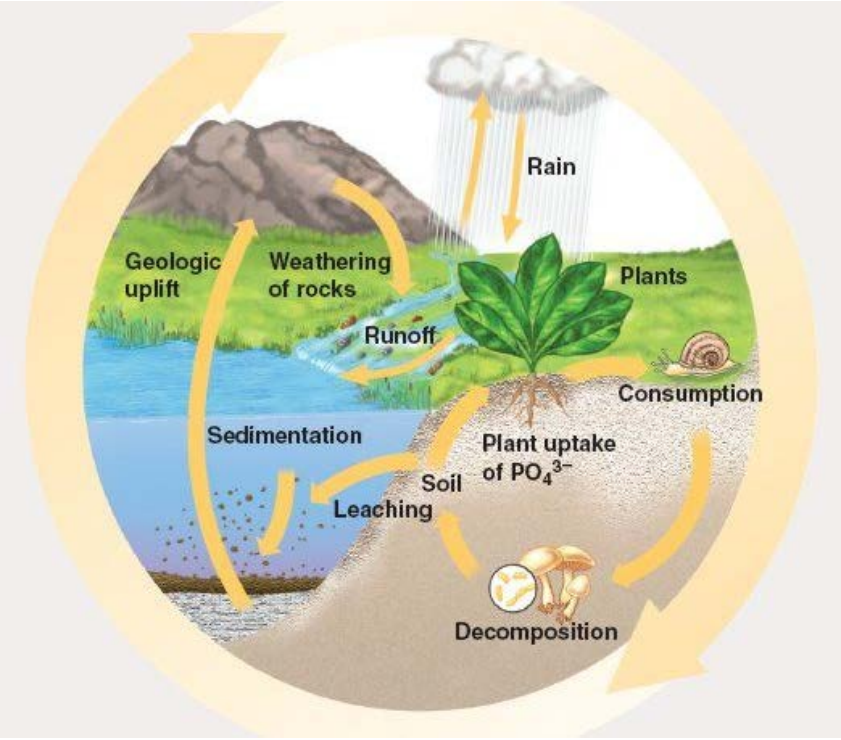
Nitrates \_\_\_\_\_ into local waters, causing  
\_\_\_\_\_ that block sun & kill other aq.  
plants

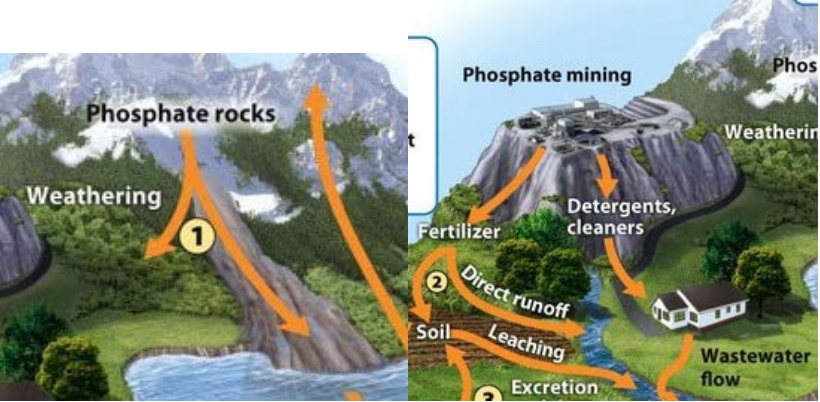


### Practice FRQ 1.5

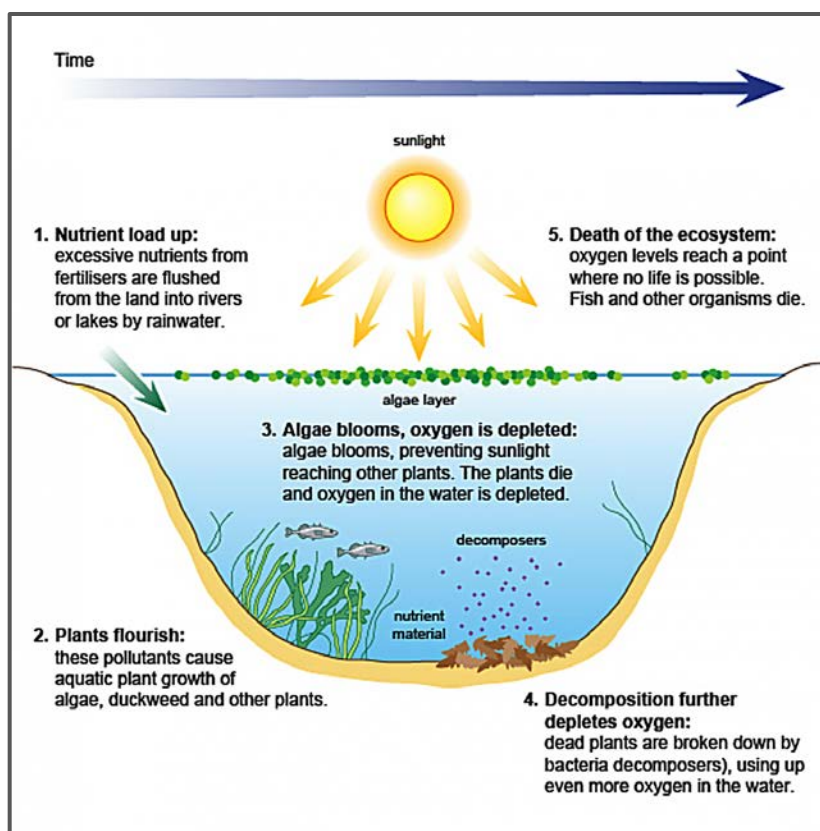
**Describe** ONE chemical transformation that occurs in the natural nitrogen cycle and **explain** the importance of that transformation to an ecosystem.

