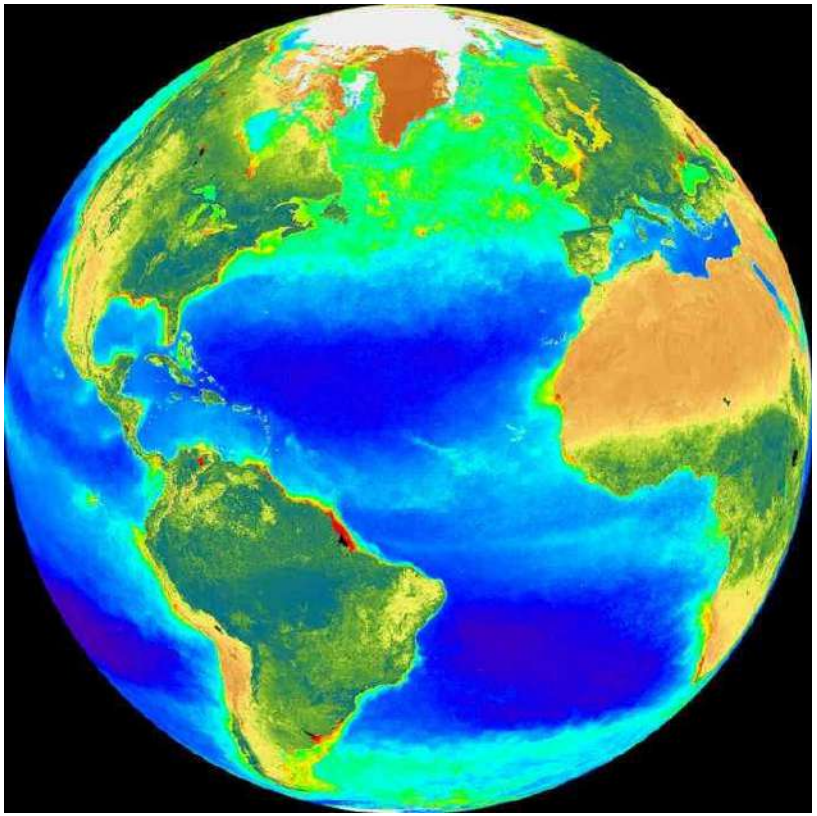
NOTES: CH 3 - Introduction to ECOLOGY / the BIOSPHERE



ECOLOGY

VOCABULARY:

Ecology
Biosphere
Predation
Parasitism
Population
Niche
Habitat
Community
Ecosystem
Biotic vs. abiotic factors

*__**ECOLOGY**__ = the scientific study of the INTERACTIONS between organisms and their environments

Ecology is MULTIDISCIPLINARY!!!

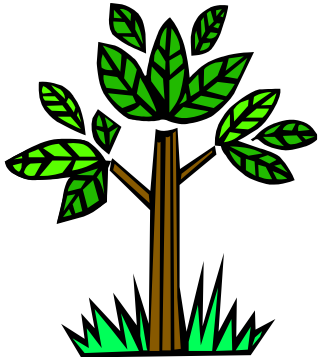
***Areas of Biology:**

-genetics

-evolution

-physiology

-behavior



***Other Areas of science:**

-physics, chemistry

-geology, meteorology

***Broad range of fields:**

-sociology, law

-politics, economics

-mathematics

BIOSPHERE

BIOSPHERE = the global ecosystem; the sum of all Earth's ecosystems

"*all of LIFE and where it lives*"

- the Earth is a single living system; it is a **biosphere**, or living globe which includes all the areas of land, air, & water where life exists

- the biosphere extends approximately 8 km above the Earth's surface as well as 11 km below the surface of the ocean

- **ECOSYSTEMS**

  -are interactions among populations and communities

  -are shaped by 2 things: **abiotic** and **biotic** factors

*the environment includes:

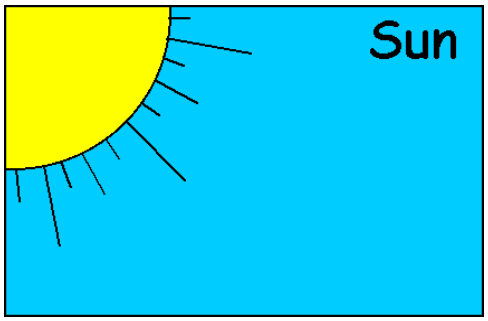
- **<u>BIOTIC components</u>**

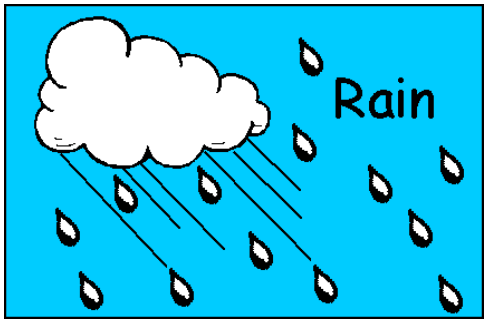
(<u>living</u>; <u>all organisms</u>)

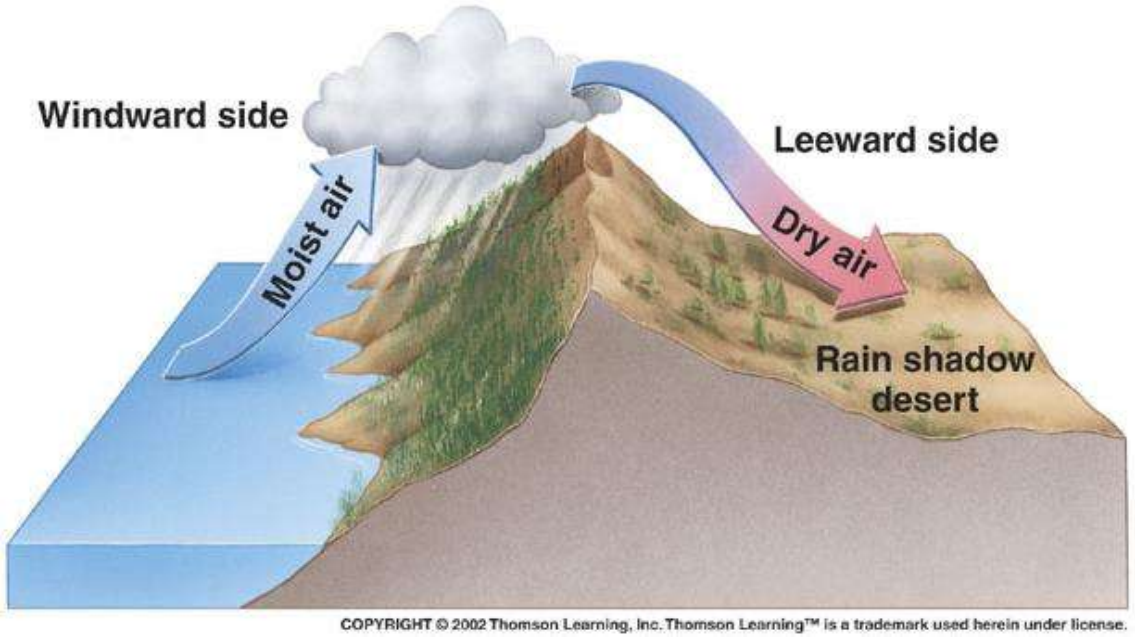
and it includes:

- **ABIOTIC components**

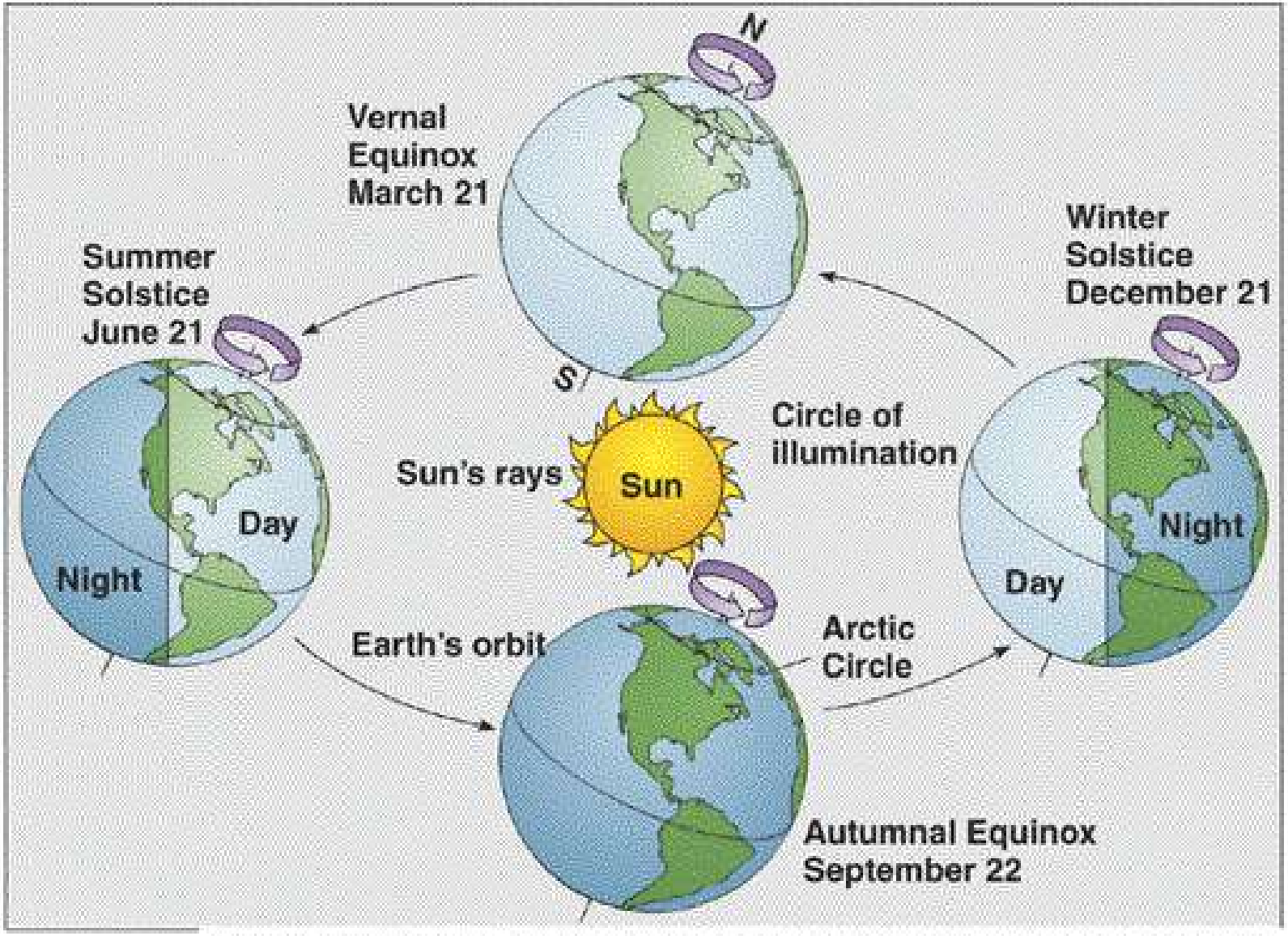
(nonliving: temp., sunlight, water, nutrients, wind, pH)

