Ecology and the Environment

Taking care of what we've been given

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Topic

Ecology and the Environment

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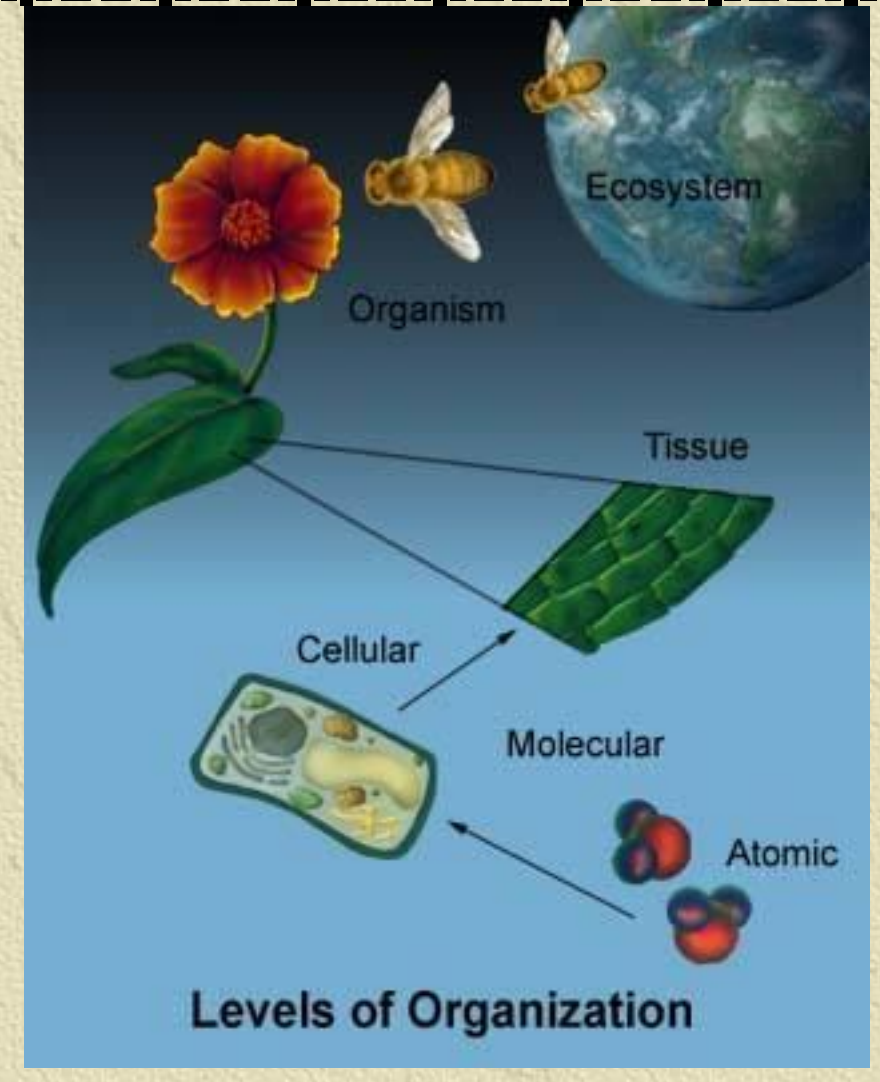
Quiz--16.1-16.3, 17.1-17.2

1. What is commensalism?
2. What is a trophic level?
3. What is nitrogen fixation?
4. Approximately how much biomass moves from one level of a food chain to the next (to the consumer)?

Organization of organisms

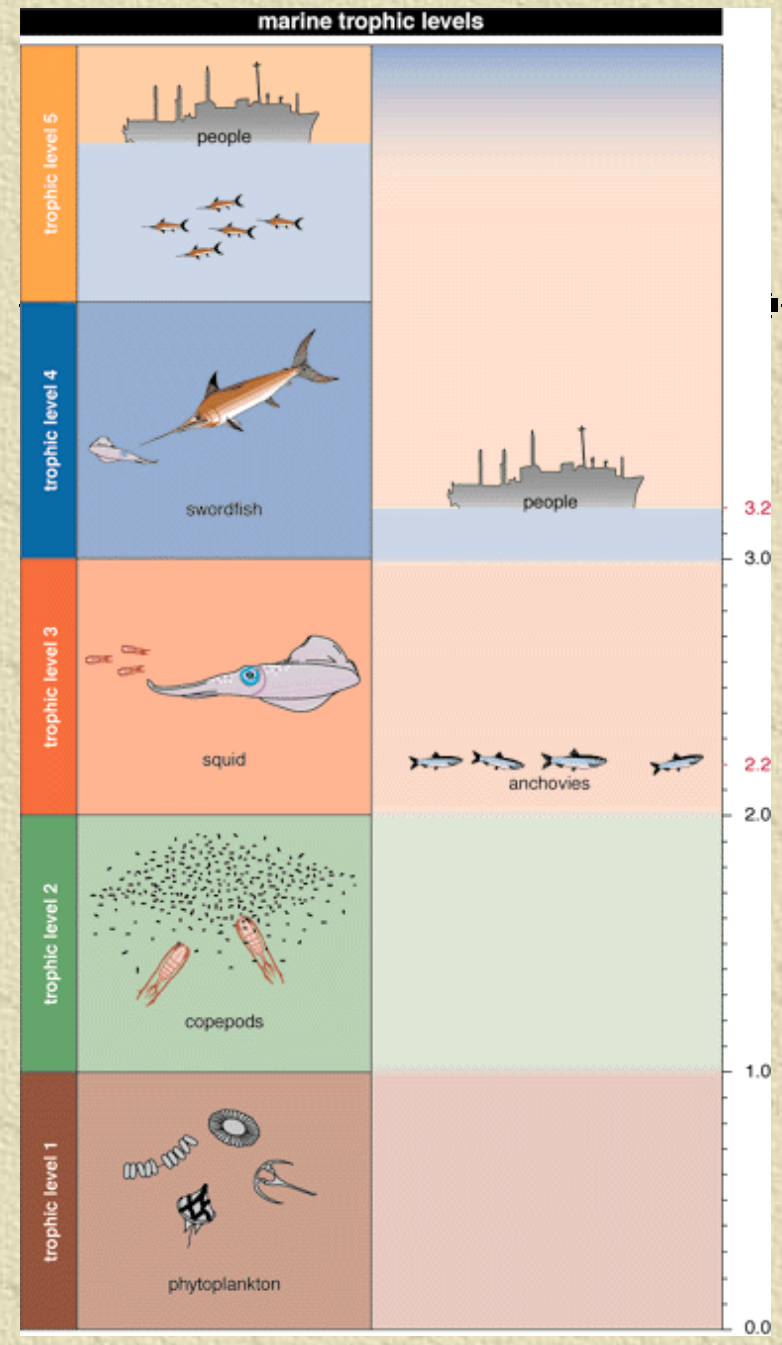


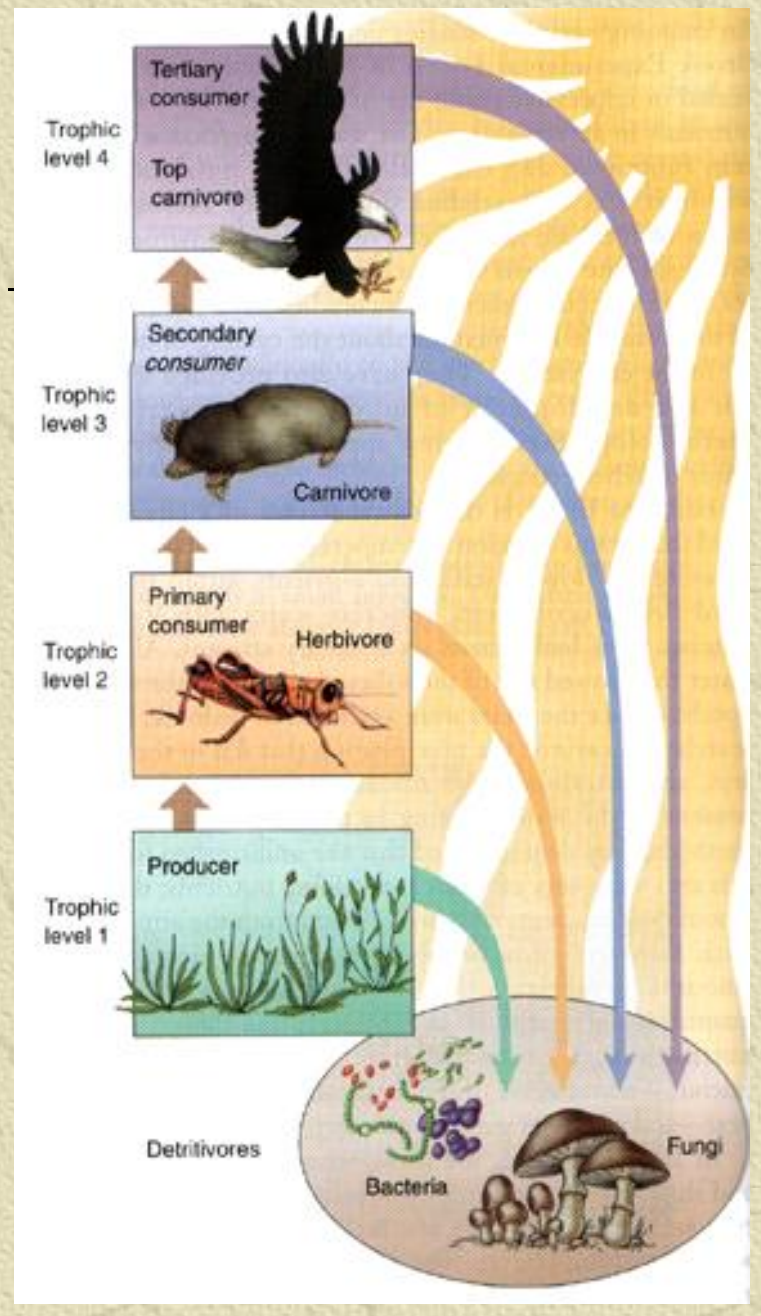
Ecosystem structure

- Producers/autotrophs--normally plants that capture the sun's energy, powering all other life on Earth (also chemosynthetic bact.)
- Consumers/heterotrophs--must eat to get food
  - Primary consumer/herbivore--feed on producers
  - Secondary consumer/carnivore (or omnivore)--feeds on primary consumer
  - Tertiary consumer/carnivore--feeds on secondary consumer
  - Quaternary consumer….you get the idea

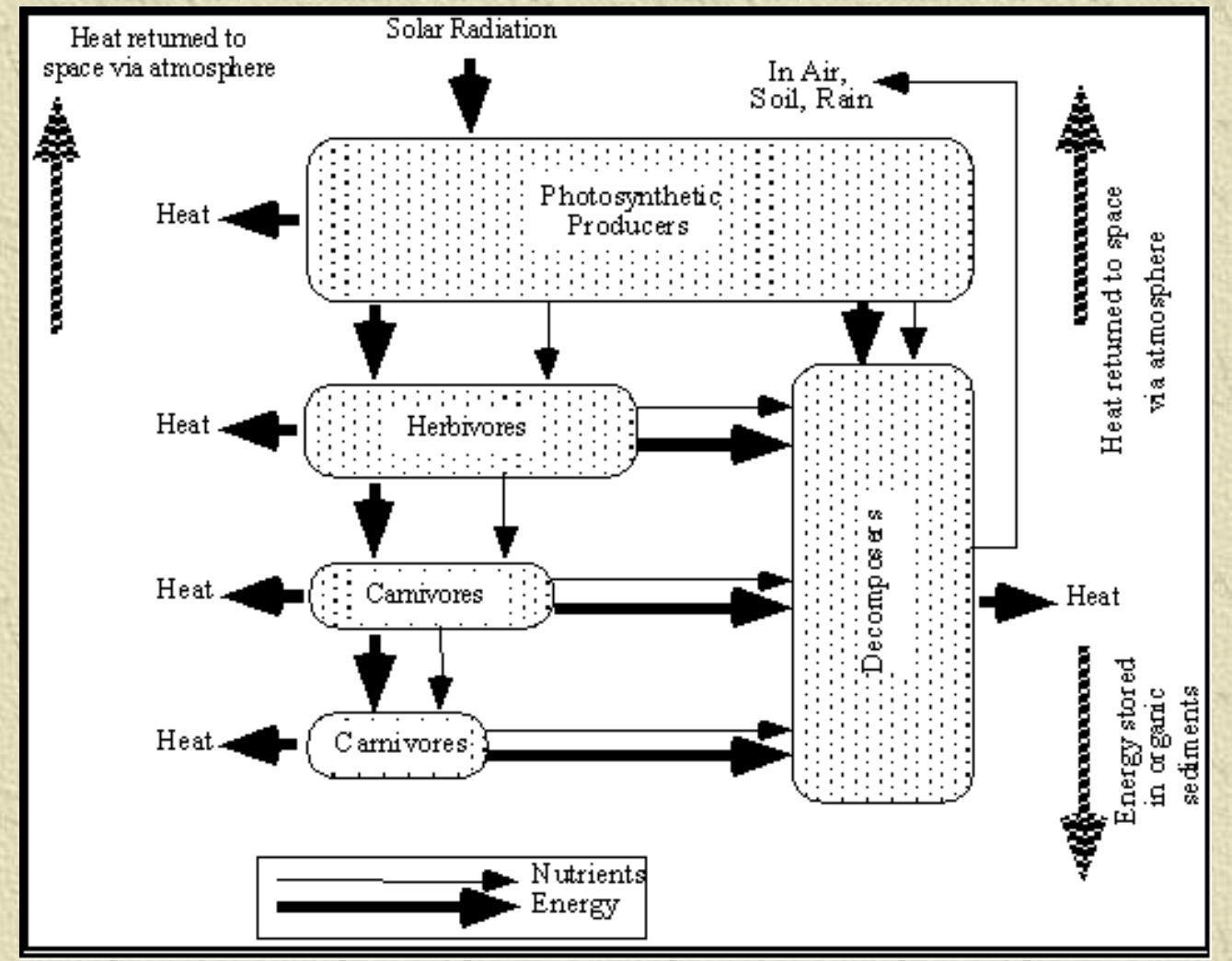
Modeling energy flow

- Scavenger--feeds on dead animals
- Decomposer--bacterium, fungus, etc. feeds on dead organisms from all trophic levels, returning nutrients to the soil
- Food chain--shows the flow of energy through a community
- Food web--combo of many food chains, more accurately showing interactions & competition
- Trophic levels--organisms that feed on similar types of food; a step in the transfer of energy through ecosystem