1.6 The Phosphorus Cycle

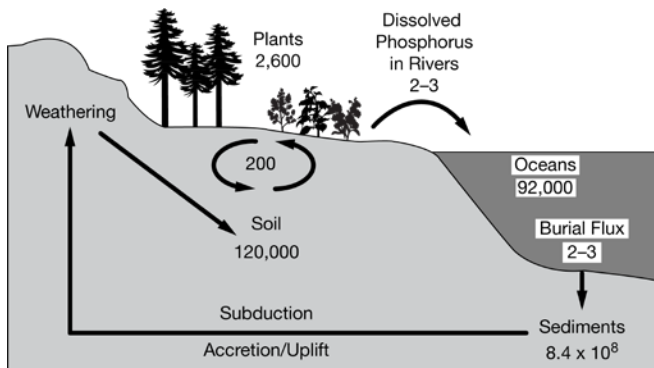
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|---------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Phosphorus Cycle Basics</b></p> | <ul style="list-style-type: none"><li>● Movement of P atoms &amp; molecules b/w _____ &amp; _____</li></ul> <p> _____ containing P minerals = major reservoirs</p> <p><b>P cycle is _____ compared to C/H<sub>2</sub>O/N cycles</b></p> <p> Takes a long time for P minerals to be _____ out of rocks &amp; _____ into soil/bodies of water</p> <p> _____ of P (doesn't enter atmosphere)</p> <p> B/c it cycles so slowly, it is a _____, meaning _____ in ecosystems is often limited by P availability in soil/water</p> <p>P is needed by all organisms for DNA, ATP (energy), bone &amp; tooth enamel in some animals</p>  |
| <p><b>Phosphorus Sources</b></p>      | <p>Major <b>natural</b> source of P is _____ that contain P minerals.</p> <p>Wind &amp; rain break down rock &amp; _____ is _____ and _____ into water; rain water</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |

|                                                    |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|----------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                    | <p>carries phosphate into nearby _____ &amp; bodies of water</p> <p>🌱 Weathering is so slow that P is often a limiting nutrient in _____ ecosystems</p> <p>_____ (human) sources of P = _____<br/>phosphate minerals &amp; adding to products like synthetic _____ &amp; _____</p> <p>Synthetic _____ containing phosphates are added to _____; _____ carries P into nearby _____</p> <p>Phosphates from _____ &amp; _____ enter bodies of water via _____ from homes</p>  |
| <p><b>Assimilation &amp; Excretion/Decomp.</b></p> | <p>Just like N, P is _____ by plant roots &amp; _____ into tissues; animals assimilate P by _____ plants or other animals</p> <p>Animal waste, plant matter &amp; other biomass is broken down by _____ that return phosphate to soil</p> <p>🌱 _____ &amp; _____ form a mini-loop within P cycle just like assimilation &amp; ammonification in N Cycle, photosynth &amp; resp. in C cycle</p>                                                                            |
| <p><b>Sedimentation &amp; Geo. Uplift</b></p>      | <p>Phosphate _____ very well into water; much of it forms solid bits of phosphate that fall to the</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                        |

|                                                               |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|---------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                               | <p>bottom as _____ (<b>sedimentation</b>)</p> <p>P sediments can be _____ into<br/>         _____ over long time periods by<br/>         pressure of overlying water</p> <p>_____ = tectonic plate collision<br/>         forcing up rock layers that form mountains; P cycle can start<br/>         over again with weathering &amp; release of phosphate from rock</p>                                                                                                                                                                                                                                       |
| <p><b>Eutrophication</b><br/> <b>(too much N &amp; P)</b></p> | <p>**Can occur from _____, human/animal<br/>         _____ contamination</p> <p>B/c they're limiting nutrients in aq. ecosystems, extra input of N<br/>         &amp; P lead to _____ (excess nutrients) which<br/>         fuels algae growth</p> <p>Algae bloom _____ of water,<br/>         _____ &amp; _____ below<br/>         surface</p> <p>Algae eventually die-off; _____ that break down<br/>         dead algae use up _____ in the water (b/c decomp. =<br/>         aerobic process)</p> <p>Lower O<sub>2</sub> levels ( _____ ) in water _____<br/>         aquatic animals, especially fish</p> |