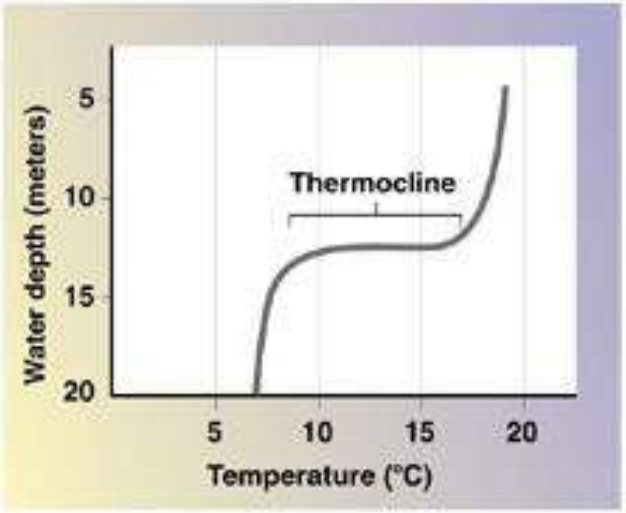


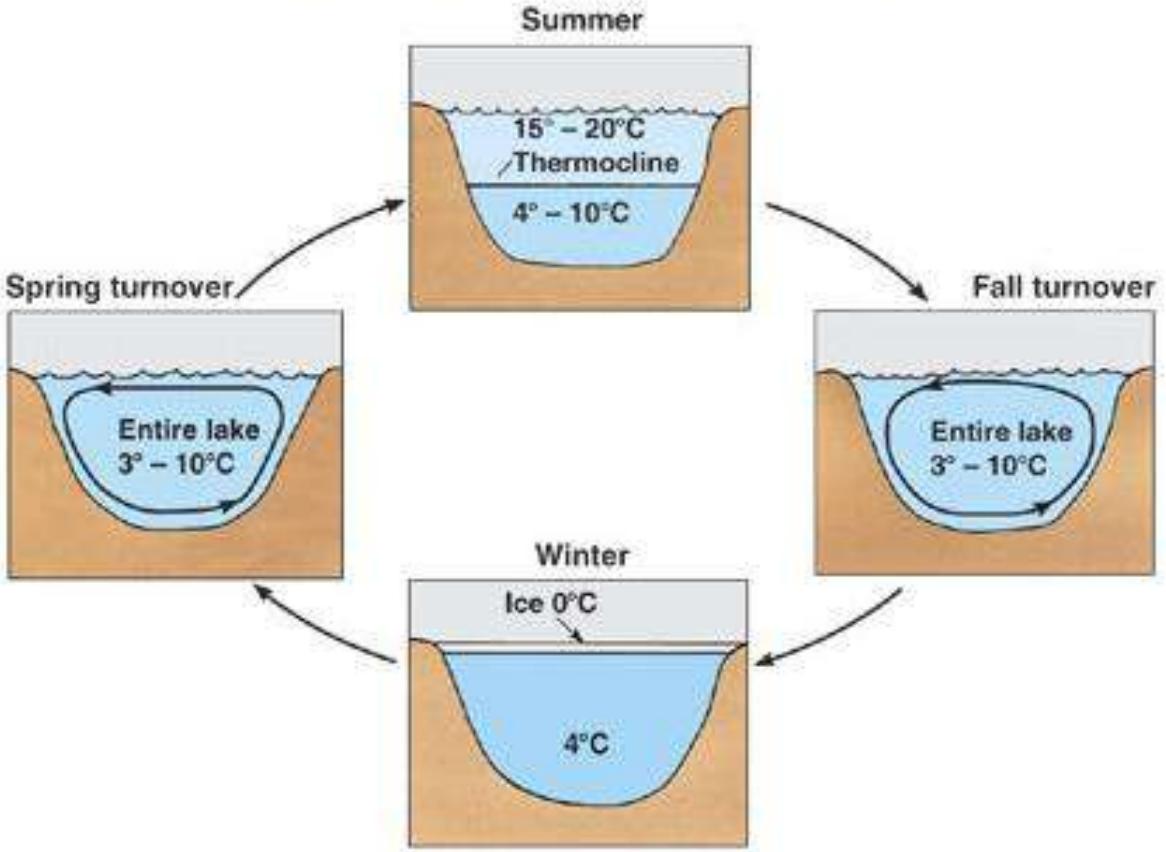


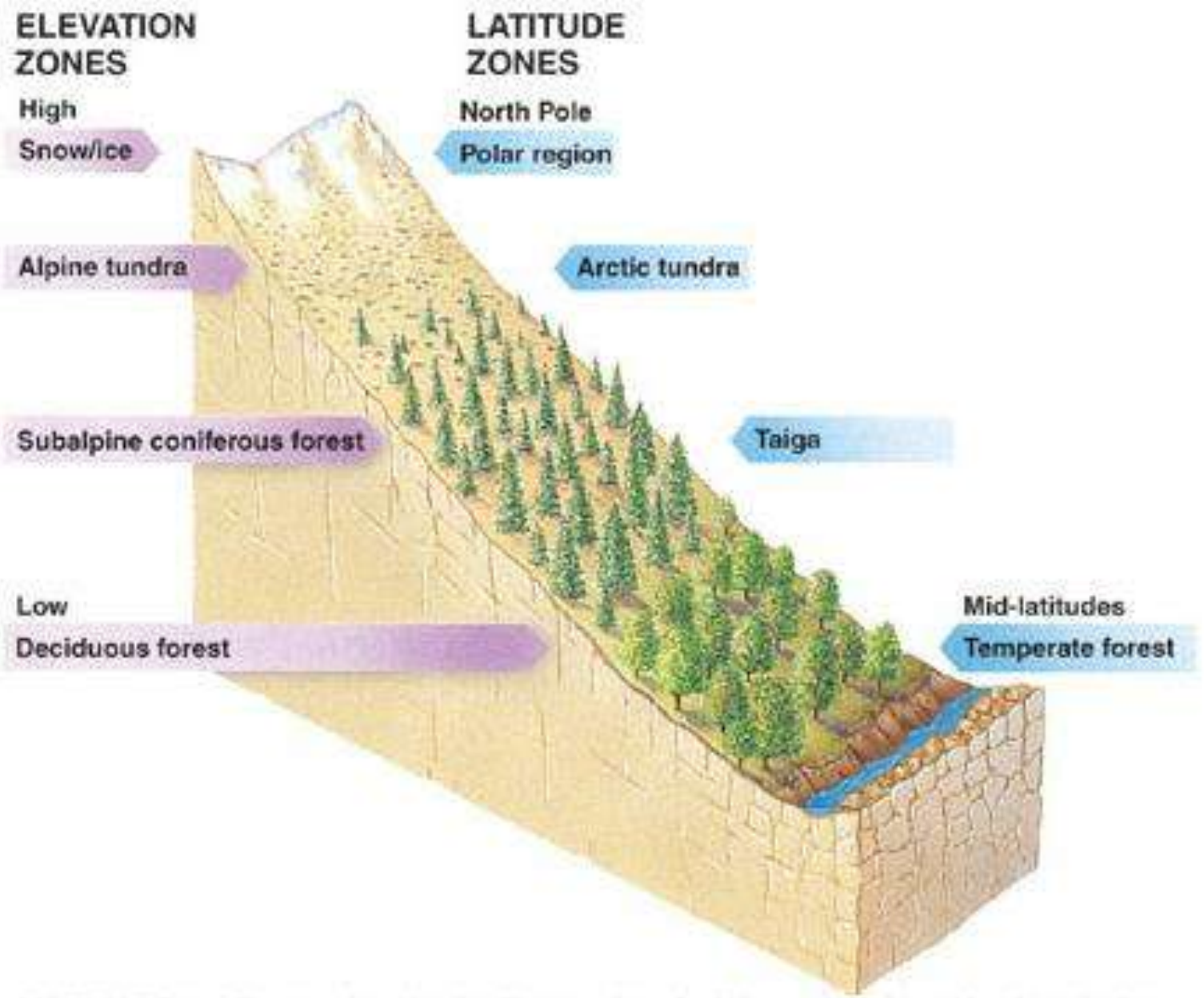


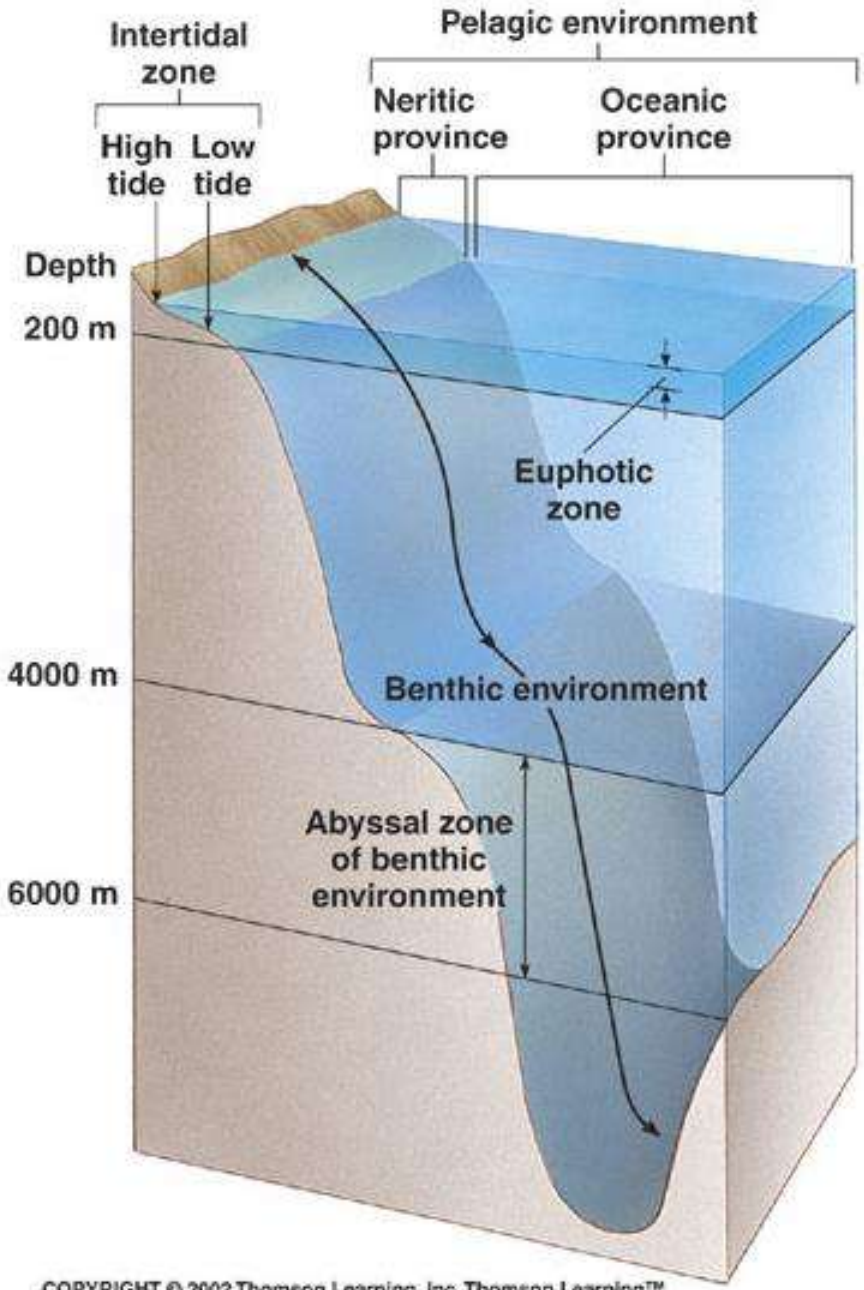
What are some biotic and abiotic factors in this picture?











Biotic and abiotic factors determine…

- the survival and growth of an organism
- the productivity of the ecosystem in which the organism lives

Ecological Hierarchy:

- Ecologists study interactions of organisms at a variety of levels:

  -**INDIVIDUAL ORGANISM**, where it lives, its prey/predators, interactions with similar/different individuals, etc…