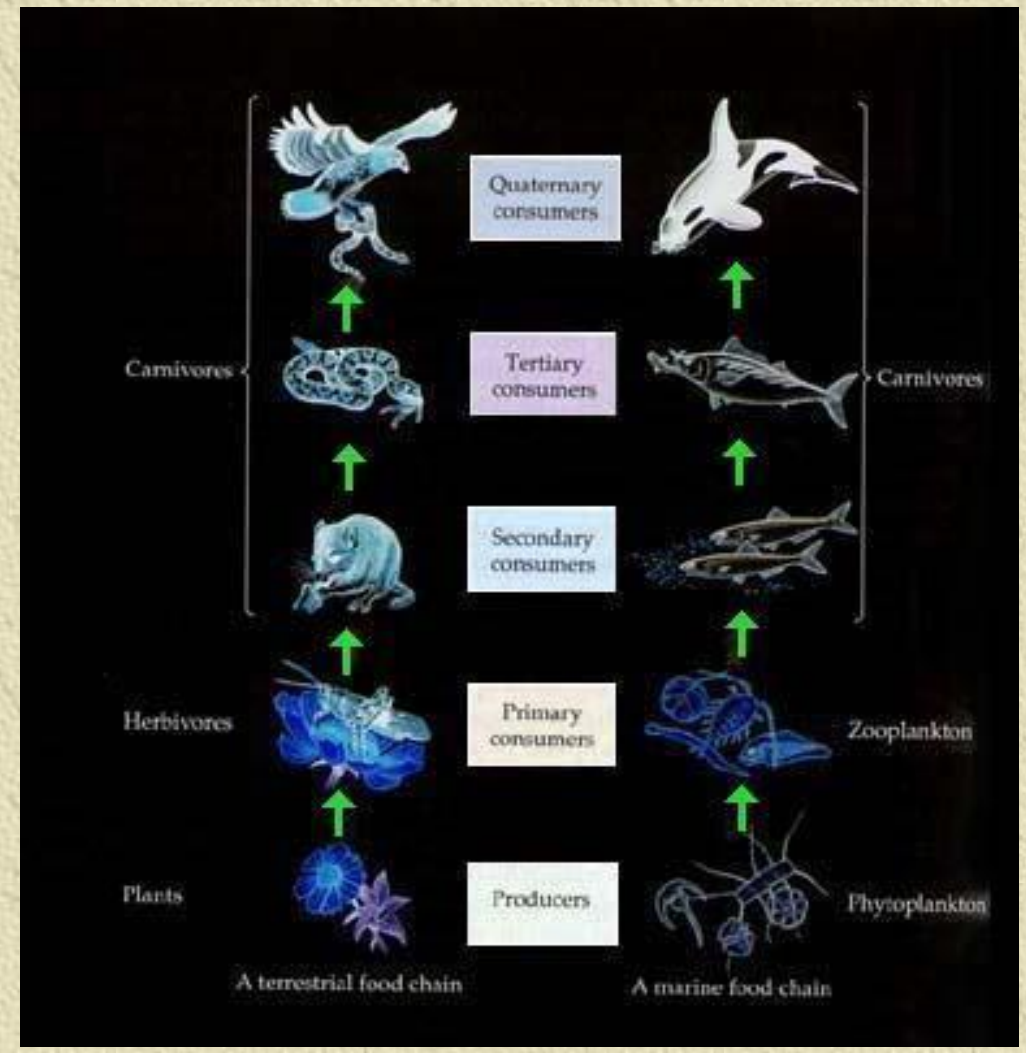

marine trophic levels
trophic level 5
trophic level 4
trophic level 3
trophic level 2
trophic level 1
people
swordfish
squid
copepods
phytoplankton
people
anchovies
3.2
3.0
2.2
2.0
1.0
0.0


Trophic level 4
Tertiary consumer
Top carnivore
Trophic level 3
Secondary consumer
Carnivore
Trophic level 2
Primary consumer
Herbivore
Trophic level 1
Producer
Detritivores
Bacteria
Fungi

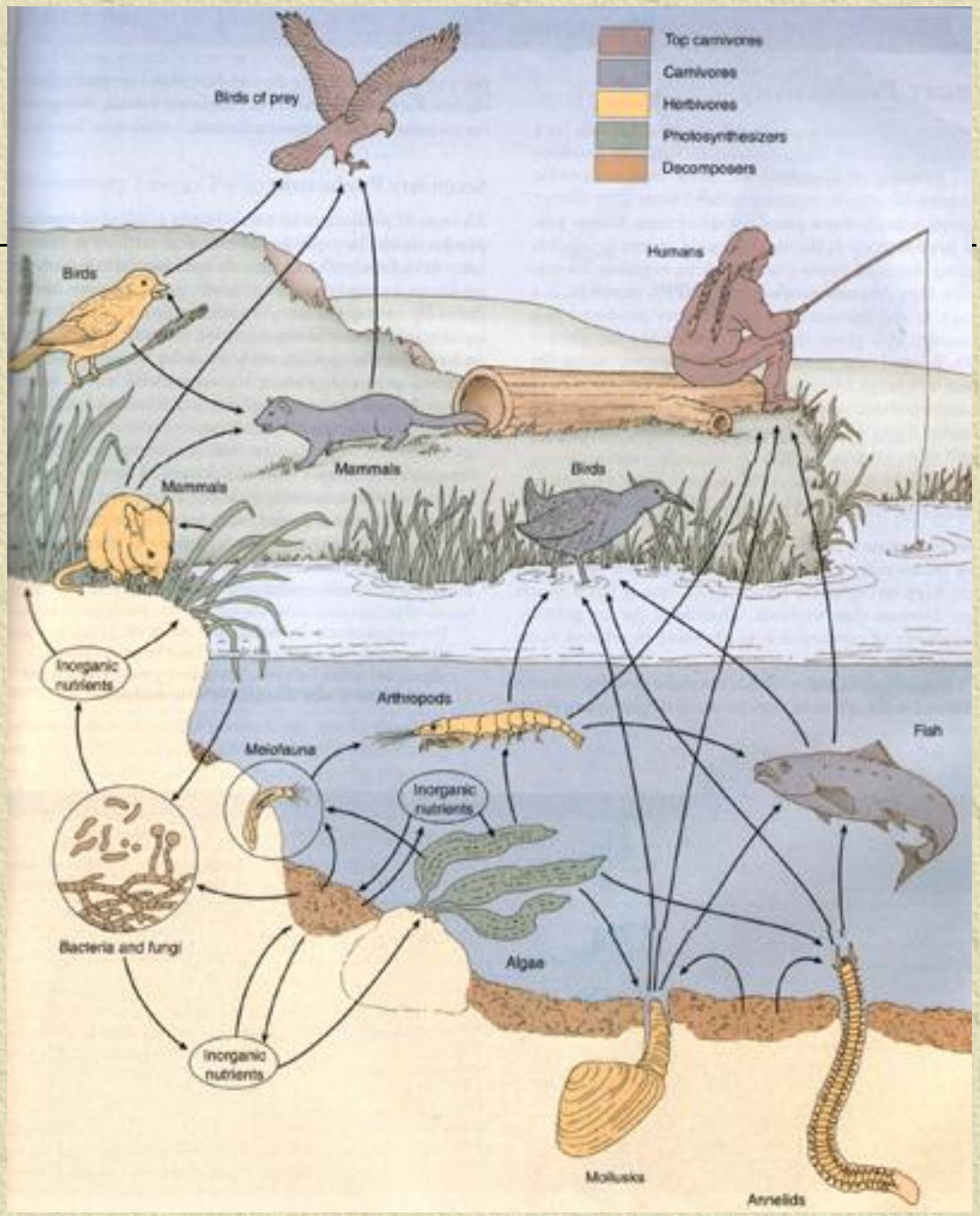
Trophic Levels



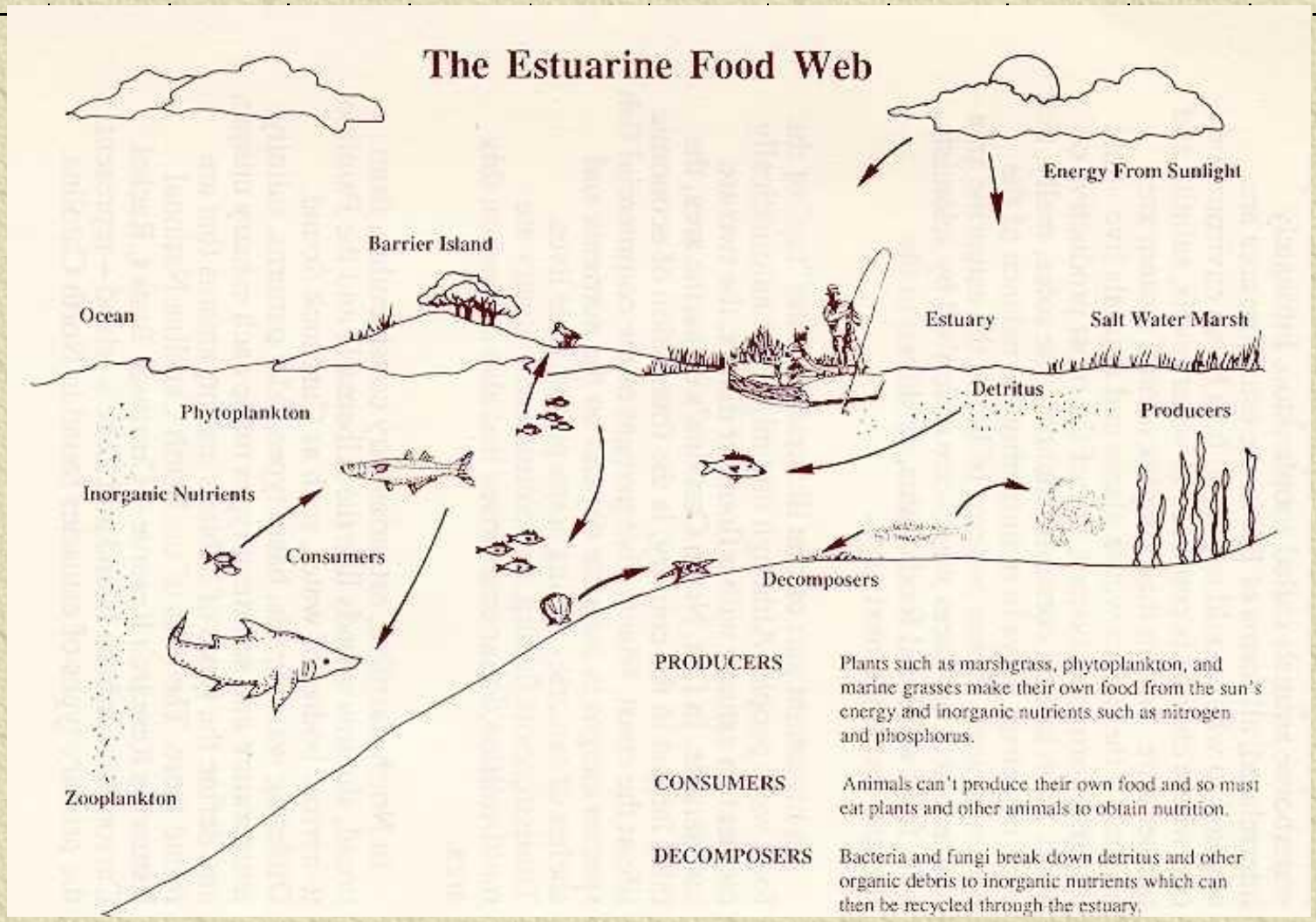
Trophic levels



Food Webs


Top carnivores
Carnivores
Herbivores
Photosynthesizers
Decomposers
Birds of prey
Birds
Humans
Mammals
Mammals
Birds
Inorganic nutrients
Arthropods
Meiofauna
Fish
Inorganic nutrients
Bacteria and fungi
Algae
Inorganic nutrients
Molluscs
Annelids

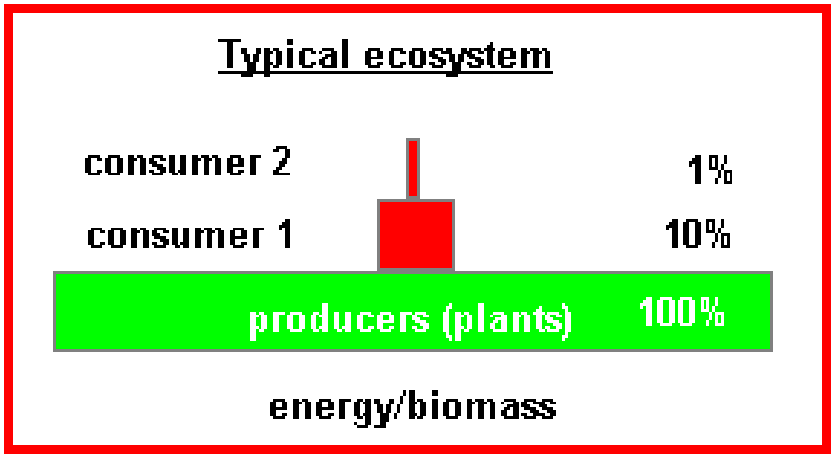
Aquatic foodweb

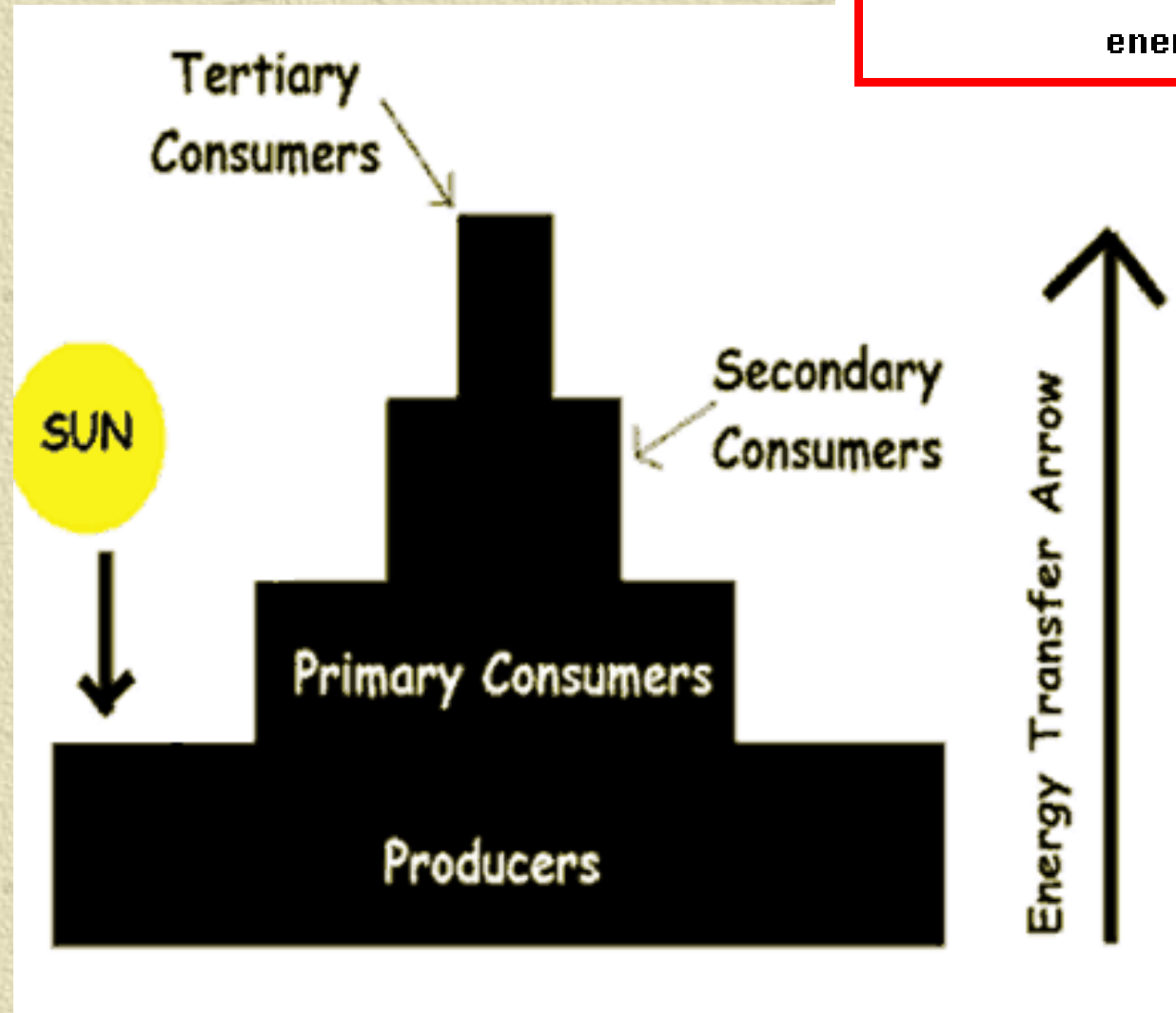


Energy flow through ecosystems

- Biomass--total mass of all organisms in a food chain
- Transfer of biomass to higher trophic levels is not very efficient
  - Some organisms are never consumed
  - Some parts of organisms aren't consumed (teeth, bones, bark, etc.)
- Ecological pyramid--shows the diminishing amount of energy/biomass at higher levels
  - Normally, about 10% of the energy available at one level is passed to the next trophic level
  - Smaller numbers of organisms at higher trophic levels