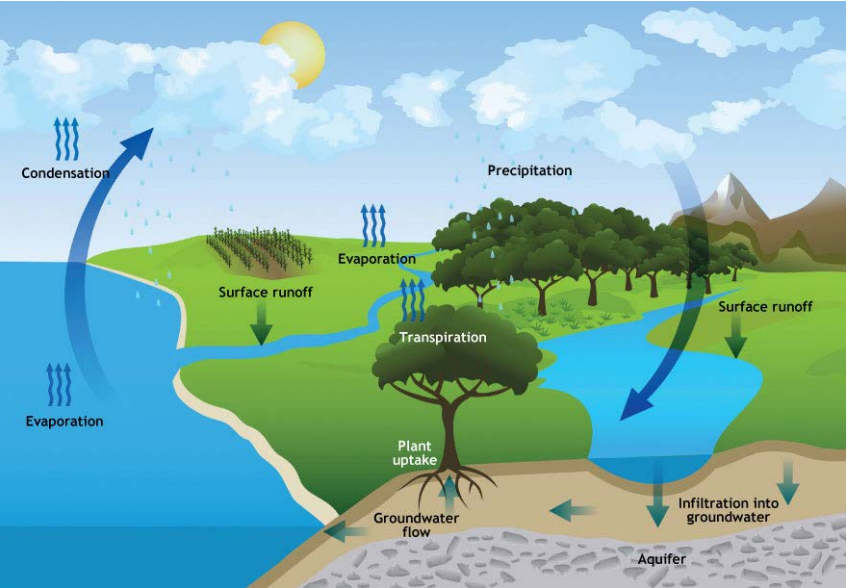


### Practice FRQ 1.6

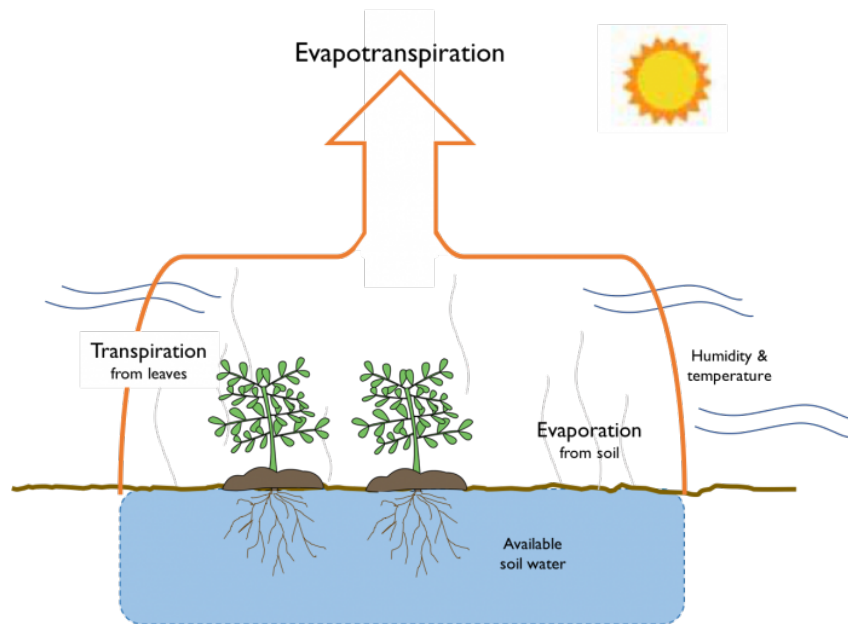


Choose 2 reservoirs depicted in the diagram above and **describe** how phosphorus moves from one to the other

## 1.7 The Hydrologic (Water) Cycle

|                                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |
|---------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Water Cycle Overview</b>                 | <p>Movement of _____ (in different states) b/w _____ &amp; _____</p> <p>_____ (solid/liquid/gas) as well as _____ water is moving are key in H<sub>2</sub>O cycle</p> <p>Ex: precipitation = atm. (gas) → land or surface water (liquid)</p> <p>_____ Energy from _____ drives the H<sub>2</sub>O cycle</p> <p>Ex: heat from sun causes liquid water in ocean to become a gas (evaporation) in atm.</p> <p>_____ = largest water reservoir</p> <p>_____ &amp; _____ are smaller reservoirs, but contain fresh, useable water for humans</p>  |
| <b>Evaporation &amp; Evapotranspiration</b> | <p>2 main _____ of water (processes that cycle it from liquid on earth back into the atmosphere)</p> <p>Sometimes called “_____” since liquid water becomes water vapor (gas) in atm.</p> <p>_____ : process _____ use to draw groundwater from _____ up to their _____</p> <p>Leaf openings called _____ open, allowing water to evap. into atm. from leaf</p> <p>Mvmnt of H<sub>2</sub>O out of leaf creates low _____ in leaf, pulling H<sub>2</sub>O up from roots</p> <p>_____ : amount of H<sub>2</sub>O that enters atm. from transpiration &amp; evap. combined</p>                                                     |

Both processes are driven by \_\_\_\_\_ from the \_\_\_\_\_



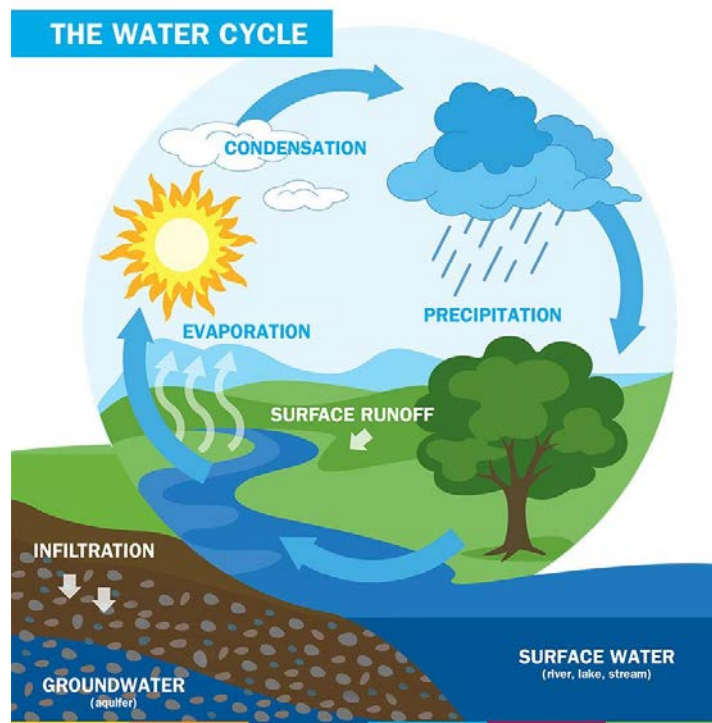
## Runoff & Infiltration

Precipitation (rain) either \_\_\_\_\_ earth's surface into a body of water (runoff) or \_\_\_\_\_ soil down into groundwater aquifers (\_\_\_\_\_)