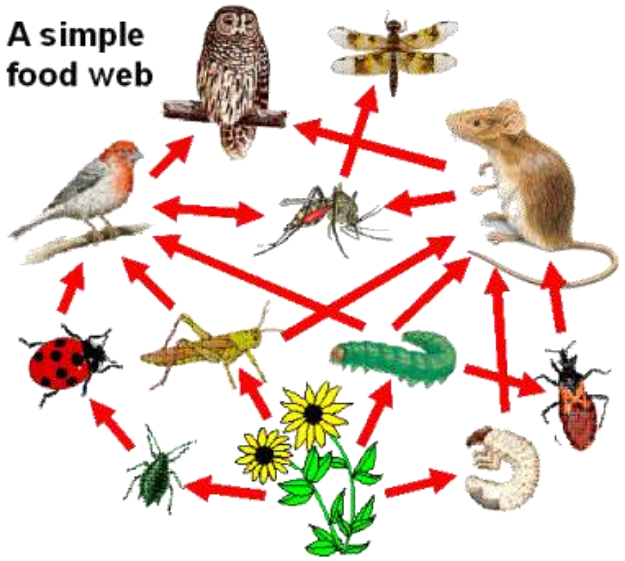
POPULATIONS:

-**POPULATION** = all members of the same species living in the same general area and interbreeding

COMMUNITIES

-COMMUNITY = all populations in a given area

-includes HOW organisms' interactions affect the community (CH 4)

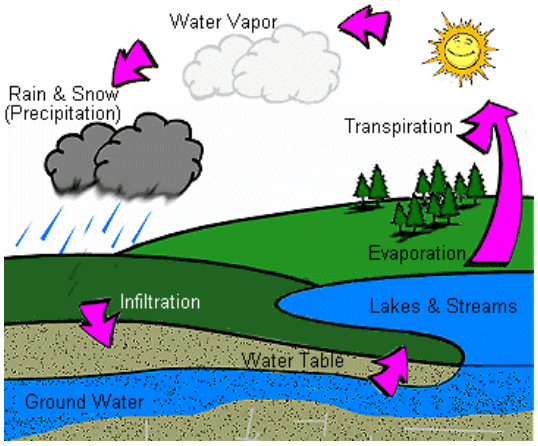


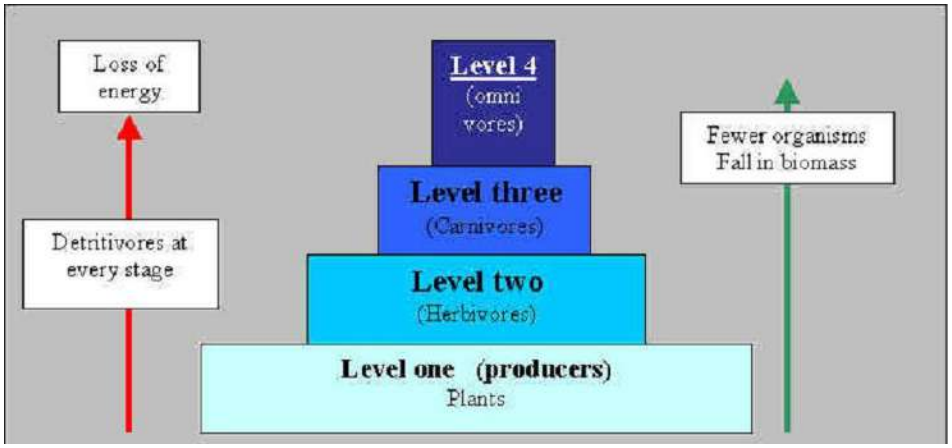
ECOSYSTEM

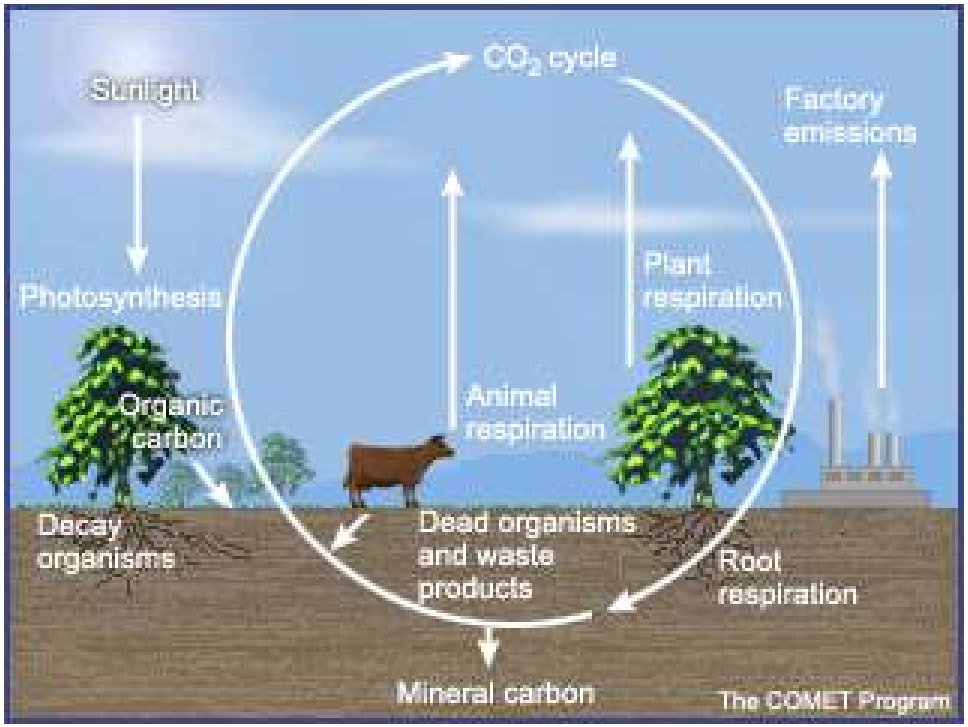
ECOSYSTEM = the community and its surrounding environment (biotic and abiotic factors)