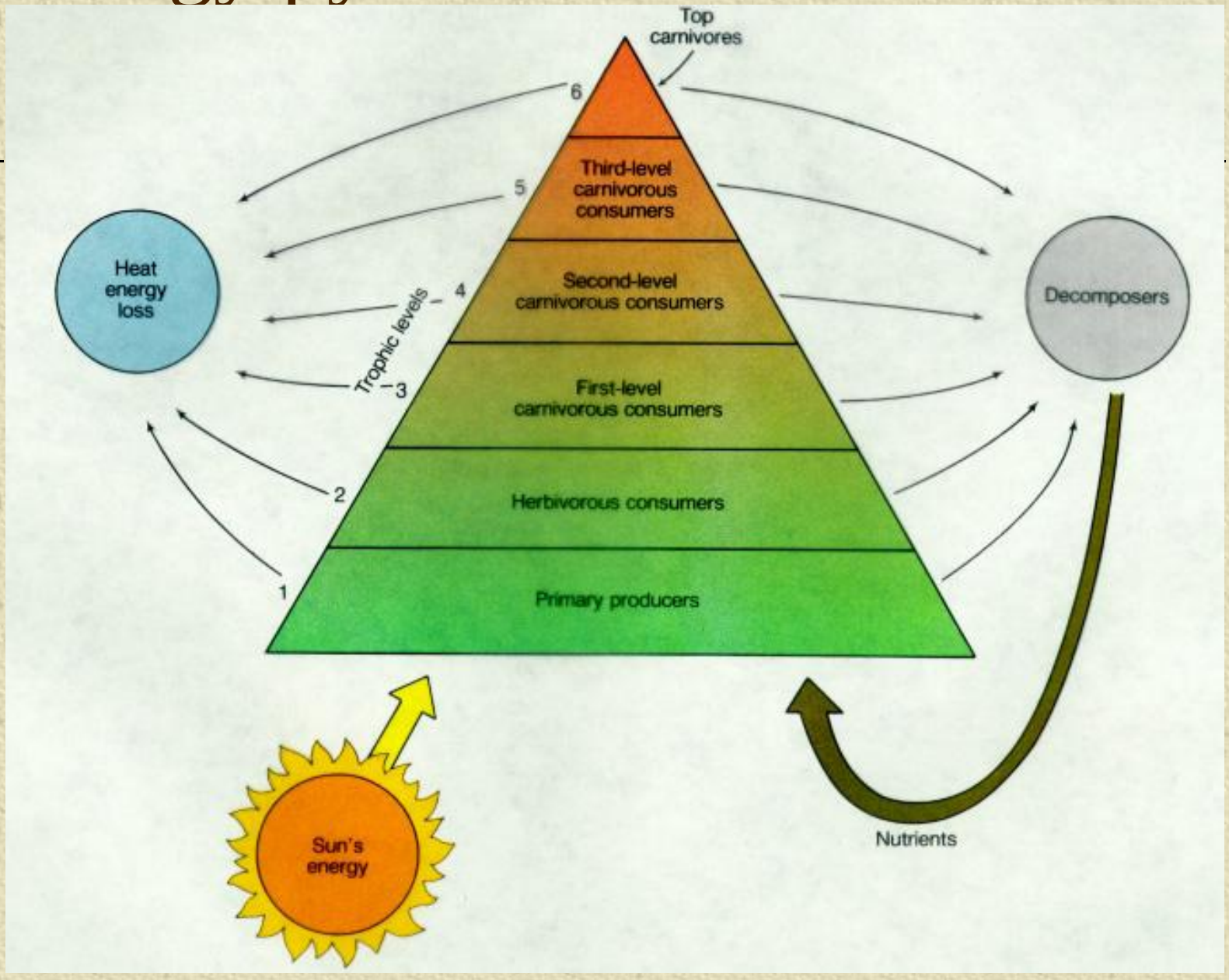
Energy transfer



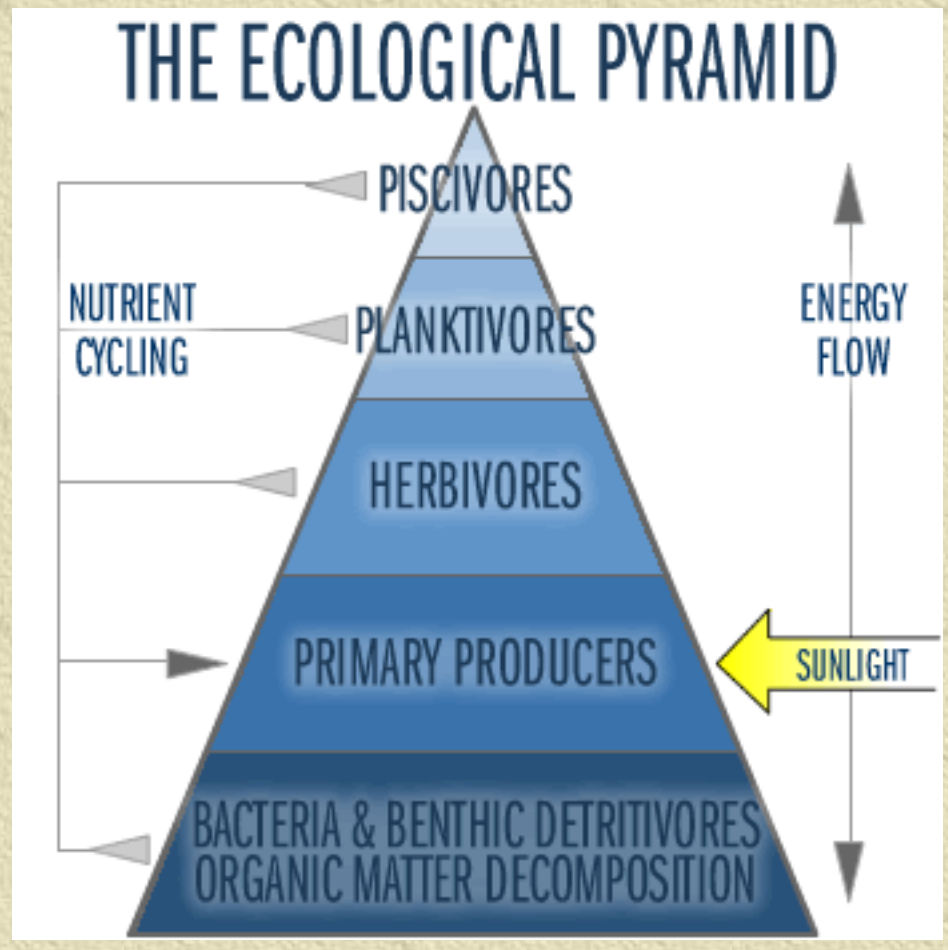


Only about 10% from each trophic level moves to the next level

Energy pyramid



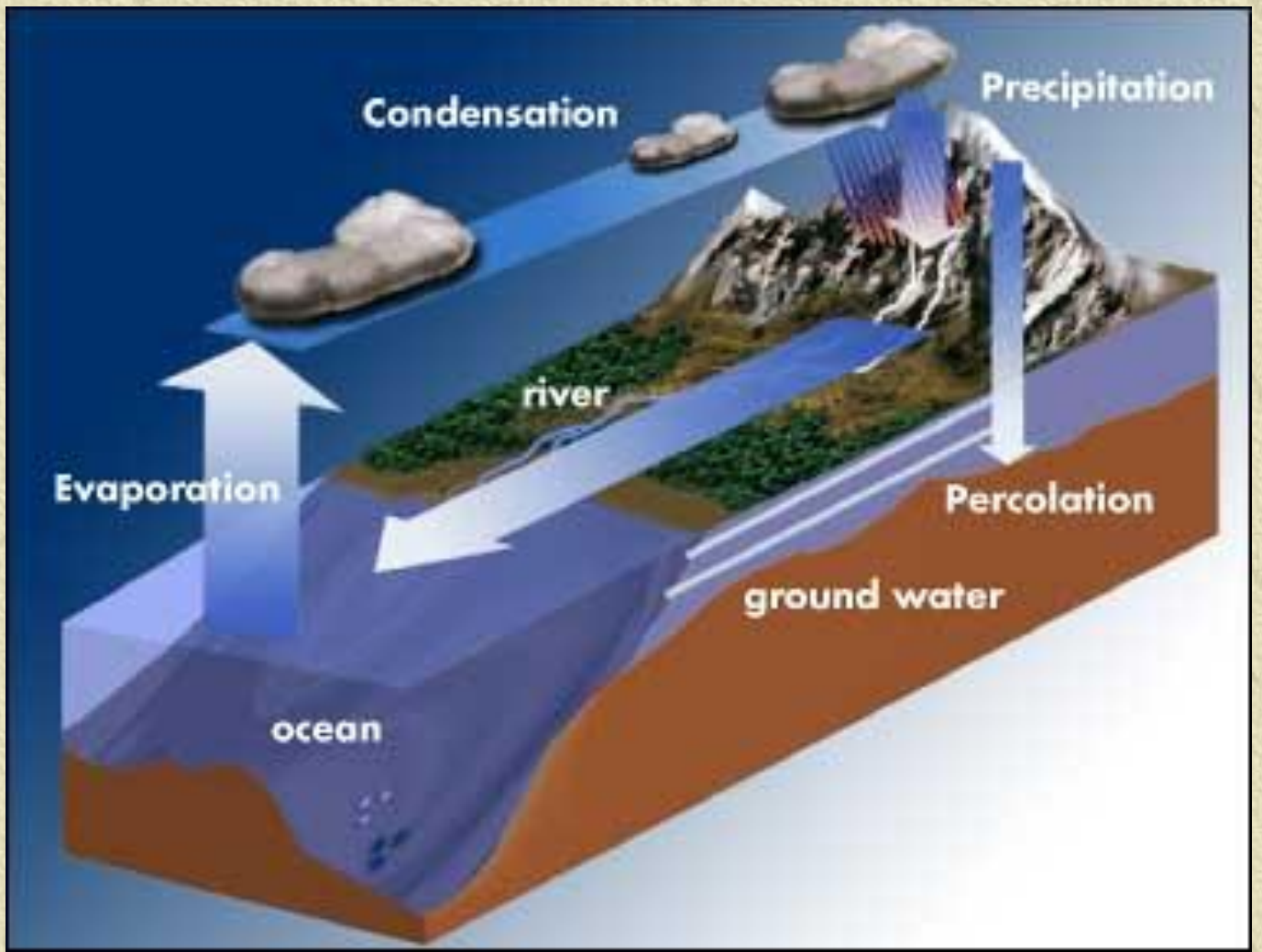
Aquatic food pyramid



Cycles of matter

- Matter cycles, energy doesn’t
- Water, nutrients, and elements cycle through the ecosystem
- Understanding the cycles SHOULD influence how we act