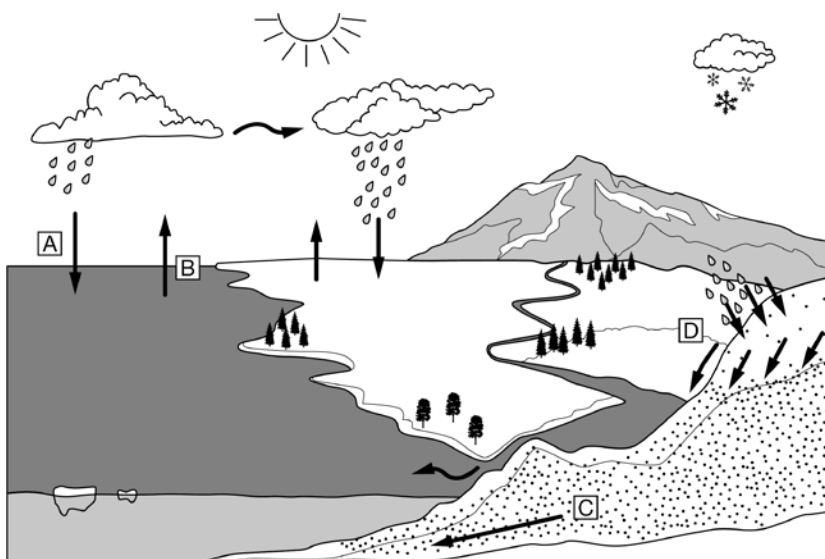
**Groundwater (\_\_\_\_\_) & surface waters (lakes/streams) are important \_\_\_\_\_ reservoirs for humans & animals**

Precipitation \_\_\_\_\_ groundwater through infiltration, but only if ground is \_\_\_\_\_ (able to let water pass through)

Runoff recharges \_\_\_\_\_ waters, but can also carry \_\_\_\_\_ into water sources



Practice FRQ 1.7



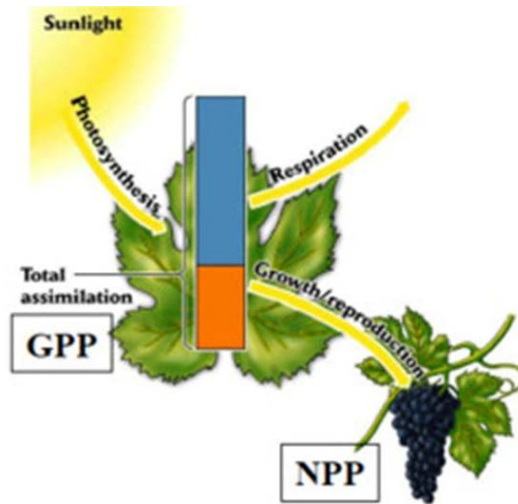
Choose a process from the diagram. **Identify** the process and **describe** how water is moving from one reservoir to another.

## 1.8 Primary Productivity

|                       |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
|-----------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>PP Basics</b>      | <p><b>Primary Productivity:</b> rate that _____ energy is _____ into _____ compounds via _____ over a unit of _____</p> <p>Aka: rate of photosynthesis of all producers in an area over a given period of time</p> <p>Since photosynthesis leads to _____, you can also think of PP as the _____ of plant _____ in an area over a given period of time</p> <p><b>units: kcal/m<sup>2</sup>/yr.</b></p> <p>_____ PP = _____ plant growth = _____ of food &amp; shelter for animals</p> <p> <b>Ecosystems with _____ PP are usually more _____ (more div. of species) than ecosystems with low PP</b></p> |
| <b>Calculating PP</b> | <p> <b>Respiration loss (RL):</b> plants _____ up some of the _____ they generate via photosynthesis by _____ (movement, internal transportation, etc.)</p> <p><i>Think of RL as taxes plants need to play</i></p> <p><b>Gross Primary Productivity (GPP):</b> The _____ amount of _____ energy (light) that plants capture and _____ to energy (_____) through photosynthesis</p> <p><i>Think of GPP as the <b>total</b> paycheck amount the plant earns</i></p> <p><b>NPP = GPP - RL</b></p>                                                                                                        |

 **Net Primary Productivity (NPP):** The amount of energy ( \_\_\_\_\_ ) leftover for \_\_\_\_\_ after plants have used some for respiration

*Think of NPP as the actual amount of the plant's paycheck it keeps after taxes*



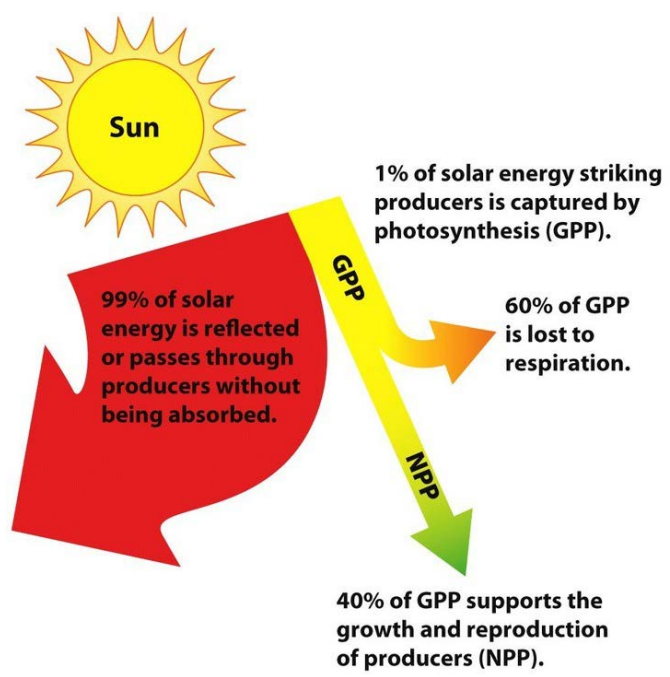
### Ecological Efficiency

The portion of \_\_\_\_\_ solar energy that is captured by plants & converted into biomass (NPP or \_\_\_\_\_ for consumers)