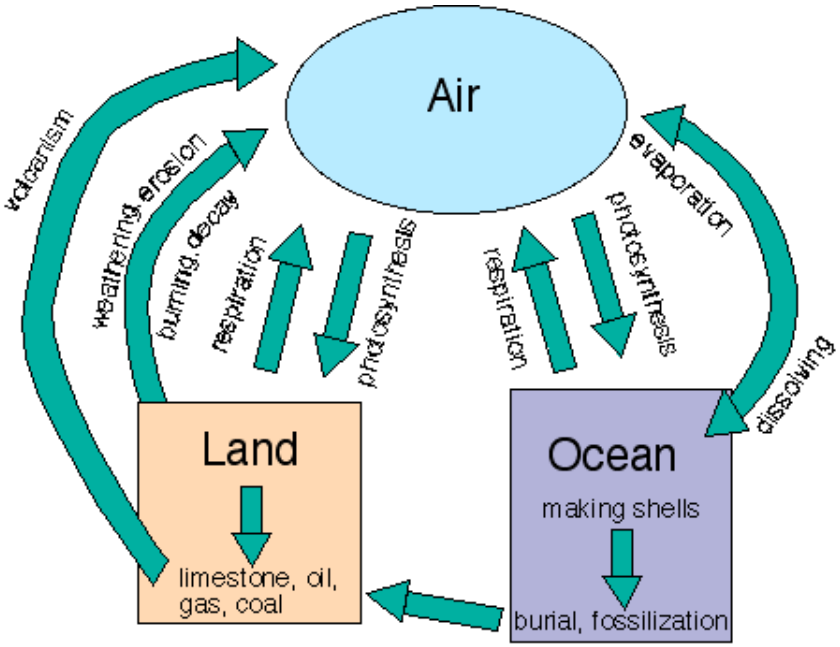
-energy flow

-materials / chemical cycling

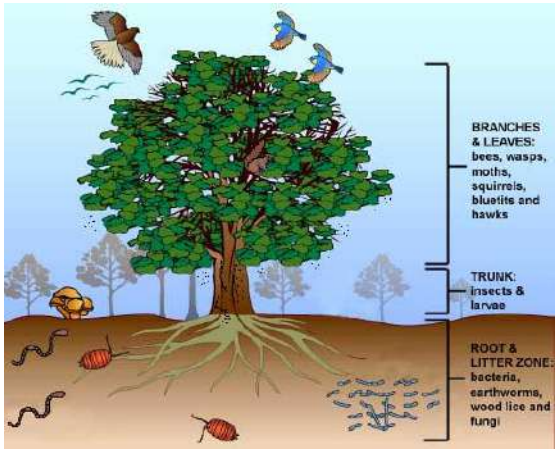








The carbon cycle on Earth



Summary of Ecological Hierarchy

The Earth System

Organism

↓

Population

↓

Community

↓

Ecosystem

↓

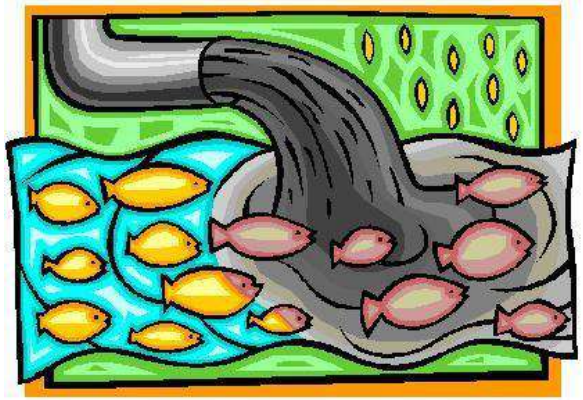
Biomes

↓

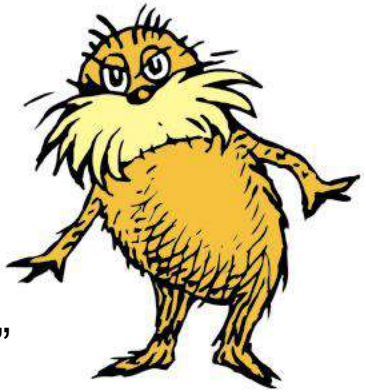
Biosphere

Also part of ECOLOGY…

- Food chains; trophic levels; food webs
- Materials cycling (water, C and N cycles)
- Population growth
- Carrying capacity, limiting factors
- Human impact on ecosystems



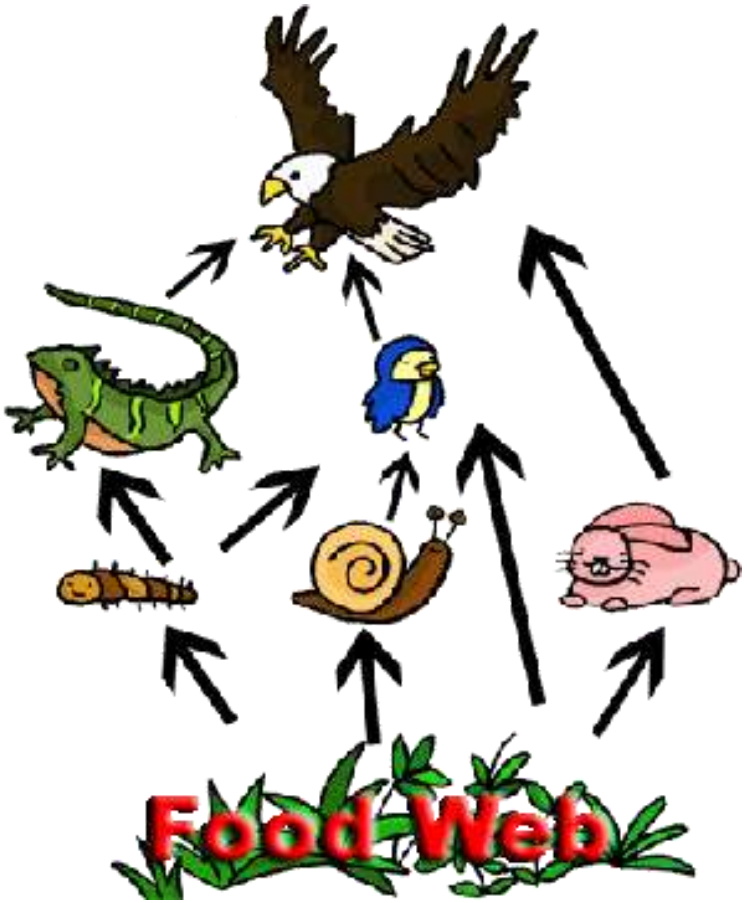
The Lorax!



“I am the Lorax, I speak for the trees, for the trees have no tongues!”

NOTES: 3.2-3.3

- Energy Flow



VOCABULARY:

Producers
Consumers
(primary, secondary, tertiary)
Decomposers
Trophic level
Herbivore
Carnivore
Omnivore

ENERGY IN AN ECOSYSTEM

*__ENERGY__ is required by all organisms for growth, maintenance, and reproduction

*ultimate source of energy = ***SUNLIGHT***

THE FLOW OF ENERGY

- organisms that use the sun's energy to make food are called: **PRODUCERS**

  -ex: plants
- each step of an organism eating another organism is called a **TROPHIC LEVEL** (*trophe* means food in Greek)

Trophic Relationships in Ecosystems

1) PRIMARY PRODUCERS:

-AUTOTROPHS (organisms that make their own food; usually photosynthetic);

-support all other trophic levels by using light or chemical energy to synthesize sugars (e.g. plants, algae, some bacteria)

Trophic Relationships in Ecosystems

2) PRIMARY CONSUMERS:

-HETEROTROPHS (must get food from environment);

-HERBIVORES: consume primary producers (e.g. insects, snails, grazing animals, seed-eating & fruit-eating birds and mammals)

Trophic Relationships in Ecosystems

3) SECONDARY CONSUMERS:

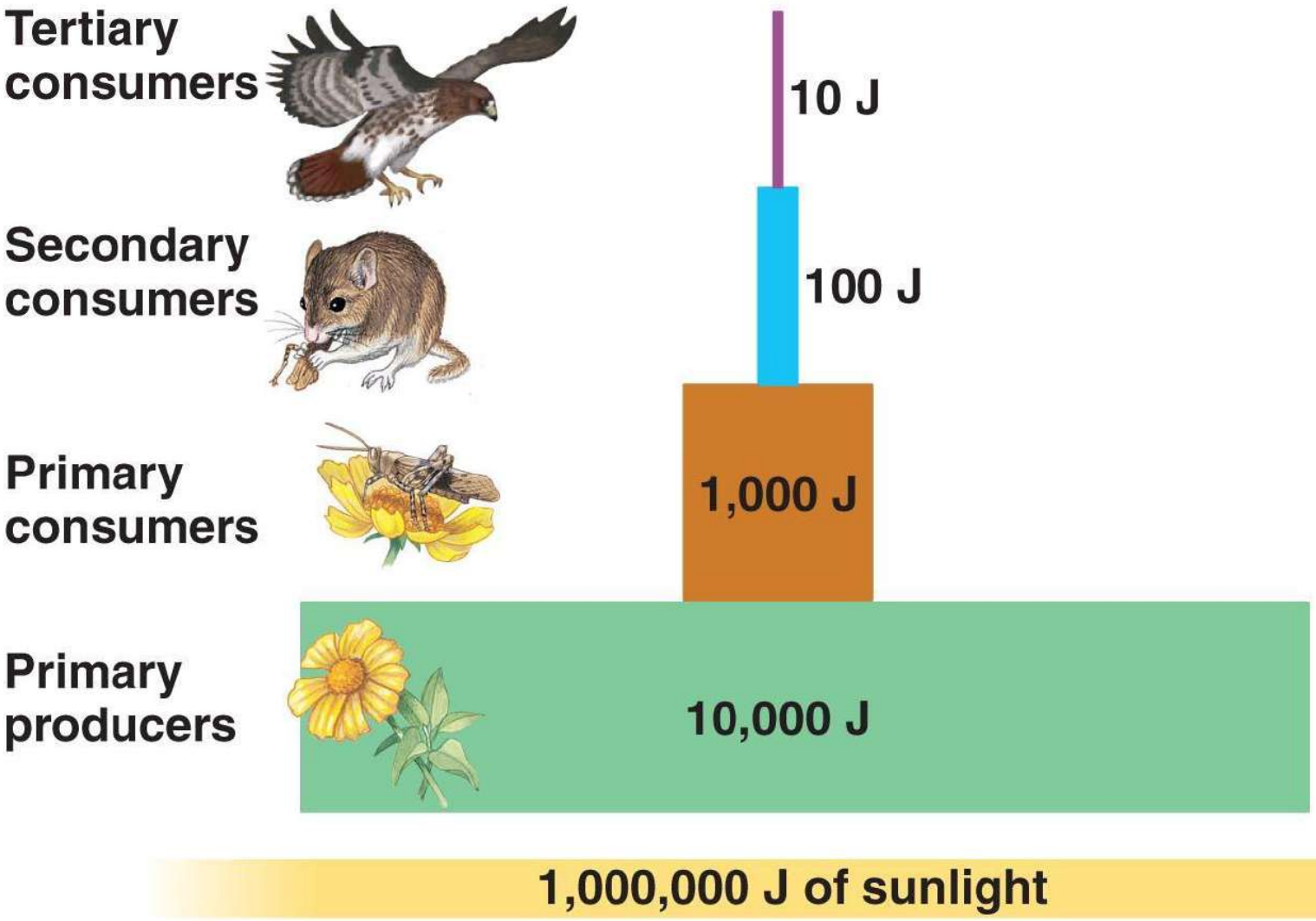
-CARNIVORES; "meat-eaters"; eat herbivores (e.g. spiders, frogs, insect-eating birds, carnivorous mammals, etc.)

Trophic Relationships in Ecosystems

4) TERTIARY CONSUMERS:

carnivores that eat other carnivores

-(e.g. hawk that eats snake that eats mouse)



Trophic Relationships in Ecosystems

also…

OMNIVORES: eat a variety of plant and animal food sources

EX: humans

SCAVENGERS: eat animals that have already died

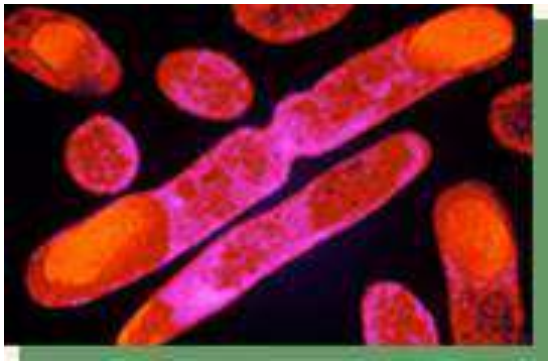
EX: vultures, buzzards, ants, beetles

Trophic Relationships in Ecosystems

5) **DECOMPOSERS**:

feed off of and break down dead materials, including feces;

(e.g.: fungi, bacteria)



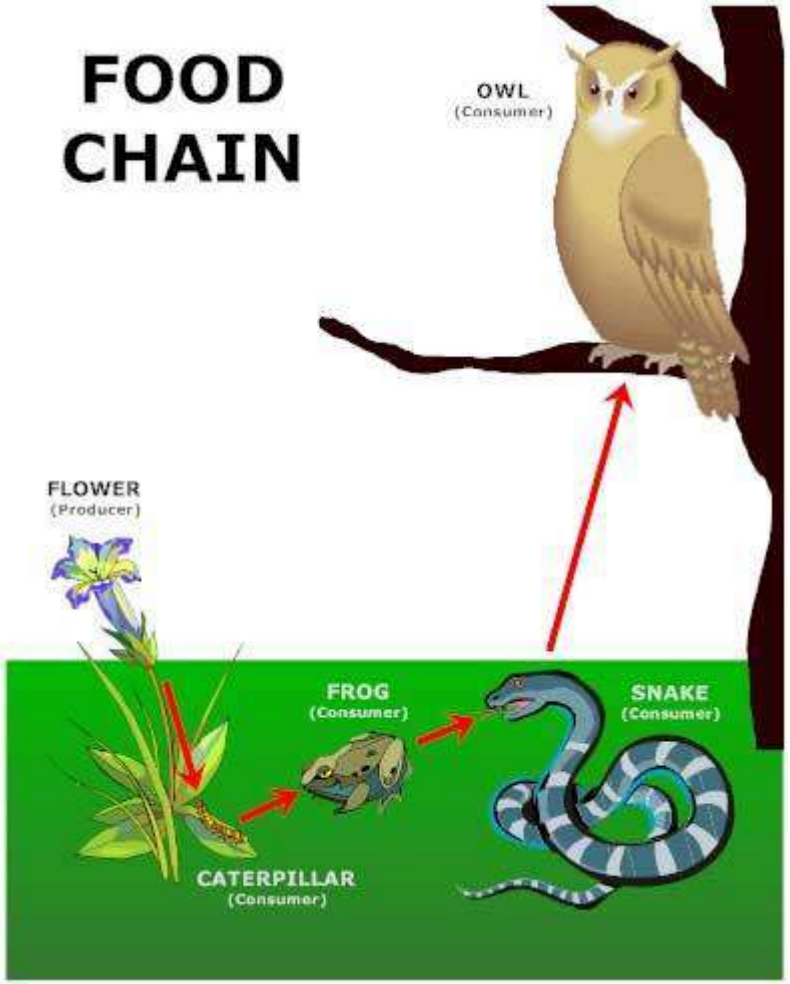
Trophic Relationships in Ecosystems

6) **DETRITOVORES**: feed on detritus particles, chewing or grinding them into even smaller pieces (e.g.: earthworms, mites, snails)

FLOW OF ENERGY:

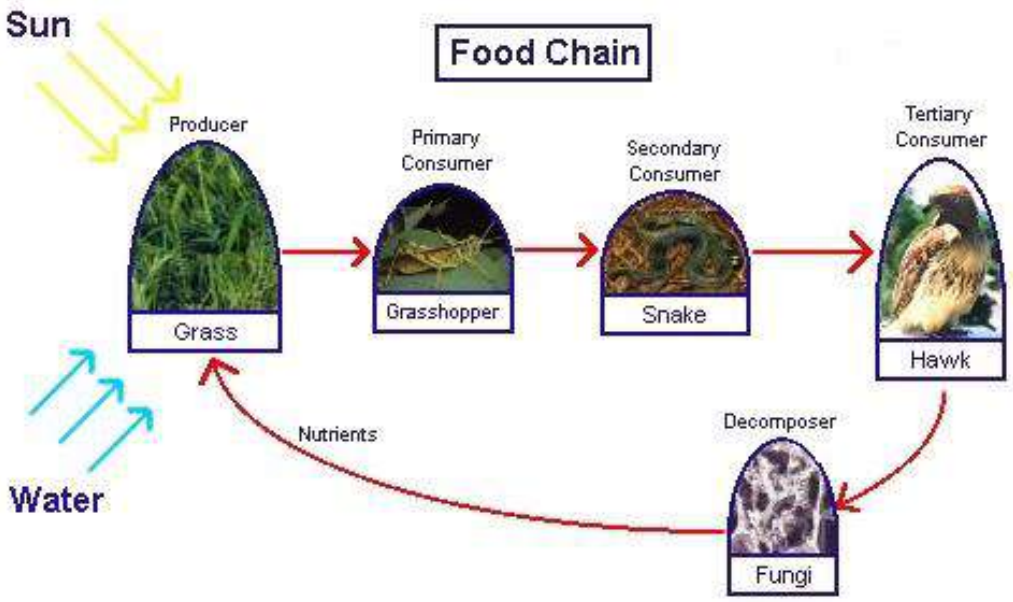
Energy flows through an ecosystem from the sun, to producers, to consumers to decomposers

IN ONE DIRECTION!!!