Water cycle


Condensation
Precipitation
river
Evaporation
Percolation
ground water
ocean

Water cycle

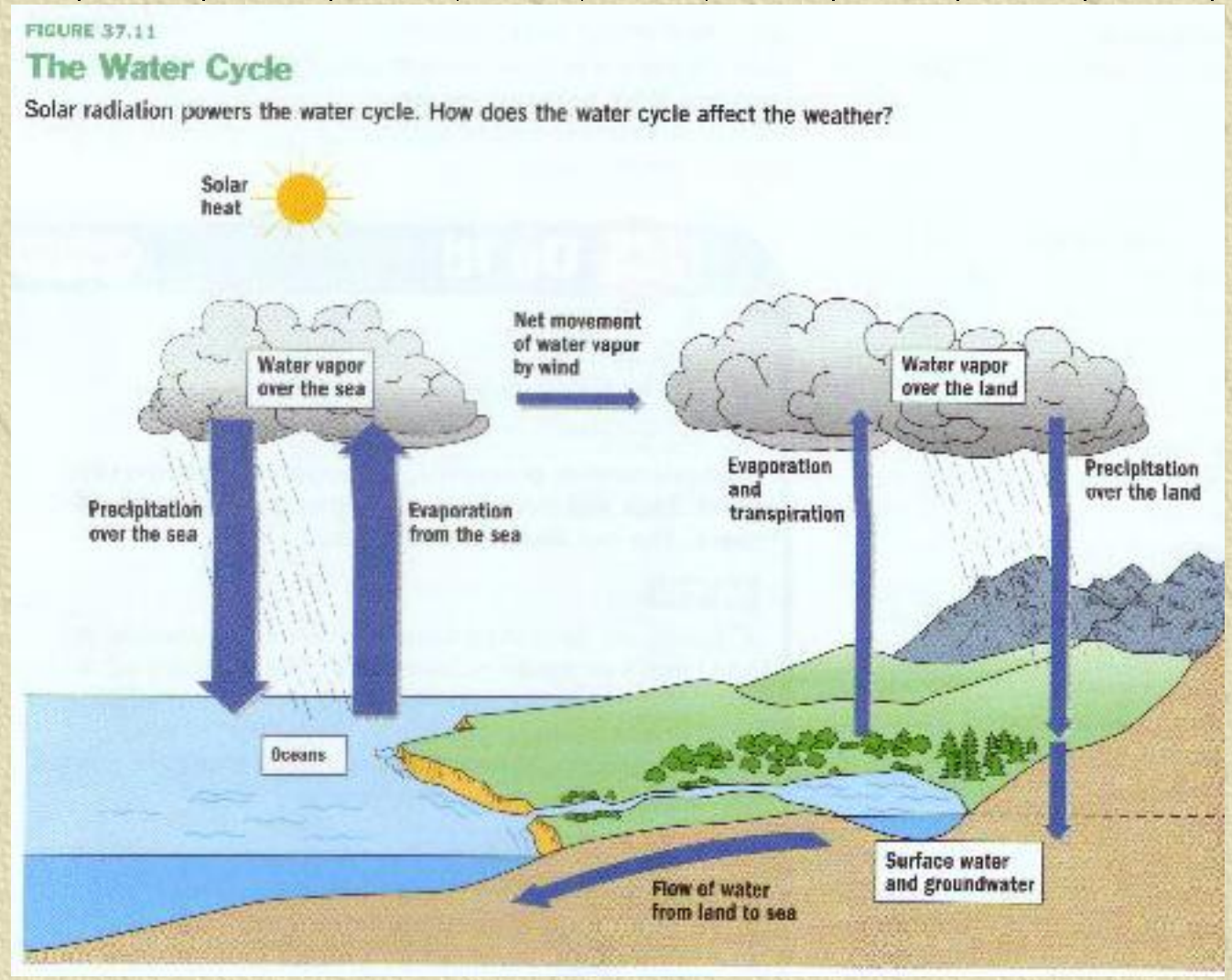
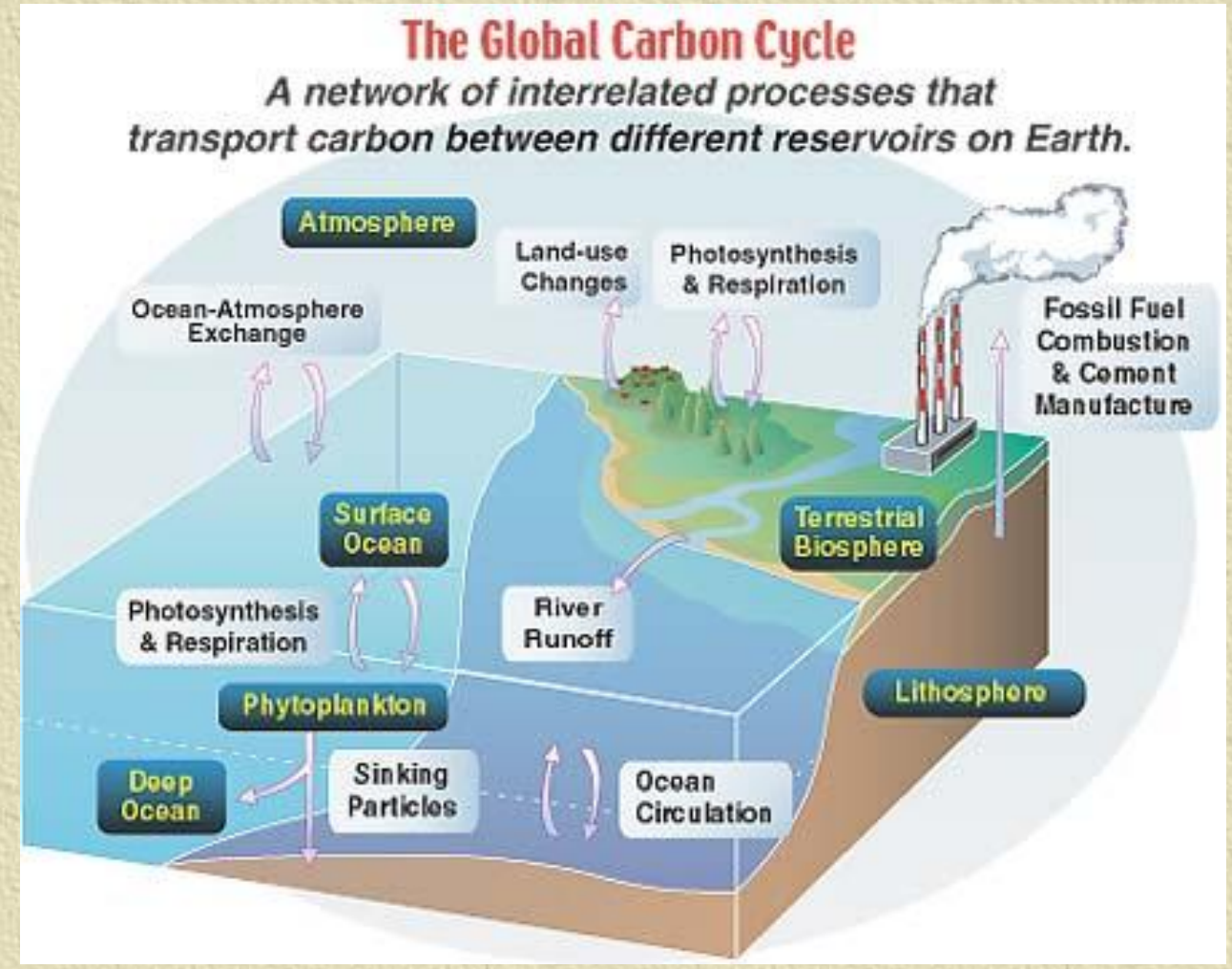
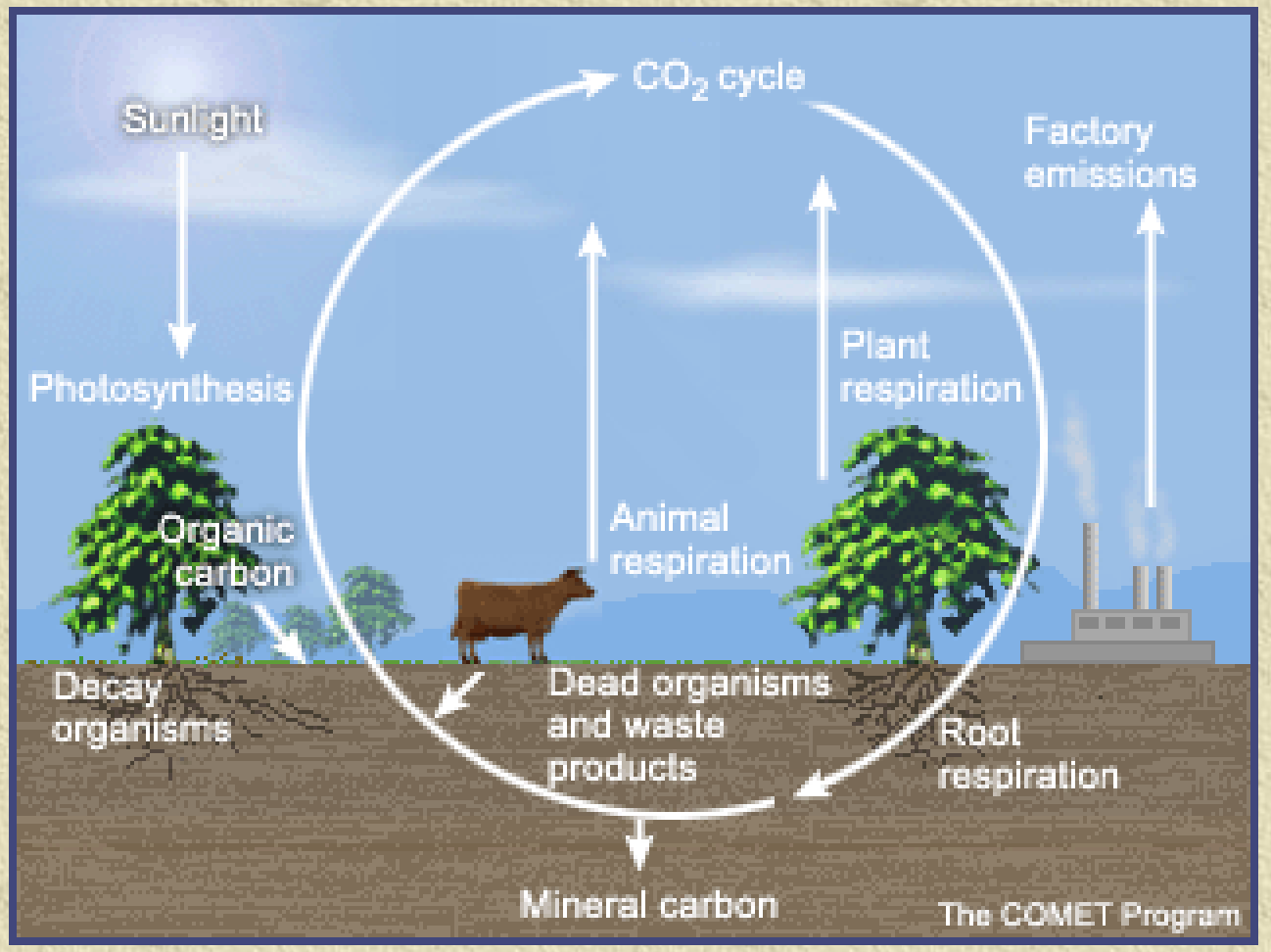


FIGURE 37.11
The Water Cycle
Solar radiation powers the water cycle. How does the water cycle affect the weather?
Solar heat
Water vapor over the sea
Net movement of water vapor by wind
Water vapor over the land
Evaporation and transpiration
Precipitation over the land
Precipitation over the sea
Evaporation from the sea
Oceans
Surface water and groundwater
Flow of water from land to sea

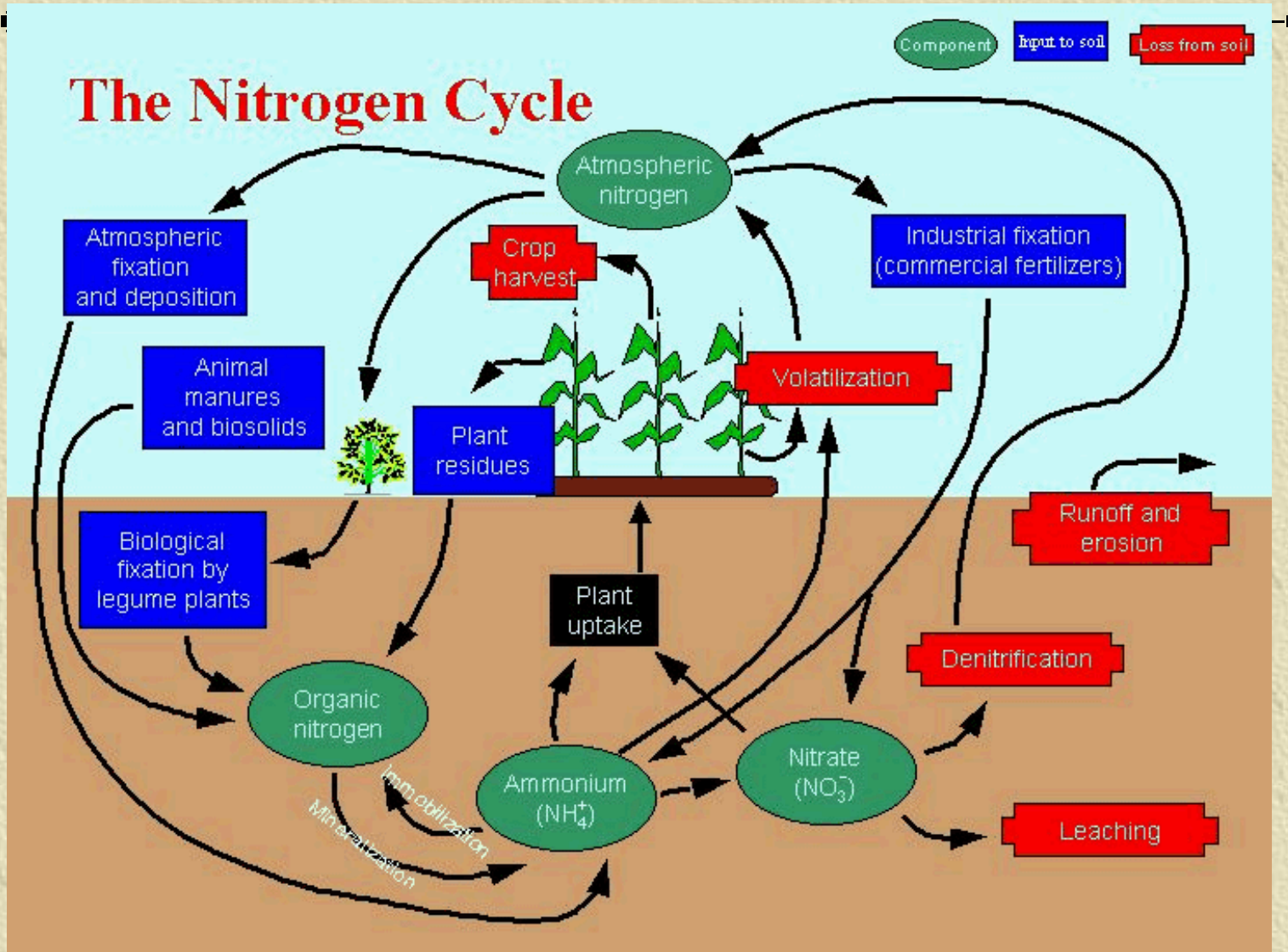
Carbon cycle



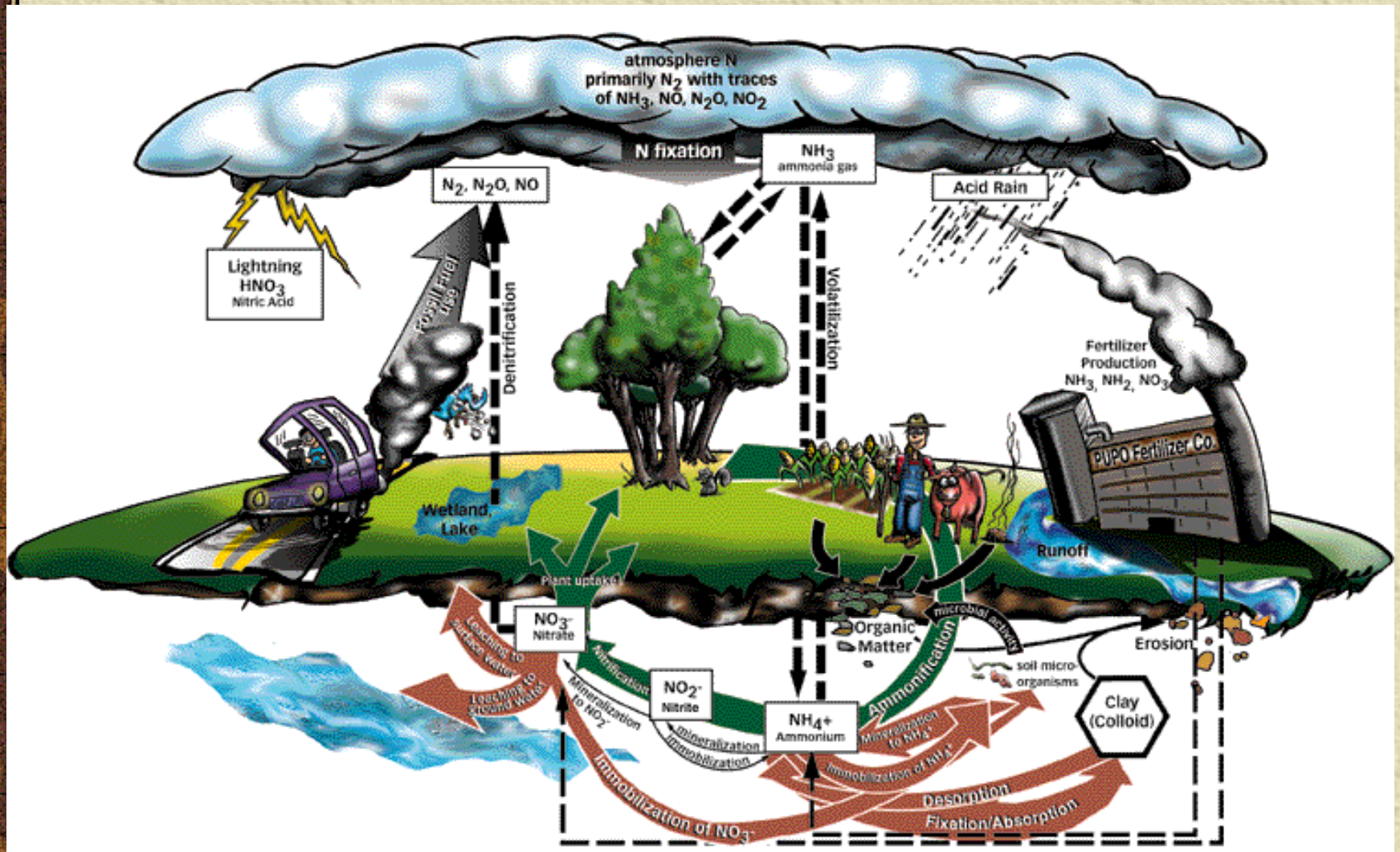
Carbon cycle



Nitrogen cycle



Nitrogen cycle



Population growth

- Populations grow and are affected by limiting factors
- Allowance options for your parents?
- If nothing limits growth, exponential growth takes place (J-shaped curve)
  - Each subsequent generation is a multiple of the previous generation
  - No matter the rate of growth, the shape of the curve is the same
  - Doubling time= 70/rate of growth (%)