Generally, only \_\_\_\_\_ of all incoming sunlight is captured & \_\_\_\_\_ into GPP via photosynthesis

Of that 1%, only about \_\_\_\_\_ (or \_\_\_\_\_ of total incoming solar energy) is converted into \_\_\_\_\_/\_\_\_\_\_ (NPP)

Some ecosystems are \_\_\_\_\_ (higher NPP) than others

|                                      |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|--------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                      |  <p><b>Sun</b></p> <p>99% of solar energy is reflected or passes through producers without being absorbed.</p> <p>1% of solar energy striking producers is captured by photosynthesis (GPP).</p> <p>GPP</p> <p>60% of GPP is lost to respiration.</p> <p>NPP</p> <p>40% of GPP supports the growth and reproduction of producers (NPP).</p>                                                                                                                                                                                                                                                                                  |
| <p><b>Trends in Productivity</b></p> | <p> The more _____ a biome is, the _____ the _____ of animal life it can _____ (high. biodiv.)</p> <p>***Try to predict the most &amp; least productive terrestrial and aquatic biomes ***</p> <p> <b>Water</b> _____, _____ temperature, and _____ availability are all factors that lead to _____ NPP</p> <p>Shortage of any of these three factors will lead to decreased NPP</p> <p><b>Ex:</b> Desert (low H<sub>2</sub>O &amp; nutrients)</p> <p>Tundra (low temp &amp; liquid H<sub>2</sub>O)</p> <p>Open ocean (low nutrients)</p> |

|                           | <p><b>Continental ecosystems</b></p> <table border="1"><thead><tr><th>Ecosystem</th><th>Net primary productivity (g C/m²/year)</th></tr></thead><tbody><tr><td>Swamps and marshes</td><td>2500</td></tr><tr><td>Tropical rainforest</td><td>2000</td></tr><tr><td>Tropical seasonal forest</td><td>1500</td></tr><tr><td>Temperate rainforest</td><td>1300</td></tr><tr><td>Temperate seasonal forest</td><td>1200</td></tr><tr><td>Boreal forest</td><td>800</td></tr><tr><td>Savanna</td><td>700</td></tr><tr><td>Cultivated land</td><td>600</td></tr><tr><td>Woodlands/Shrublands</td><td>550</td></tr><tr><td>Lakes and streams</td><td>500</td></tr><tr><td>Temperate grassland</td><td>500</td></tr><tr><td>Tundra</td><td>150</td></tr><tr><td>Desert scrub</td><td>100</td></tr><tr><td>Extreme desert</td><td>50</td></tr><tr><td><b>Marine ecosystems</b></td><td></td></tr><tr><td>Coral reefs</td><td>2000</td></tr><tr><td>Salt marshes</td><td>1800</td></tr><tr><td>Upwelling zones</td><td>500</td></tr><tr><td>Continental shelf</td><td>400</td></tr><tr><td>Open ocean</td><td>200</td></tr></tbody></table> <p>Net primary productivity (g C/m²/year)</p> | Ecosystem | Net primary productivity (g C/m²/year) | Swamps and marshes | 2500 | Tropical rainforest | 2000 | Tropical seasonal forest | 1500 | Temperate rainforest | 1300 | Temperate seasonal forest | 1200 | Boreal forest | 800 | Savanna | 700 | Cultivated land | 600 | Woodlands/Shrublands | 550 | Lakes and streams | 500 | Temperate grassland | 500 | Tundra | 150 | Desert scrub | 100 | Extreme desert | 50 | <b>Marine ecosystems</b> |  | Coral reefs | 2000 | Salt marshes | 1800 | Upwelling zones | 500 | Continental shelf | 400 | Open ocean | 200 |
|---------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------|----------------------------------------|--------------------|------|---------------------|------|--------------------------|------|----------------------|------|---------------------------|------|---------------|-----|---------|-----|-----------------|-----|----------------------|-----|-------------------|-----|---------------------|-----|--------|-----|--------------|-----|----------------|----|--------------------------|--|-------------|------|--------------|------|-----------------|-----|-------------------|-----|------------|-----|
| Ecosystem                 | Net primary productivity (g C/m²/year)                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Swamps and marshes        | 2500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Tropical rainforest       | 2000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Tropical seasonal forest  | 1500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Temperate rainforest      | 1300                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Temperate seasonal forest | 1200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Boreal forest             | 800                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Savanna                   | 700                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Cultivated land           | 600                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Woodlands/Shrublands      | 550                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Lakes and streams         | 500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Temperate grassland       | 500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Tundra                    | 150                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Desert scrub              | 100                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Extreme desert            | 50                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| <b>Marine ecosystems</b>  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Coral reefs               | 2000                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Salt marshes              | 1800                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Upwelling zones           | 500                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Continental shelf         | 400                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Open ocean                | 200                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |
| Practice FRQ 1.8          | <p><b>Describe</b> the process of net primary productivity (NPP).</p> <p><b>Describe</b> the relationship between primary productivity and biodiversity.</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                   |           |                                        |                    |      |                     |      |                          |      |                      |      |                           |      |               |     |         |     |                 |     |                      |     |                   |     |                     |     |        |     |              |     |                |    |                          |  |             |      |              |      |                 |     |                   |     |            |     |