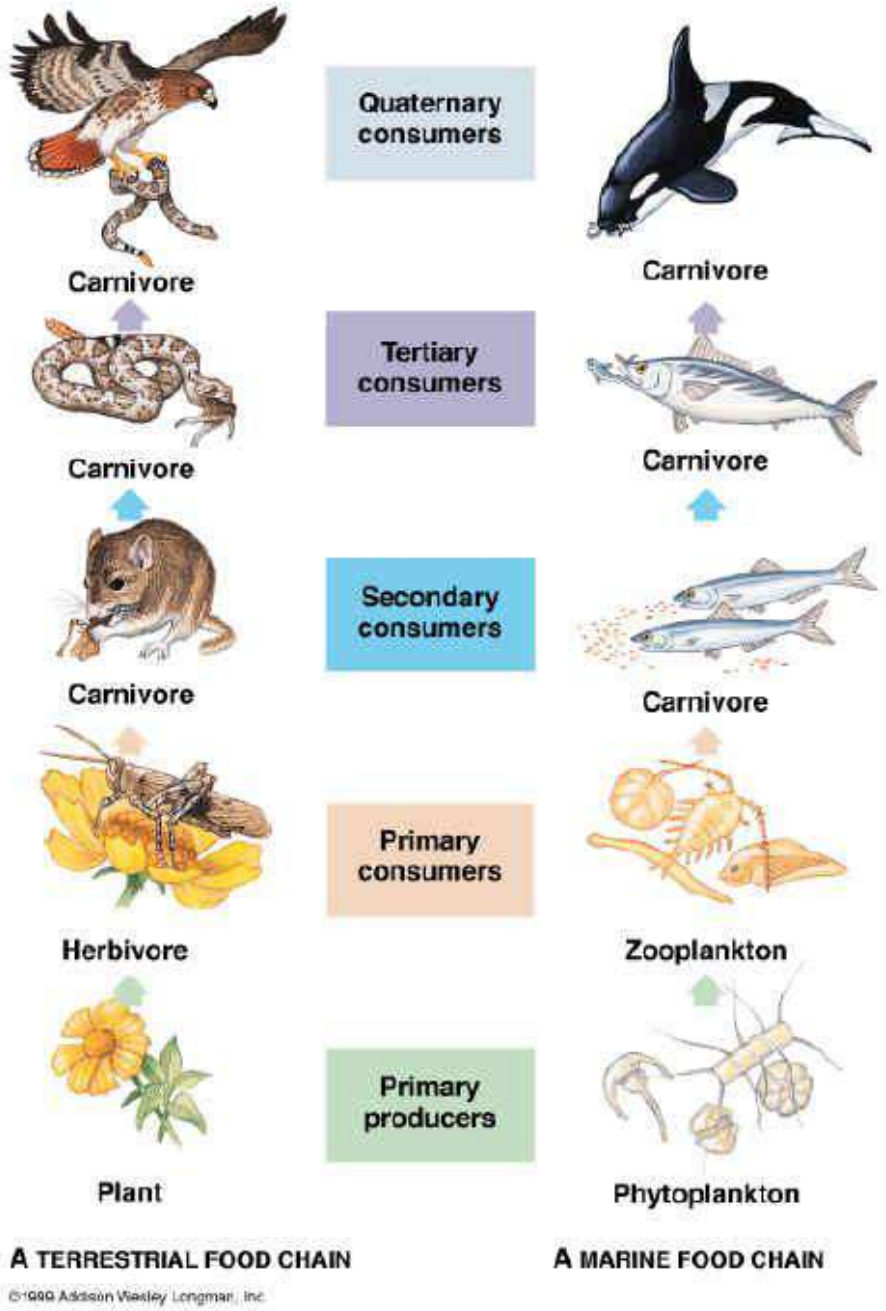


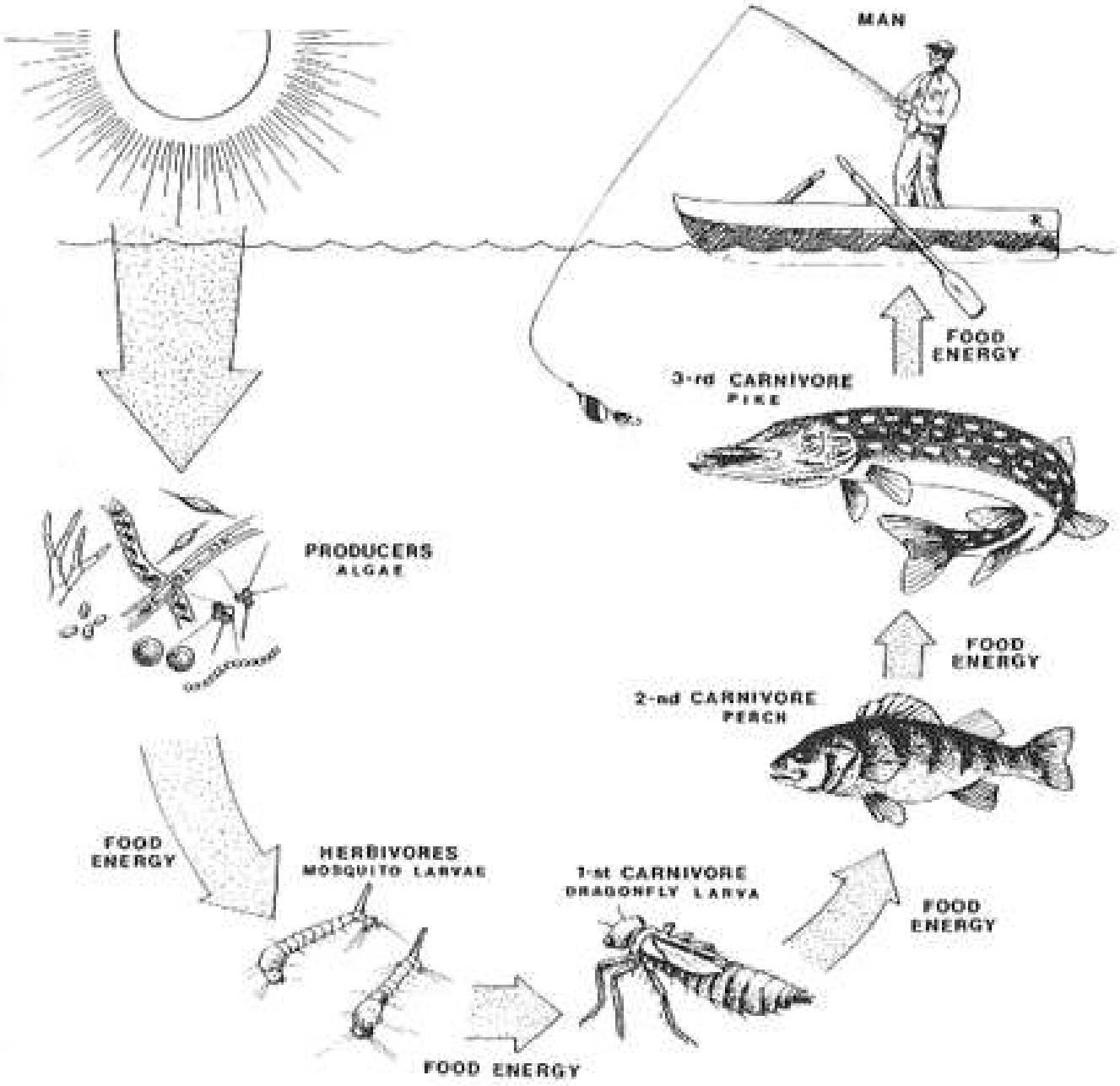
FOOD CHAINS

- **FOOD CHAIN**: the pathway along which food / energy is transferred from trophic level to trophic level, **beginning with the primary producers**



**arrows show the direction of energy flow!




MAN
FOOD ENERGY
3-rd CARNIVORE
PIKE
FOOD ENERGY
2-nd CARNIVORE
PERCH
FOOD ENERGY
1-st CARNIVORE
DRAGONFLY LARVA
FOOD ENERGY
HERBIVORES
MOSQUITO LARVAE
FOOD ENERGY
PRODUCERS
ALGAE
FOOD ENERGY