Populations

- Population--group of same species in an area
- Community--all the populations that live and interact in an area
  - Influenced by biotic (other organisms) and abiotic factors (e.g. water, temperature, sunlight, nutrients, etc.)
- Ecosystem--populations and the abiotic factors of an area
- Habitat--type of environment in which a species lives
- Niche--the role of an organism in its habitat

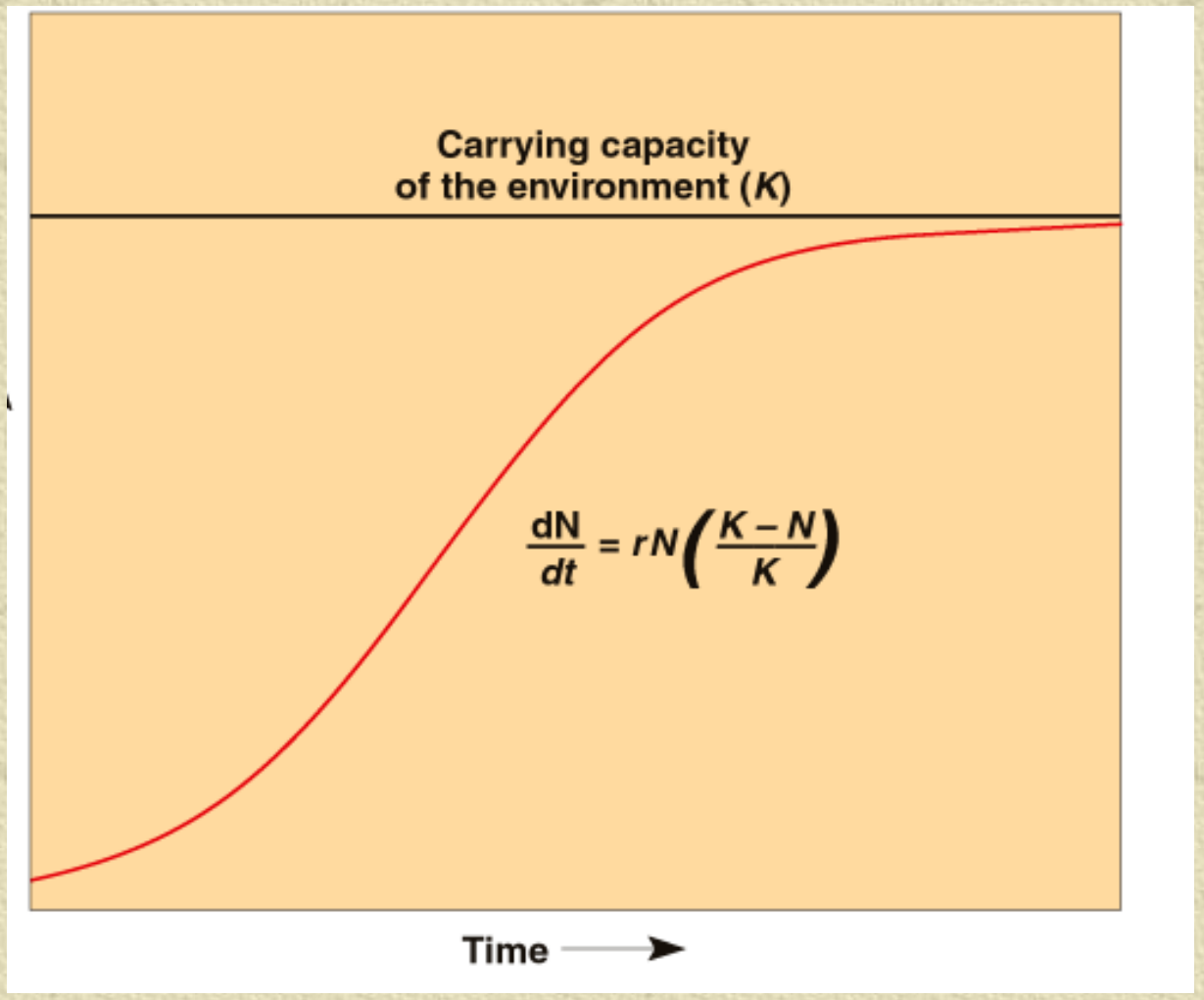
Factors in growth

- Four factors affect growth rate:
  - Birth rate (natality)
  - Immigration
  - Death rate (mortality)
  - Emigration
- Age structures can indicate future growth

Limiting factors

- When some factors are in short supply, competition occurs
- Limiting factor--prevents exponential growth from taking place
- Carrying capacity--number of individuals in a population an area can support
- S-shaped growth occurs when as carrying capacity is reached

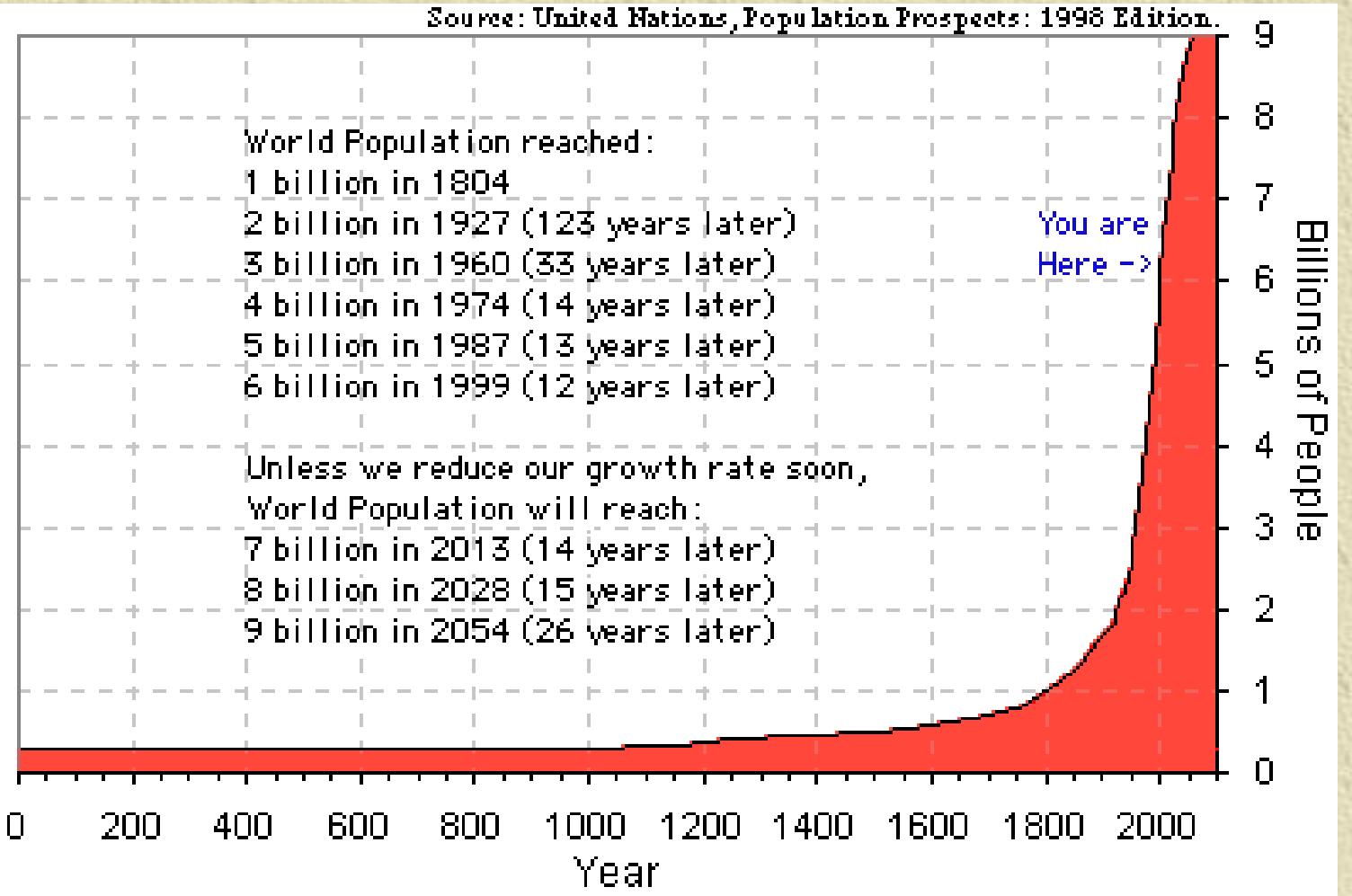
Logistic (S-shaped) growth



Limiting factors

- Density-dependent factors
  - Disease
  - Competition
  - Predation
- Density-independent factors
  - Natural disasters--weather, seasonal cycles, natural disaster, human intervention
- Thomas Malthus--wrote about the idea of human population control OOC
- Is there a limit to our population???

Human population growth (Brainpop)

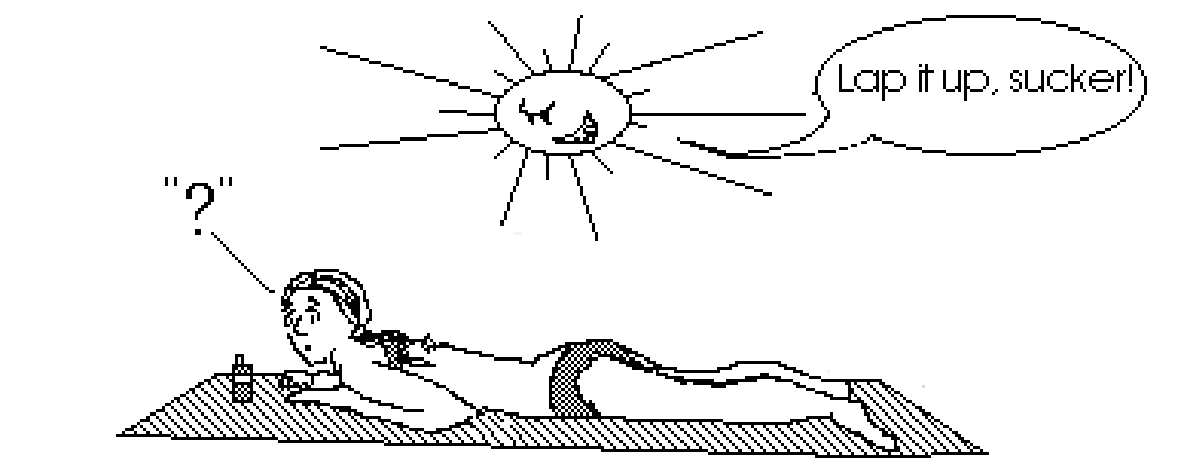


Interactions

- Competition--fighting for resources
- Predation--one eats another
- Symbiosis--one species lives in close association with another
  - Mutualism--both organisms benefit (pollinators and plants, digestive microorganisms and host)
  - Parasitism--one benefits, other is harmed (pathogen and host, parasitic worms, ticks, fleas, lice, etc.)
  - Commensalism--one benefits, other unaffected (e.g. barnacles on whale, bird living in tree)
- Diversity keeps everything in balance
- Introduced/exotic species can disrupt the interactions that exist

Atmospheric quiz

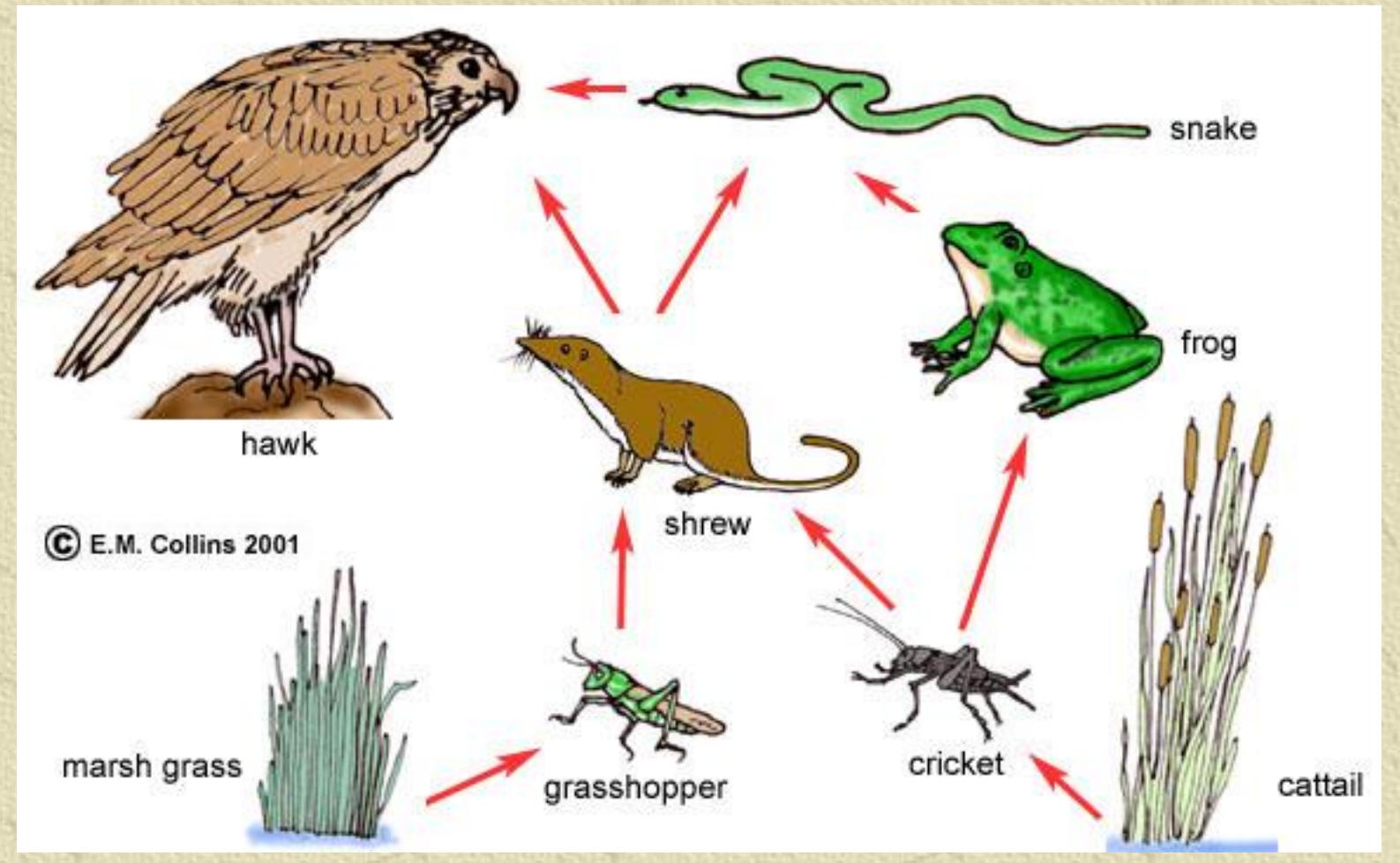
1. What specific type(s) of UV radiation is absorbed by the ozone layer?
2. What specific type of UV radiation causes sunburns?