## 1.9 & 1.10 Trophic Levels & The 10% Rule

### Conservation of Matter & Energy

🌱 Matter & energy are never \_\_\_\_\_ or \_\_\_\_\_; they only \_\_\_\_\_

Ex: Tree dies & the C/N/H<sub>2</sub>O/P are returned to the soil & atmosphere

Ex: Sun rays (\_\_\_\_\_ energy) hit leaves & are \_\_\_\_\_ into glucose (\_\_\_\_\_ energy)

🌱 \_\_\_\_\_ of \_\_\_\_\_: energy is never created or destroyed

\_\_\_\_\_ demonstrate conservation of matter (C/N/H<sub>2</sub>O/P)

🌱 \_\_\_\_\_ demonstrate conservation of energy

Ex: When a rabbit eats a leaf, the energy from the leaf (glucose) is transferred to the rabbit & stored as body tissue like fat/muscle

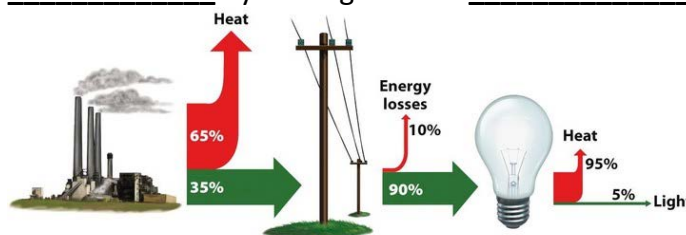
### 2nd Law of Thermodynamics

🌱 Each time energy is transferred, some of it is \_\_\_\_\_ as \_\_\_\_\_

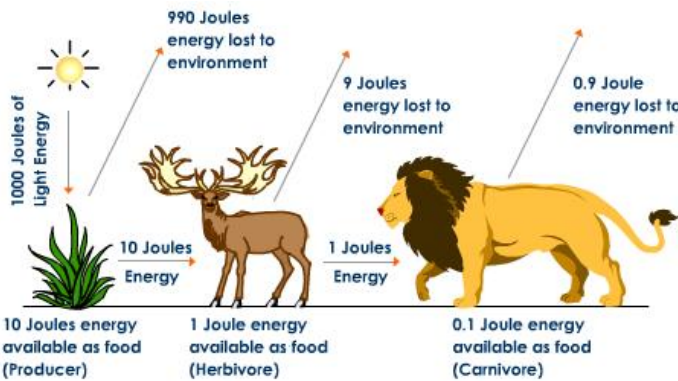
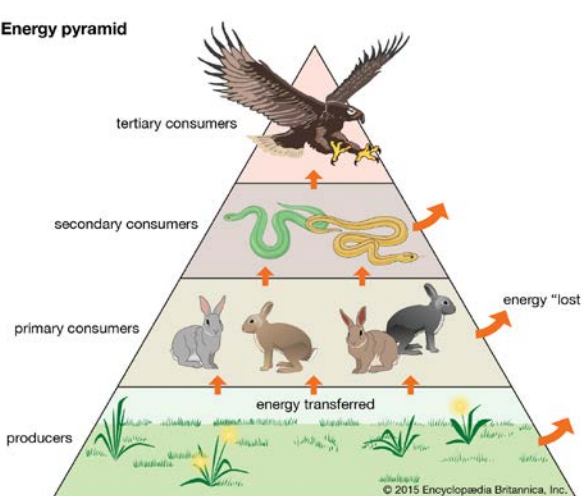
Applied to food webs: the amount of **useable** energy decreases \_\_\_\_\_ as you move \_\_\_\_\_ the food chain (organisms use up most of it for movement, development, etc.)

🌱 Because **\*available\*** energy decreases with each step up the food chain, a \_\_\_\_\_ (troph = nourishment or growth) is used to \_\_\_\_\_ how energy moves \_\_\_\_\_ an ecosystem

🌱 **10% Rule:** in trophic pyramids, only about \_\_\_\_\_ of the energy from \_\_\_\_\_ makes it to the \_\_\_\_\_; the other \_\_\_\_\_ is \_\_\_\_\_ by the organism & \_\_\_\_\_ as heat