FOOD WEBS

- **FOOD WEB**: more elaborate pathway showing **ALL** feeding relationships

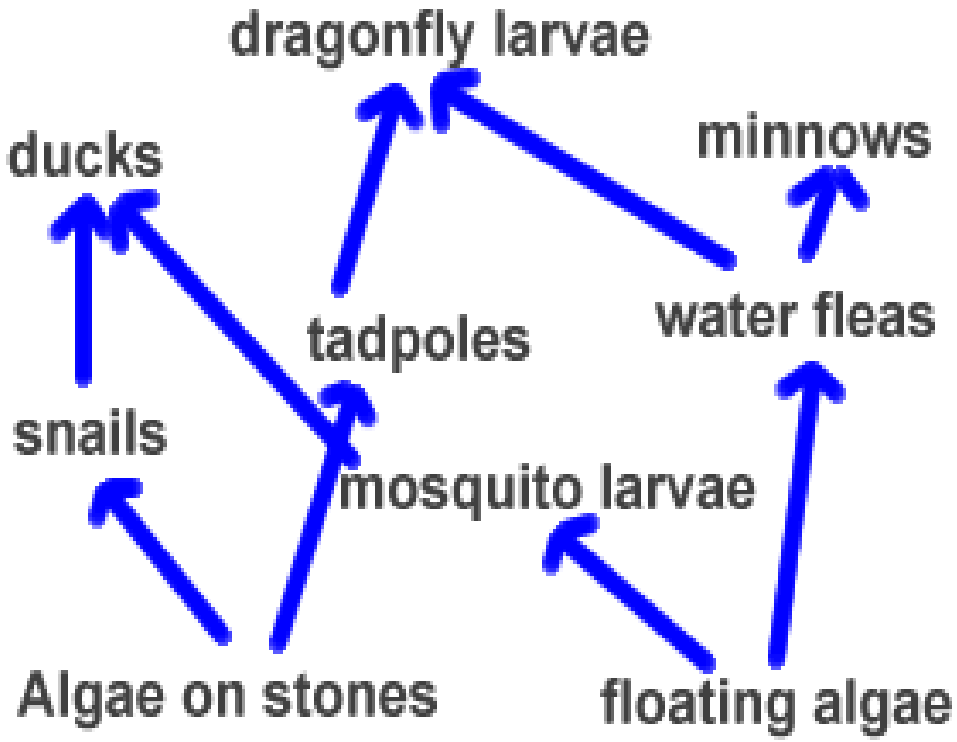
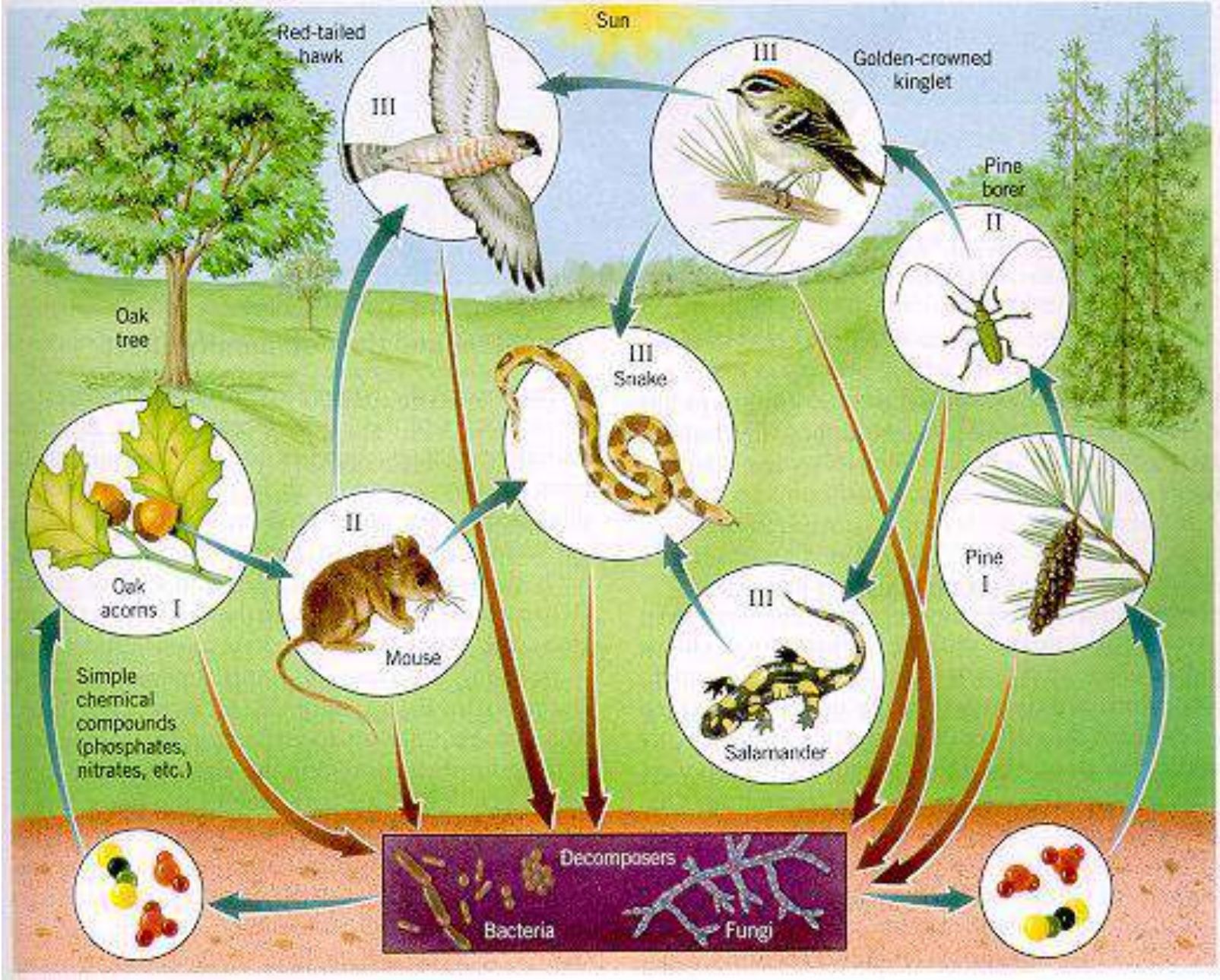
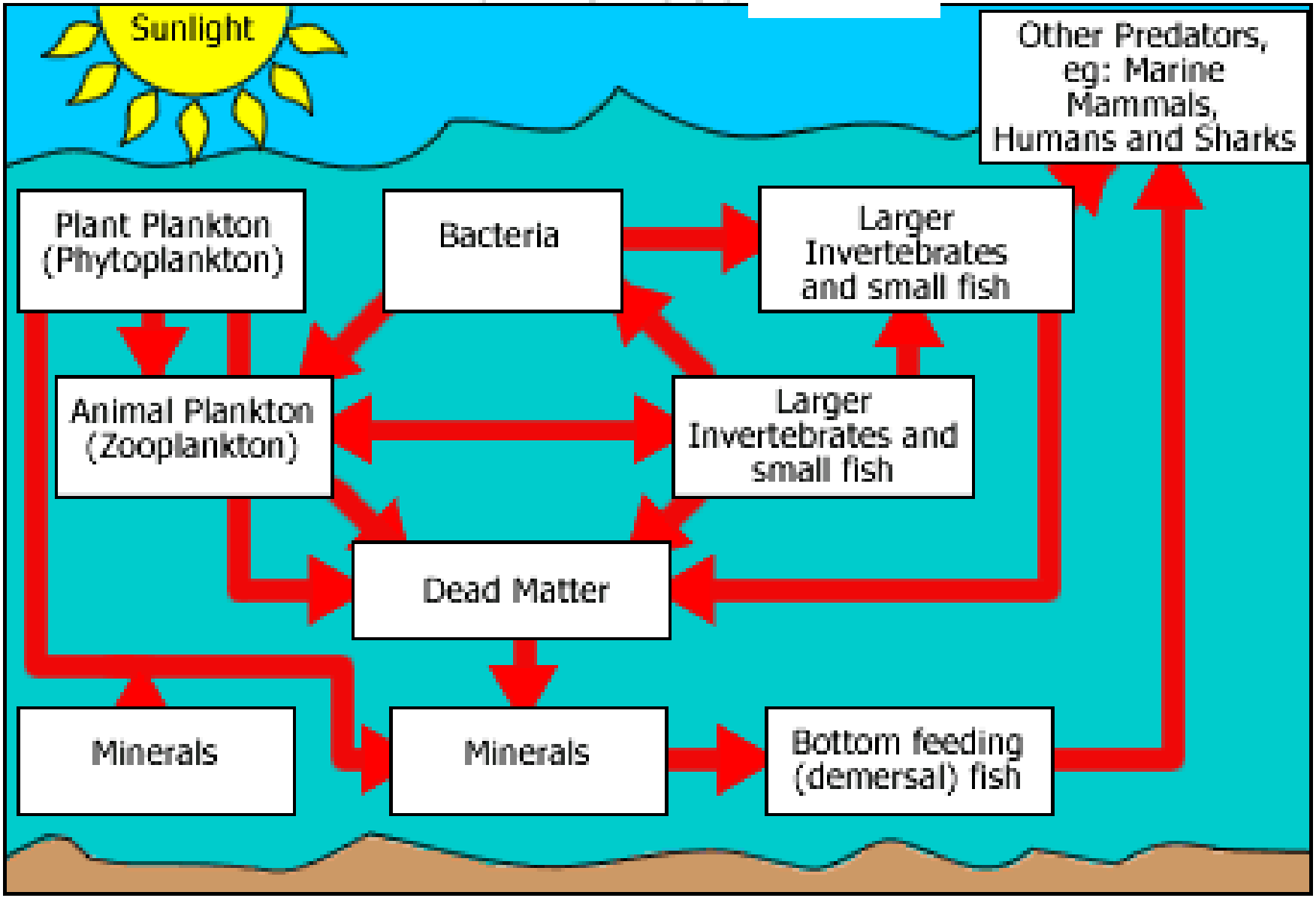
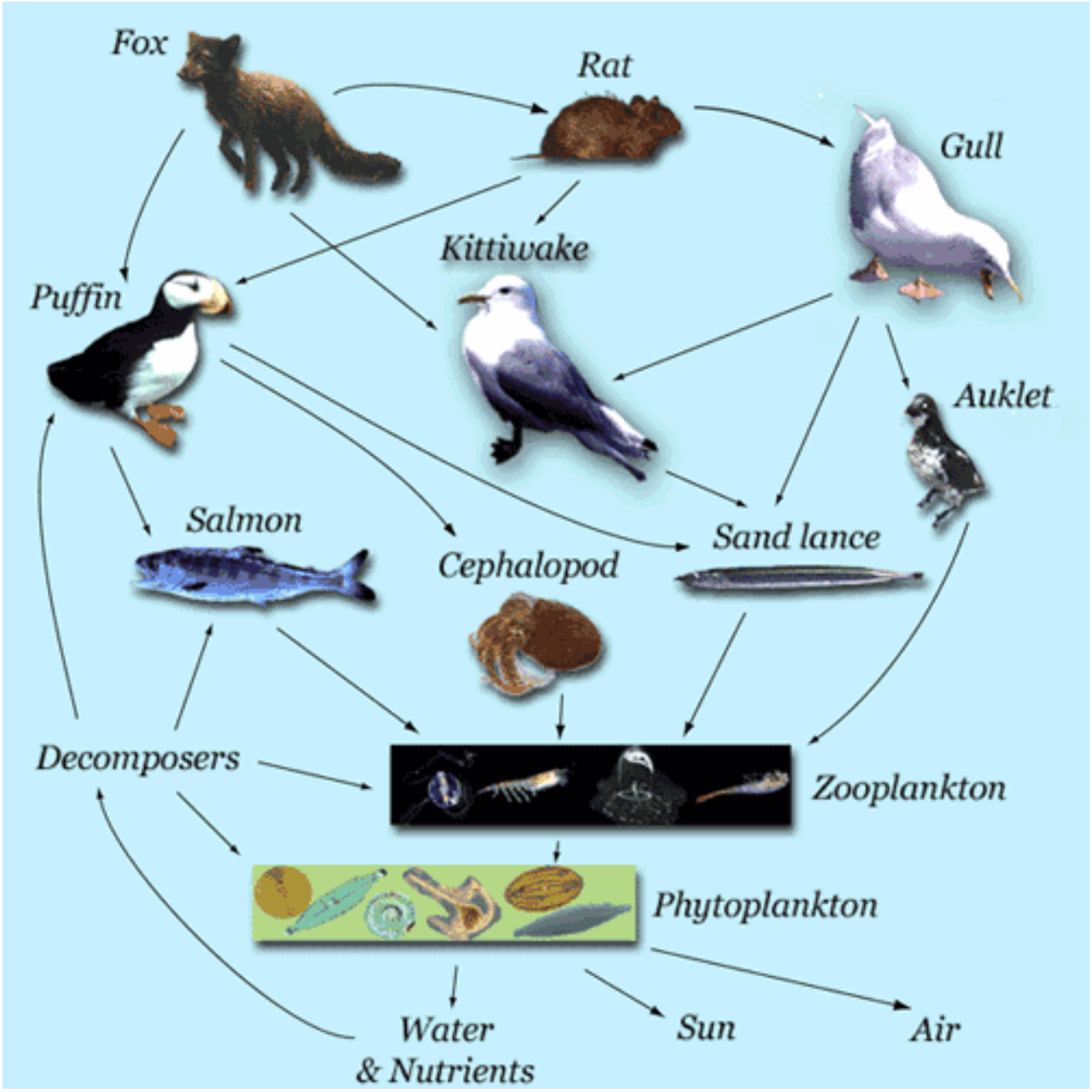