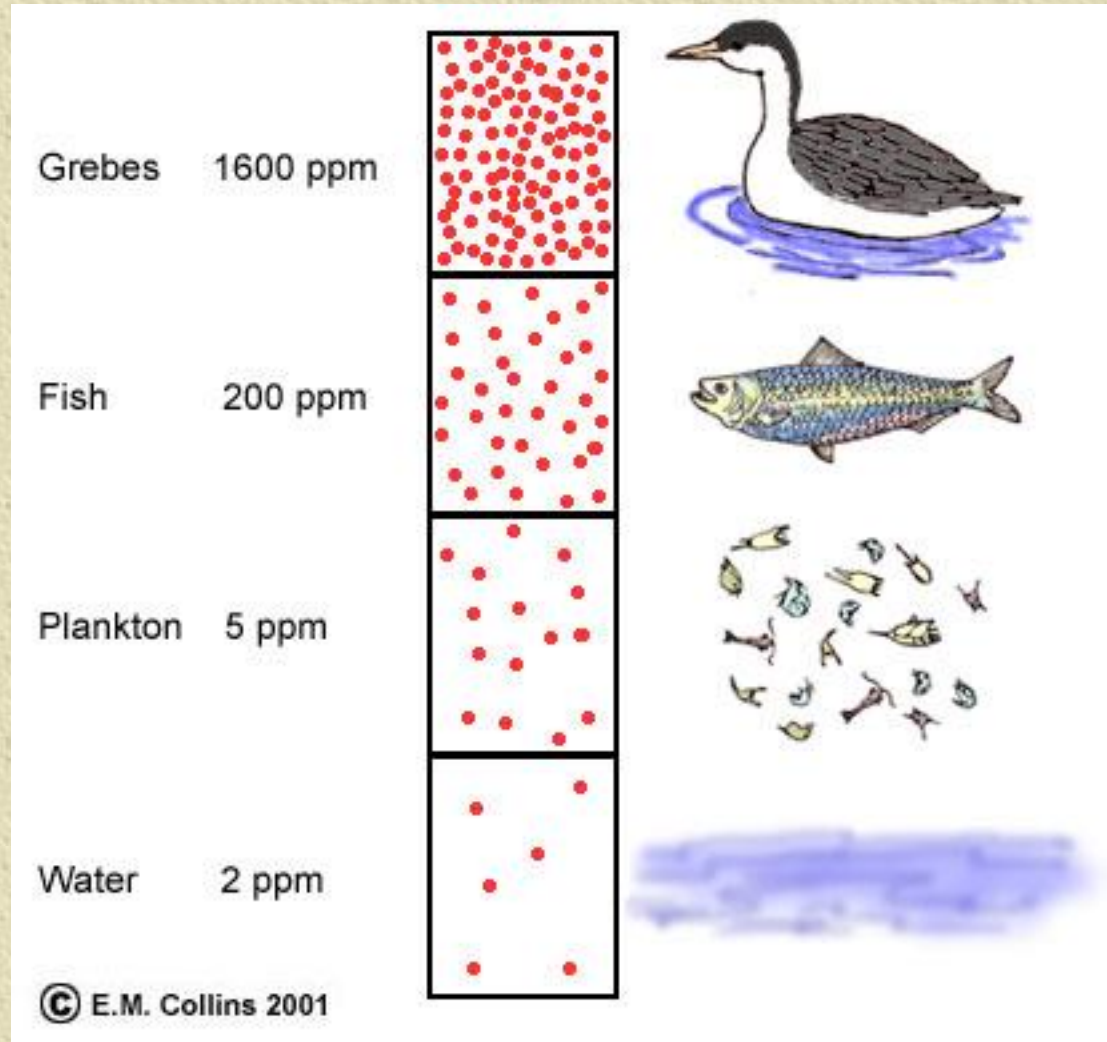
Biological magnification

- Biological magnification--buildup of pollutant in organisms at higher trophic levels
- DDT in eagles and other birds
- Causes serious problems for top-level consumers, such as thin shells in eagle eggs

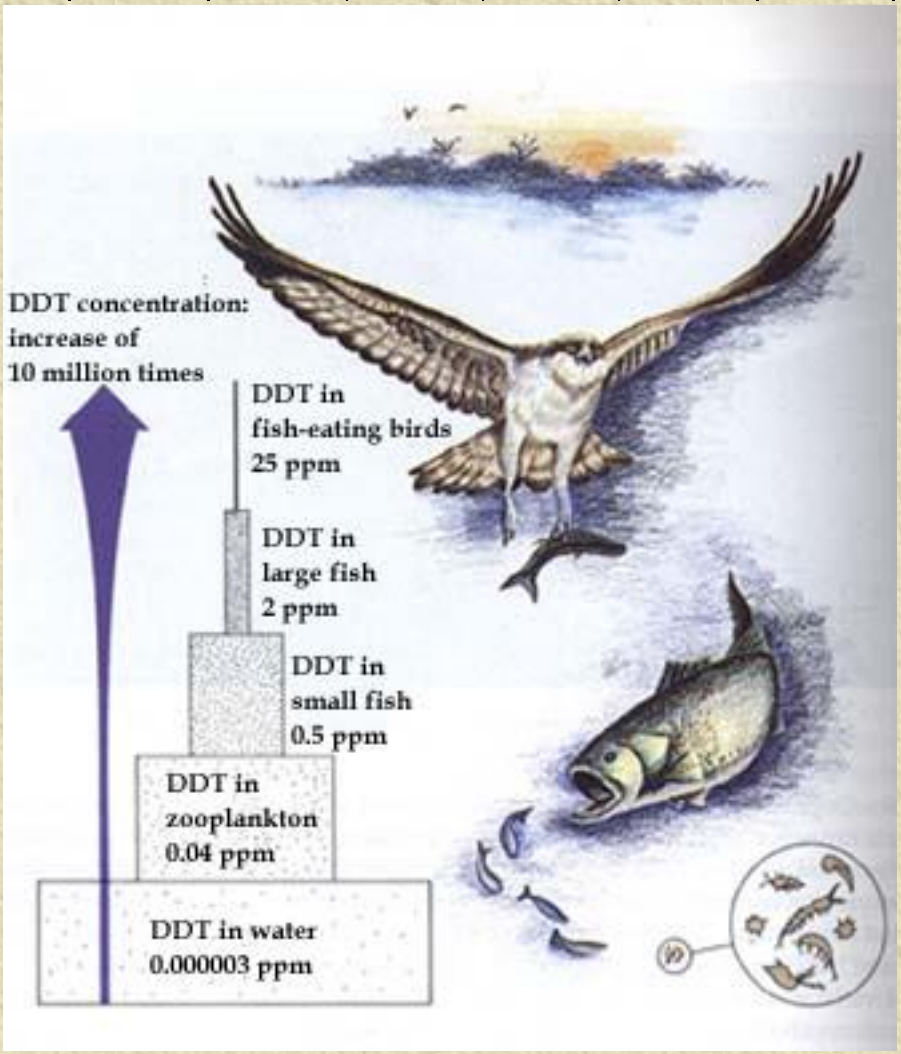
Biological magnification



Biological magnification



Bio magnification of DDT



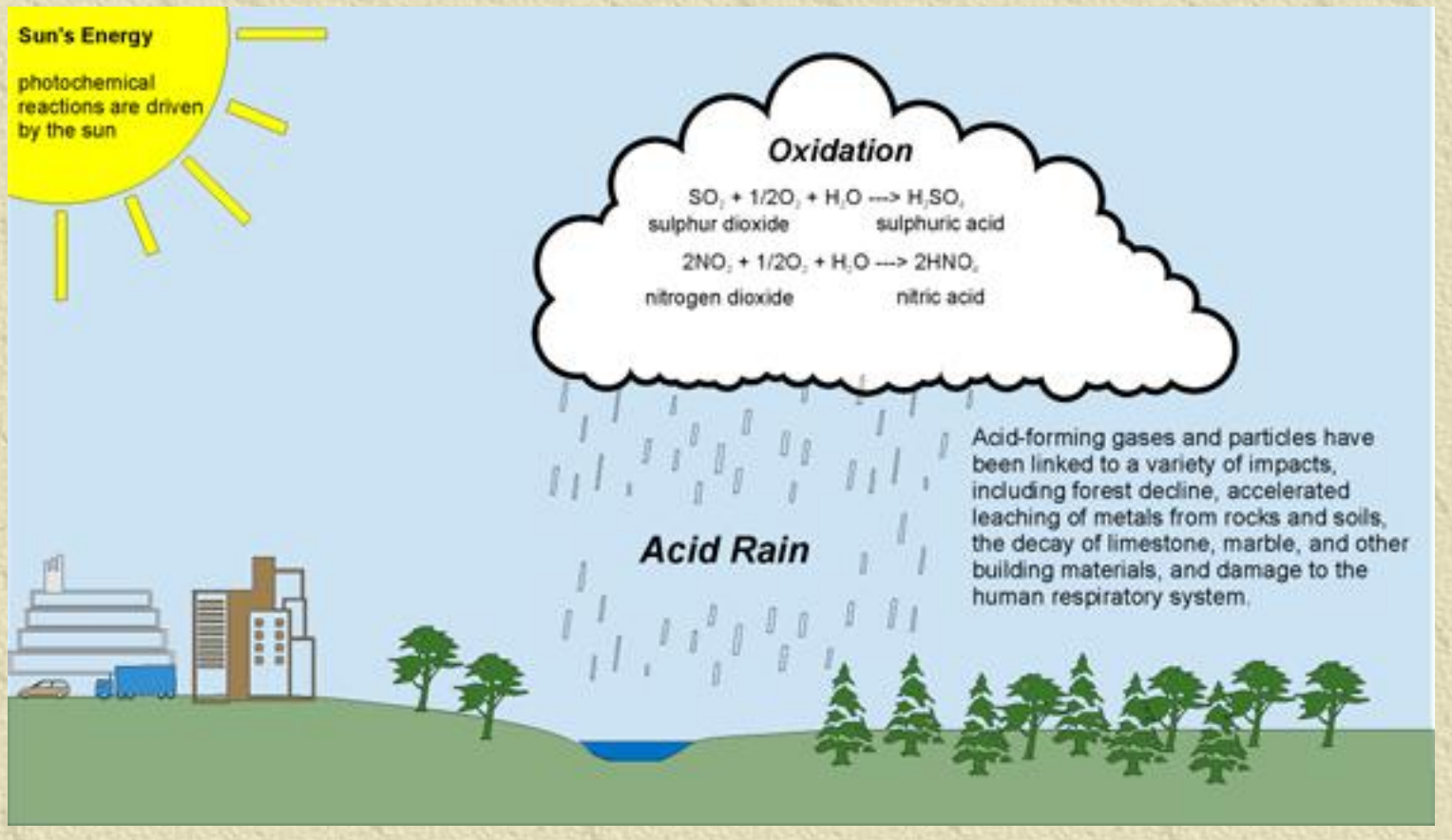
Air pollution

- Pollution in the air:
  - Natural--volcanic eruptions
  - Human--cars, factories, aerosols
- Smog--haze of pollutants over big cities
- Pollutants cause respiratory irritations for humans and a host of environmental problems
- Laws/regulations have helped reduce some pollution, especially from factories
- ….but….the major contributor to air pollution…..car exhaust! (do you <u>really</u> care about the environment??)

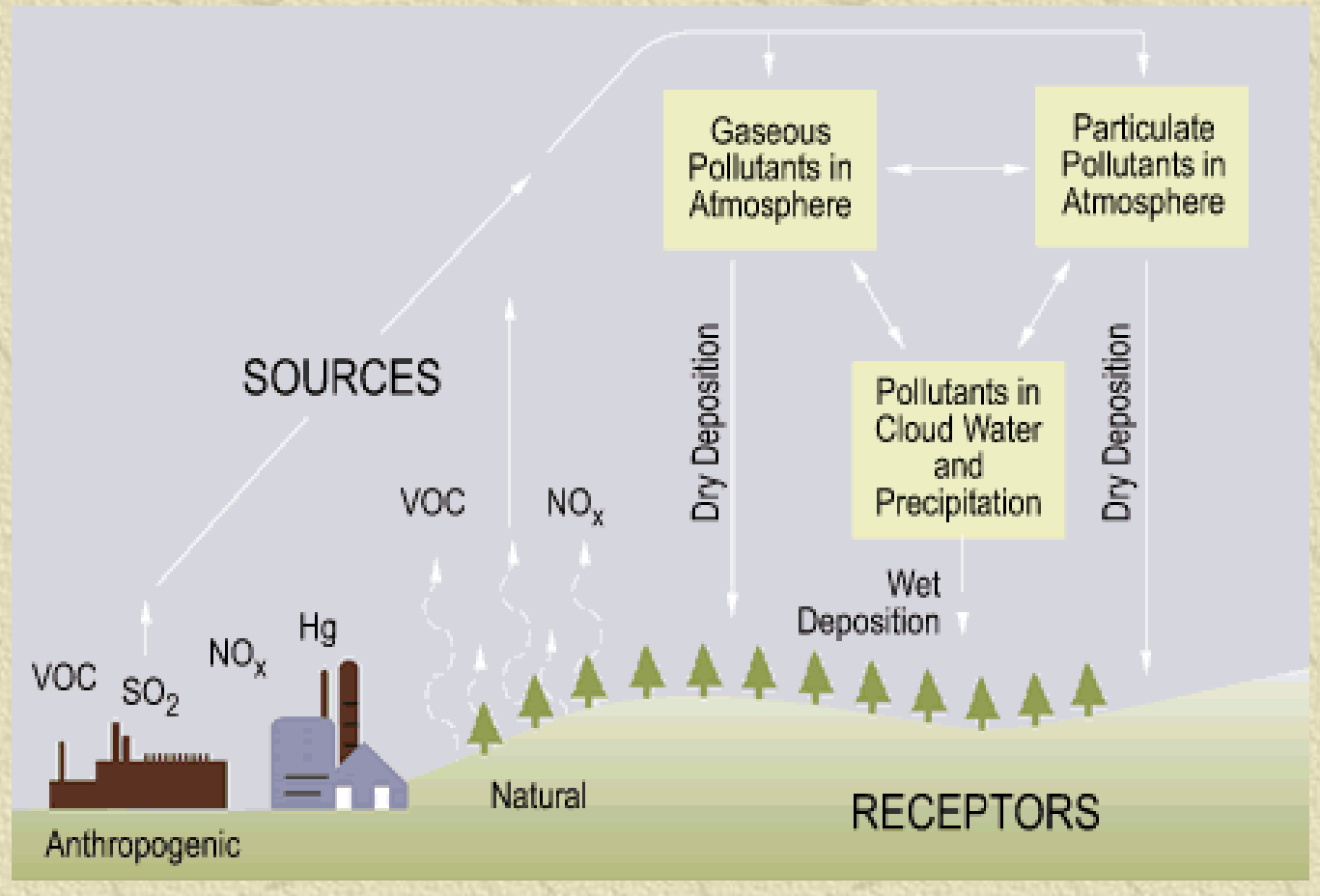
Acid rain

- Pollutants in the air mix with rain to create nitric and sulfuric acid
- Normally, rain is pH 5-6 (from carbonic acid formation)
- Acid rain in the eastern US can be pH 4.3 (10 times more acidic!) other areas get pH of 2.3 (1000 times more acidic!)
- Changes soil chemistry, and kills aquatic organisms
- Acid rain accelerates breakdown of metal and limestone deposits