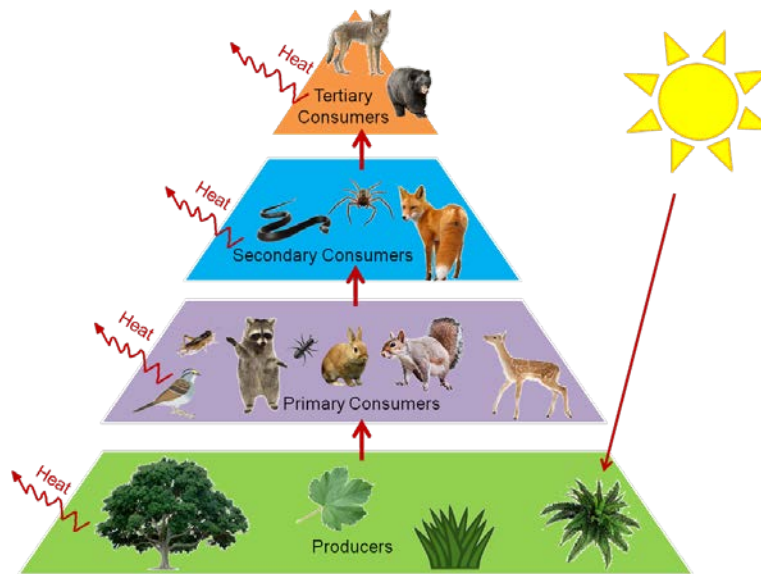


Calculation:  $(35\%) \times (90\%) \times (5\%) = 1.6\%$  efficiency

|                                                |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                                                |  <p>1000 Joules of Light Energy</p> <p>990 Joules energy lost to environment</p> <p>10 Joules Energy</p> <p>9 Joules energy lost to environment</p> <p>1 Joules Energy</p> <p>0.9 Joule energy lost to environment</p> <p>10 Joules energy available as food (Producer)</p> <p>1 Joule energy available as food (Herbivore)</p> <p>0.1 Joule energy available as food (Carnivore)</p> <p>Progressive Loss of Energy in Food Chain</p><br> <p>Energy pyramid</p> <p>tertiary consumers</p> <p>secondary consumers</p> <p>primary consumers</p> <p>producers</p> <p>energy transferred</p> <p>energy "lost"</p> <p>© 2015 Encyclopædia Britannica, Inc.</p> |
| <p><b>Trophic Levels &amp; 10% Biomass</b></p> | <p><u>                    </u> <b>Consumers</b>: animals that eat secondary consumers or carnivores &amp; omnivores (aka - top/apex predators)</p> <p><u>                    </u> <b>Consumers</b>: animals that eat primary consumers or herbivores (aka - carnivores &amp; omnivores)</p> <p><u>                    </u> <b>Consumers</b>: animals that eat plants (herbivores)</p> <p><u>                    </u> (plants) "produce"- really convert sun's light energy into chemical energy (glucose)</p> <p>🌱 10% rule also applies to <u>                    </u> (or mass of all living things at each trophic level) Since energy is needed for growth &amp; only 10% of energy transfers from one level to the next, only 10% of the biomass can be grown/supported</p>                                              |
| <p><b>Calculating Biomass &amp; Energy</b></p> | <p>🌱 To calculate biomass or energy available at the next level up, <u>                    </u> the <u>                    </u> <u>                    </u> to the V <u>                    </u> (or <u>          </u> by 10)</p>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |

**Calculating Biomass & Energy**

**Try calculating biomass**



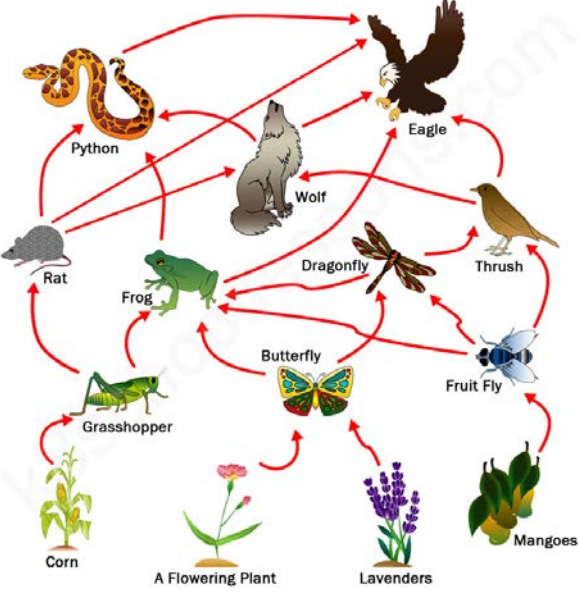
**Practice FRQs 1.9 & 1.10**

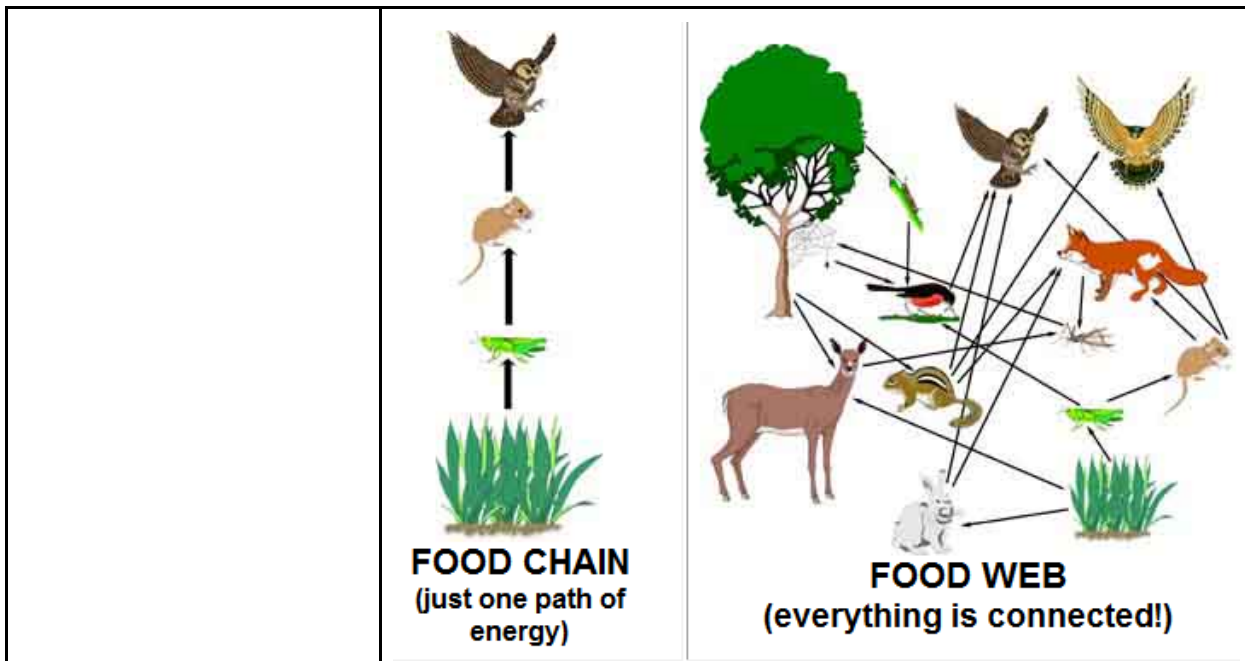
**Explain** why a relatively large forest can only support a small number of wolves.