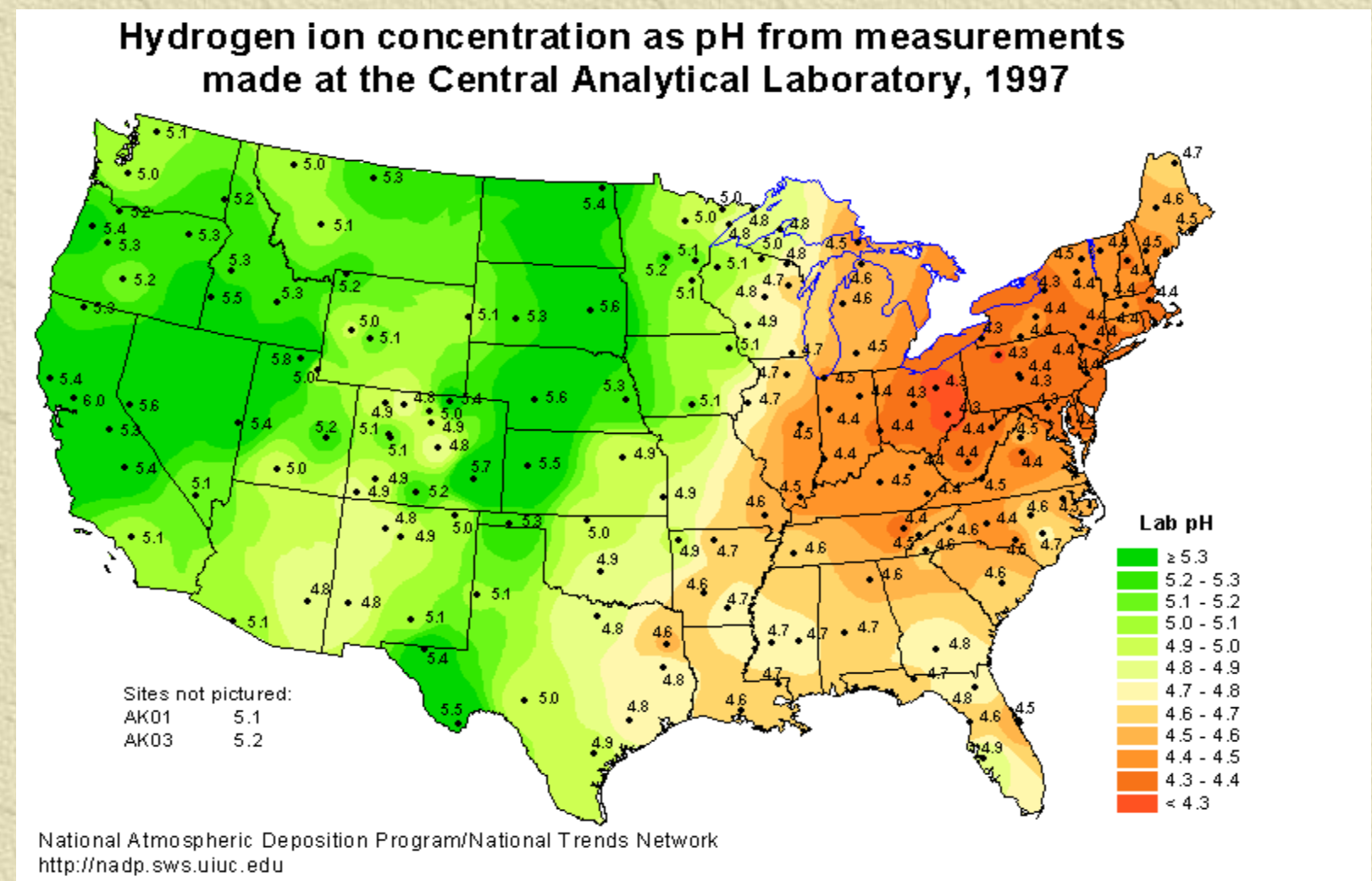
Acid Rain


Sun's Energy
photochemical reactions are driven by the sun
Oxidation
$SO_2 + 1/2O_2 + H_2O \rightarrow H_2SO_4$
sulphur dioxide
sulphuric acid
$2NO_2 + 1/2O_2 + H_2O \rightarrow 2HNO_3$
nitrogen dioxide
nitric acid
Acid Rain
Acid-forming gases and particles have been linked to a variety of impacts, including forest decline, accelerated leaching of metals from rocks and soils, the decay of limestone, marble, and other building materials, and damage to the human respiratory system.

Acid Rain


Gaseous Pollutants in Atmosphere
Particulate Pollutants in Atmosphere
SOURCES
Dry Deposition
Pollutants in Cloud Water and Precipitation
Dry Deposition
VOC
NO_x
Wet Deposition
VOC
SO_2
NO_x
Hg
Natural
RECEPTORS
Anthropogenic

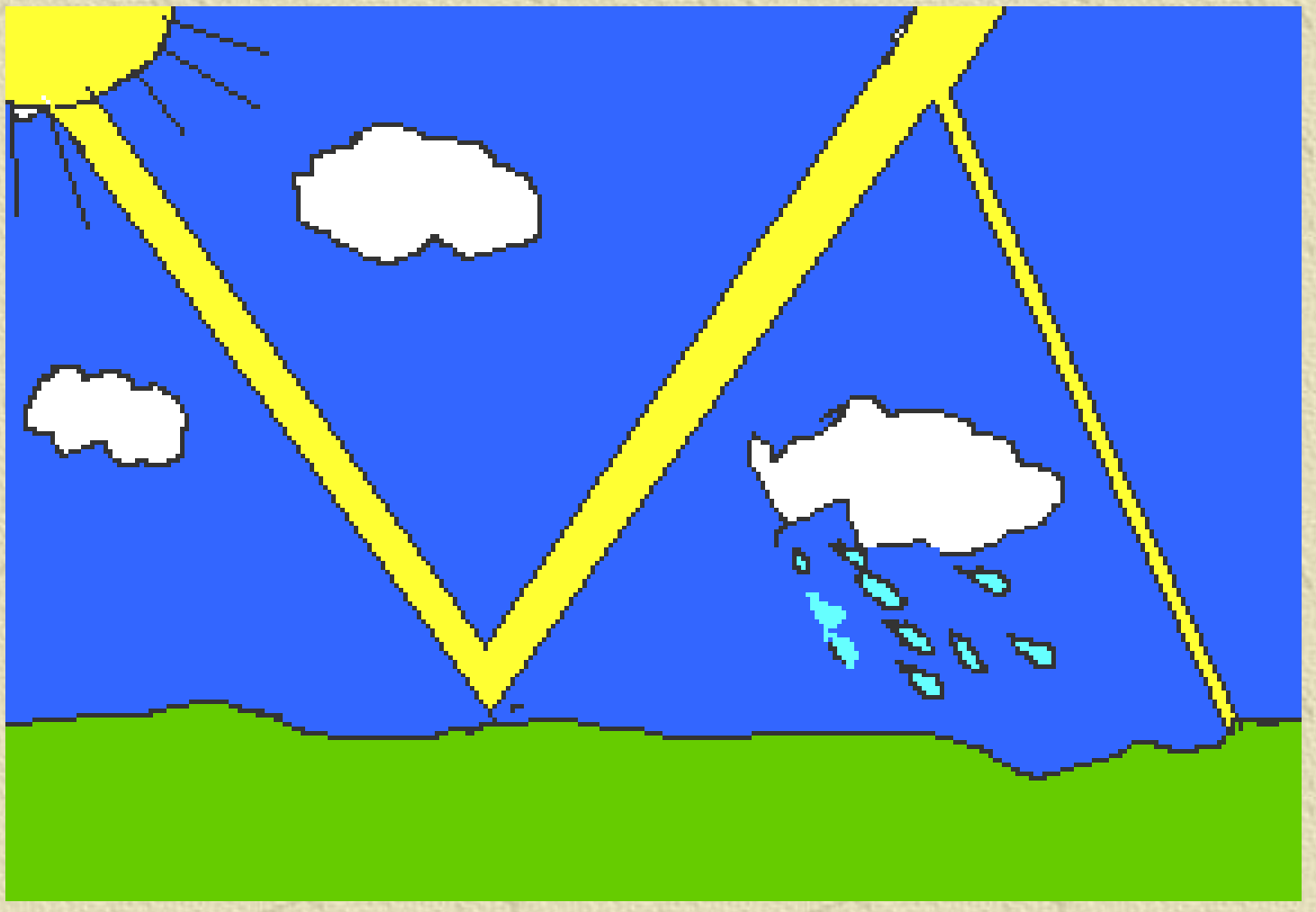
Acid Rain


Hydrogen ion concentration as pH from measurements made at the Central Analytical Laboratory, 1997
Lab pH
≥ 5.3
5.2 - 5.3
5.1 - 5.2
5.0 - 5.1
4.9 - 5.0
4.8 - 4.9
4.7 - 4.8
4.6 - 4.7
4.5 - 4.6
4.4 - 4.5
4.3 - 4.4
< 4.3
Sites not pictured:
AK01 5.1
AK03 5.2
National Atmospheric Deposition Program/National Trends Network
http://nadp.sws.uiuc.edu

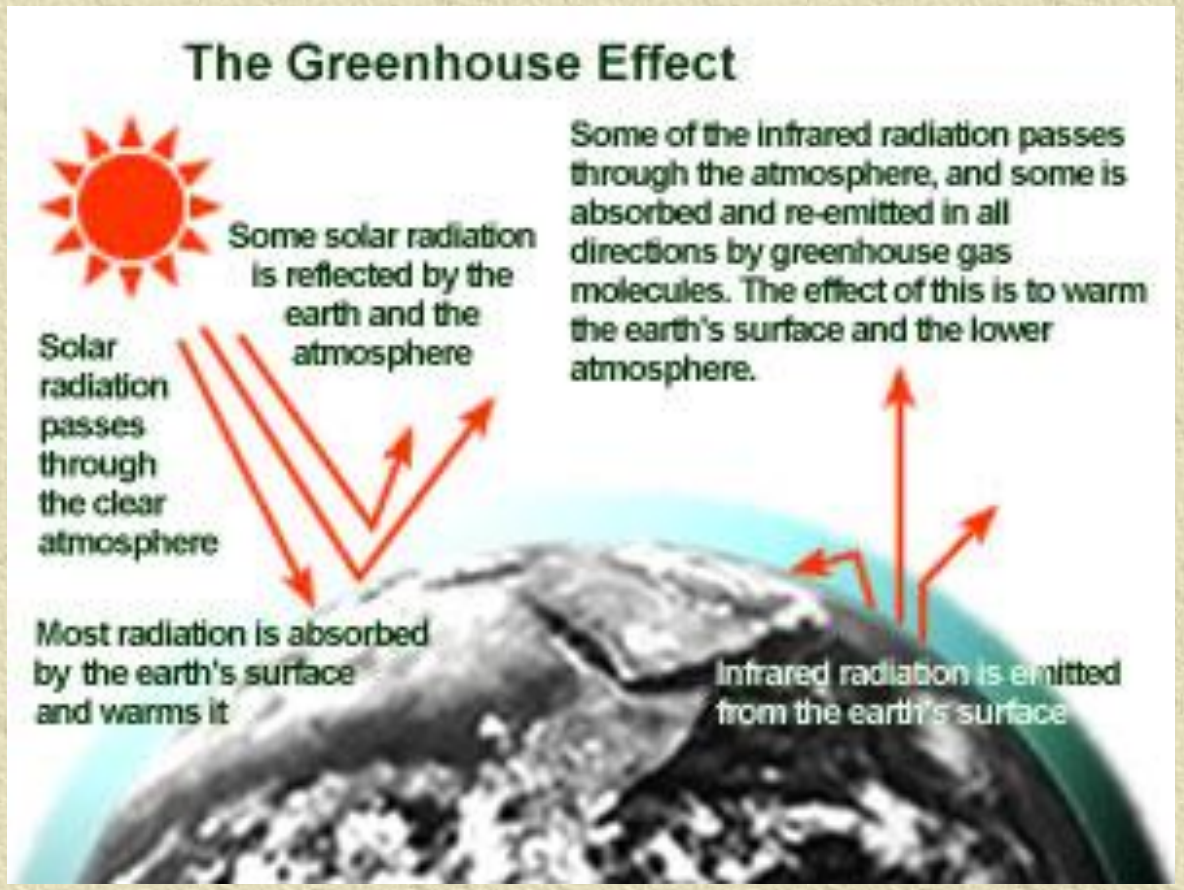
Greenhouse effect (global warming) Brainpop animation)

- Carbon dioxide and other gases (e.g. methane) in atmosphere act as a blanket
- The suns energy normally enters the atmosphere and a portion is radiated back into space
- The blanket holds in more energy than it should, and the Earth warms up--global warming
  - Climate change, ice caps could melt, etc.
  - Try this link!

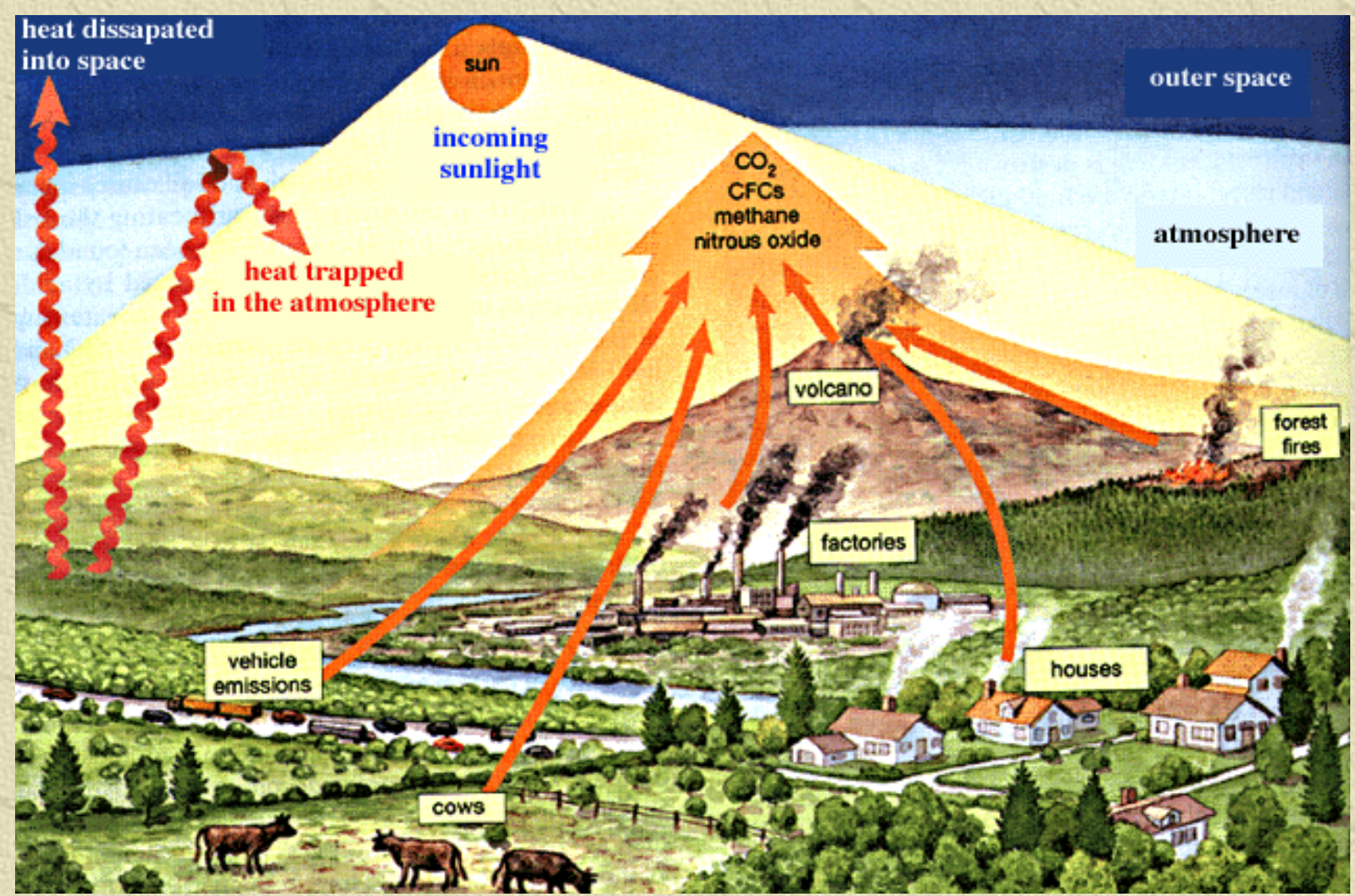
Global warming



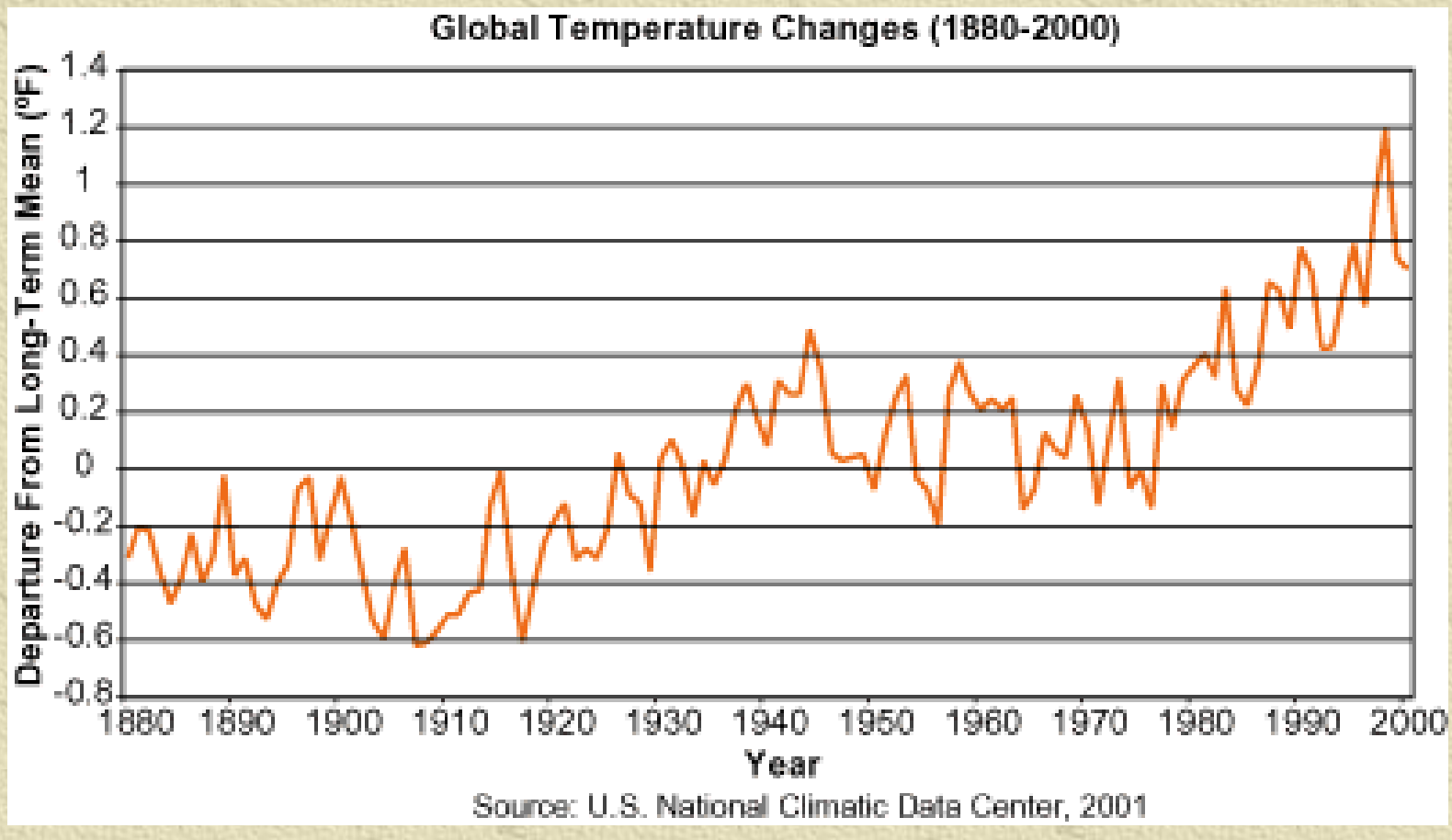
Greenhouse effect



Greenhouse effect



Temperature changes



20 Steps to reduce global warming

HOME APPLIANCES

1. Run your dishwasher only with a full load. Use the energy-saving setting to dry the dishes. Don't use heat when drying.

   Carbon dioxide reduction: *200 pounds a year.*

2. Wash clothes in warm or cold water, not hot.

   Carbon dioxide reduction *(for two loads a week): up to 500 pounds a year.*

3. Turn down your water heater thermostat; 120 degrees is usually hot enough.

   Carbon dioxide reduction *(for each 10- degree adjustment): 500 pounds/year.*

HOME HEATING AND COOLING

4. Don't overheat or overcool rooms. Adjust your thermostat (lower in winter, higher in summer).

   Carbon dioxide reduction *(for each 2-degree adjustment): about 500 pounds a year.*

5. Clean or replace air filters as recommended. Cleaning a dirty air conditioner filter can save 5% of the energy used.

   Carbon dioxide reduction: *About 175 pounds a year.*

20 Steps to reduce global warming

SMALL INVESTMENTS THAT PAY OFF

6. Buy energy-efficient compact fluorescent bulbs for your most-used lights.

   Carbon dioxide reduction *(by replacing one frequently used bulb): about 500 pounds a year.*

7. Wrap your water heater in an insulating jacket (but only if the water heater is over 5 years old and has no internal insulation).

   Carbon dioxide reduction: *Up to 1000 pounds a year.*

8. Install low-flow shower heads to use less hot water.

   Carbon dioxide reduction: *Up to 300 pounds a year.*

9. Caulk and weatherstrip around doors and windows to plug air leaks.

   Carbon dioxide reduction: *Up to 1000 pounds a year.*

10. Ask your utility company for a home energy audit to find out where your home is poorly insulated or energy-inefficient.

    Carbon dioxide reduction: *Potentially, thousands of pounds a year.*

20 Steps to reduce global warming

GETTING AROUND

11. Whenever possible, walk, bike, carpool or use mass transit.

    Carbon dioxide reduction *(for every gallon of gasoline you save): 20 pounds.*

12. When you buy a car, choose one that gets good gas mileage.

    Carbon dioxide reduction *(if your new car gets 10 mpg more than your old one): about 2500 pounds a year.*

REDUCE, REUSE, RECYCLE

13. Reduce waste: Buy minimally packaged goods; choose reusable products over disposable ones; recycle.

    Carbon dioxide reduction *(if you cut down your garbage by 25%): 1000 pounds a year.*

14. If your car has an air conditioner, make sure its coolant is recycled whenever you have it serviced.

    Equivalent carbon dioxide reduction: *Thousands of pounds.*

20 Steps to reduce global warming

HOME IMPROVEMENTS

15. Insulate your walls and ceilings; this can save about 25% of home heating bills.
    Carbon dioxide reduction: *Up to 2000 pounds a year.*
16. If you need to replace your windows, install the best energy-saving models.
    Carbon dioxide reduction: *Up to 10,000 pounds a year.*
17. Plant trees next to your home and paint your home a light color if you live in a warm climate, or a dark color in a cold climate.
    Carbon dioxide reduction: *About 5000 pounds a year.*
18. As you replace home appliances, select the most energy-efficient models.
    Carbon dioxide reduction *(if you replace your old refrigerator with an efficient model): 3000 pounds a year.*

SCHOOLS, BUSINESS, AND COMMUNITIES

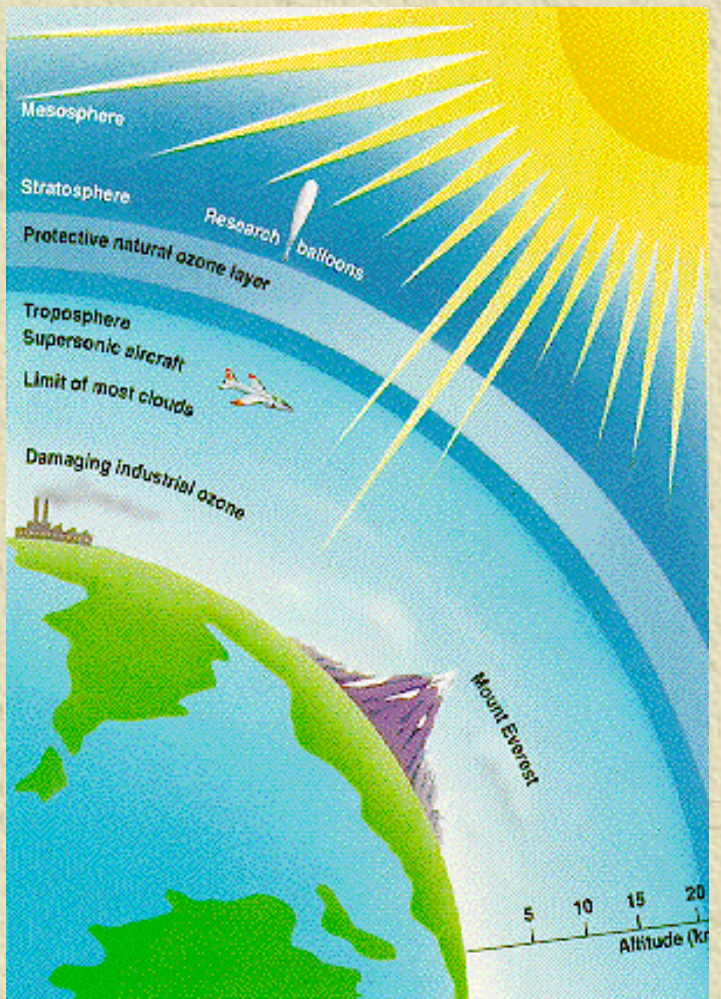
19. Reduce waste and promote energy-efficient measures at your school or workplace. Work in your community to set up recycling programs.
    Carbon dioxide reduction *(for every pound of office paper recycled): 4 pounds.*
20. Be informed about environmental issues. Keep track of candidates' voting records and write or call to express concerns.
    Carbon dioxide reduction *(if we vote to raise U.S. auto fuel efficiency): Billions of pounds.*

Another motivation to stop GW

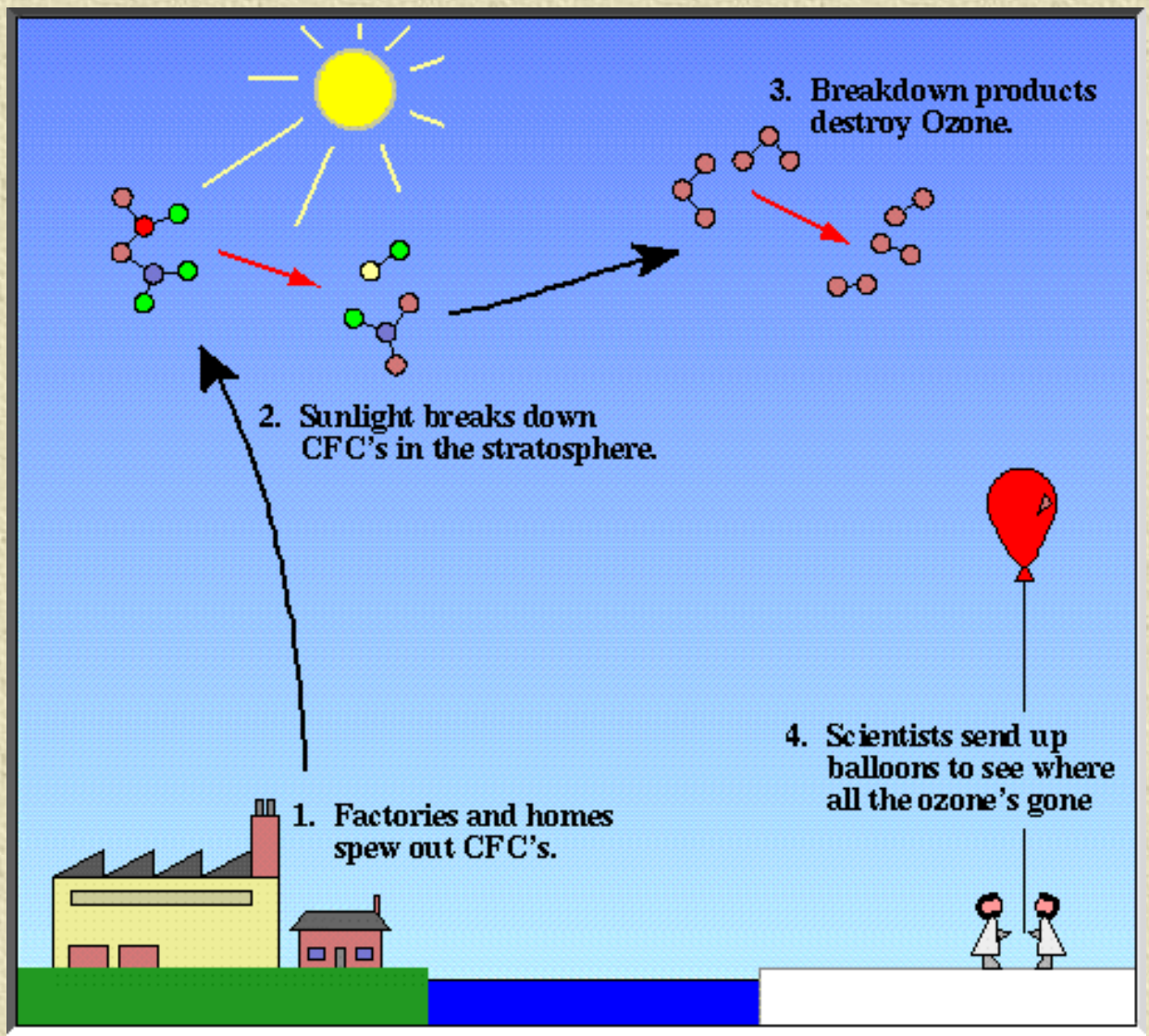
Ozone layer (Brainpop)

- In the stratosphere (20-50 km above earth), there is a protective "sunscreen" that filters UV radiation
  - Made of O3
- Ozone can be thinned by chlorofluorocarbons (CFC's) once used as:
  - Propellents in aerosols
  - Coolants in air conditioners, refrig/freezers
- CFC's persist in atmosphere for years, so damage continues
- Ozone hole growing over Antarctica (south pole)
- Breakdown of ozone increases risk of skin cancers, cataracts, as well as effects on plant life

The Ozone layer



The science of ozone breakdown



The Ozone Hole