**Calculate** the amount of energy available to a tertiary consumer in the following ecosystem.

*100,000 J of energy produced by plants in the ecosystem*

1.11 Food Chains & Food Webs

|                                  |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|----------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p><b>Food Web Basics</b></p>    | <p>Shows how _____ &amp; _____ flow _____ an ecosystem, from organism to organism</p> <p>When one organism _____ (eats) _____, the matter (C/N/H<sub>2</sub>O/P) and energy (glucose, muscle tissue, etc.) are _____ on to the _____</p> <p> _____ in food webs indicate _____ of _____ (point to the org. taking in the energy)</p> <p><b>A Food Web</b></p>  |
| <p><b>Food Web vs. Chain</b></p> | <p>Food chains just show _____, _____ of energy &amp; matter</p> <p><b>Food webs have <u>at least 2</u> different, _____ food chains</b></p> <p>Webs show that organisms can exist at different trophic levels</p> <p>grass → hare → owl (sec. cons.)</p> <p>grass → grasshopper → robin → owl (tert. cons.)</p>                                                                                                                                                                                                                   |



**Interactions &  
Trophic Cascade**

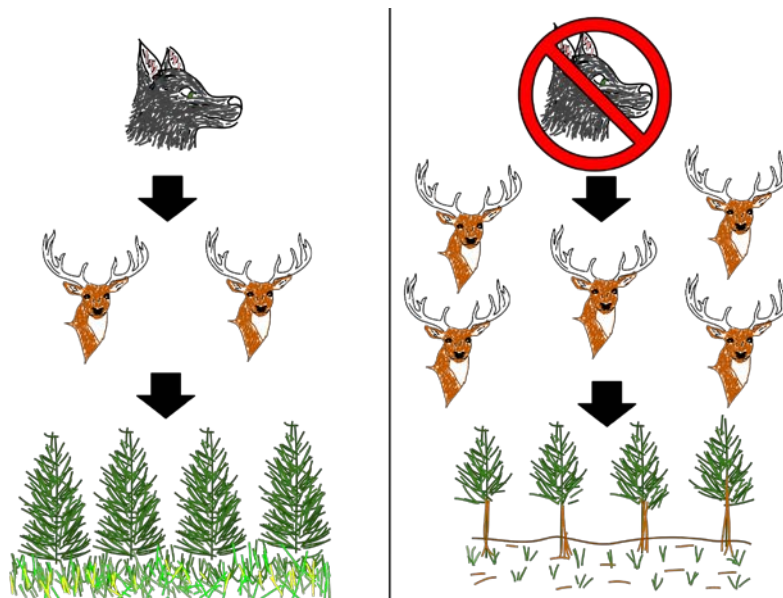
Food webs show how \_\_\_\_\_ or \_\_\_\_\_ in \_\_\_\_\_ of a given species \_\_\_\_\_ the rest of the food web

Ex: Increase in python pop.

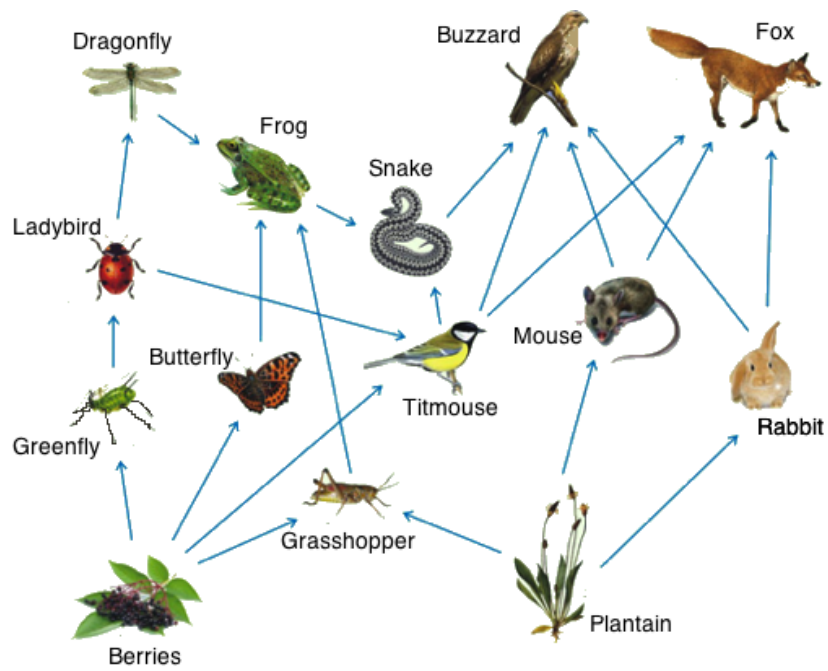
- Decrease in frog & rat pops.
- Increase in grasshopper pop.
- Decrease in corn

\_\_\_\_\_ : removal or addition of a  
\_\_\_\_\_ has a \_\_\_\_\_ effect  
\_\_\_\_\_ through lower troph. Levels

Ex: decline in wolf pop. = increase in deer pop. which leads to overgrazing & decline in trees



**Practice FRQ 1.11**



**Describe** one direct effect that a decline in the frog population would have on the food web.

**Identify** an organism that is both a secondary and tertiary consumer.