FIGURE 6.3 Food webs: (*a*) a typical terrestrial food web. Roman numerals identify trophic levels.



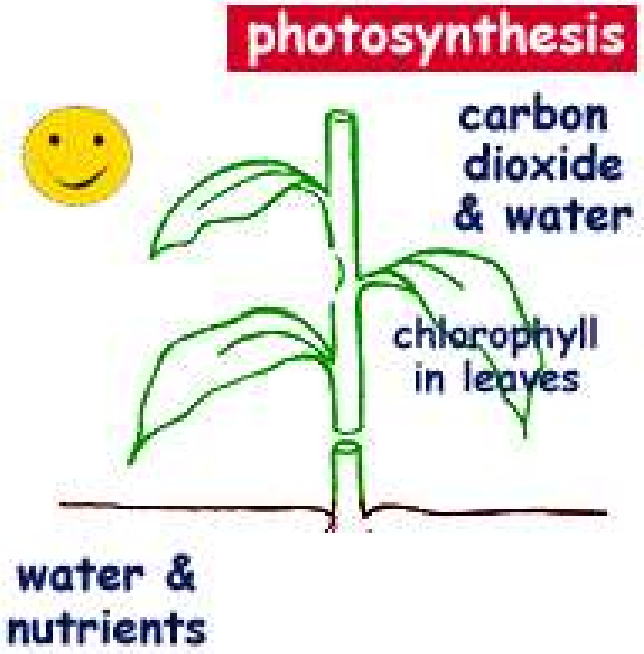
Marine Food Web



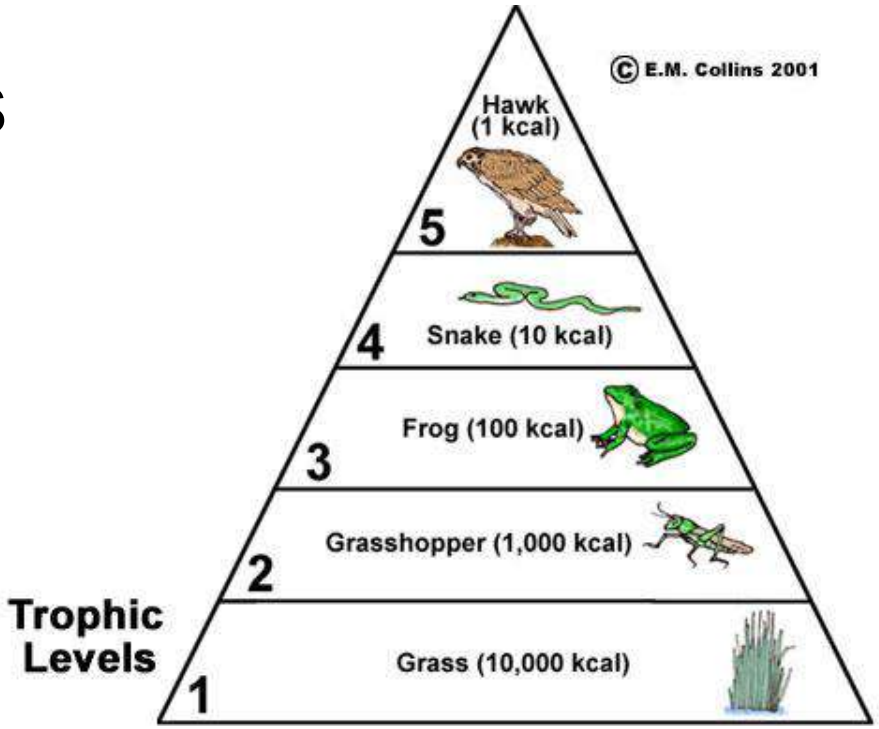

Fox
Rat
Gull
Kittiwake
Puffin
Auklet
Salmon
Cephalopod
Sand lance
Decomposers
Zooplankton
Phytoplankton
Water
& Nutrients
Sun
Air

ENERGY IN AN ECOSYSTEM

- an ecosystem's entire "energy budget" is determined by the **photosynthetic activity** of the system

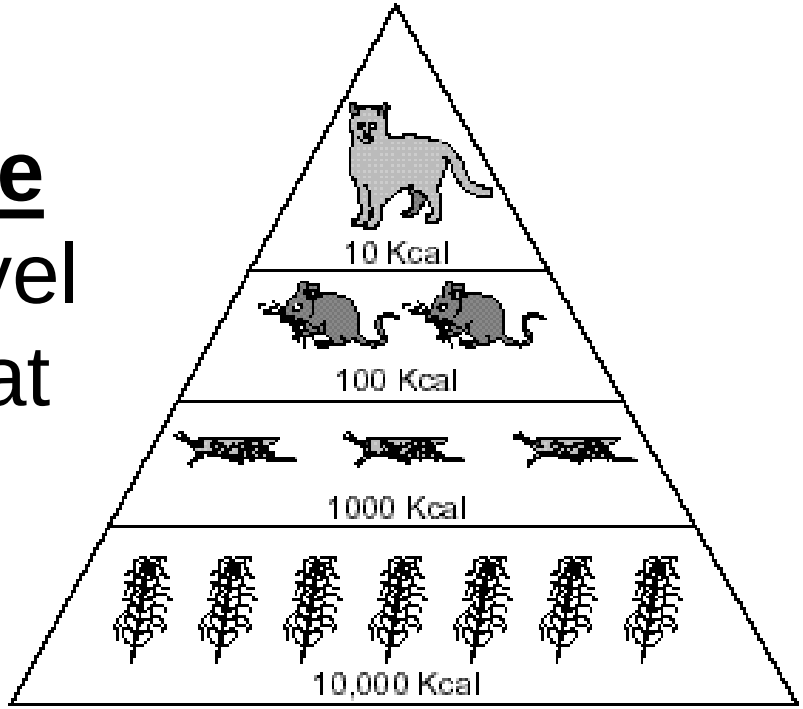


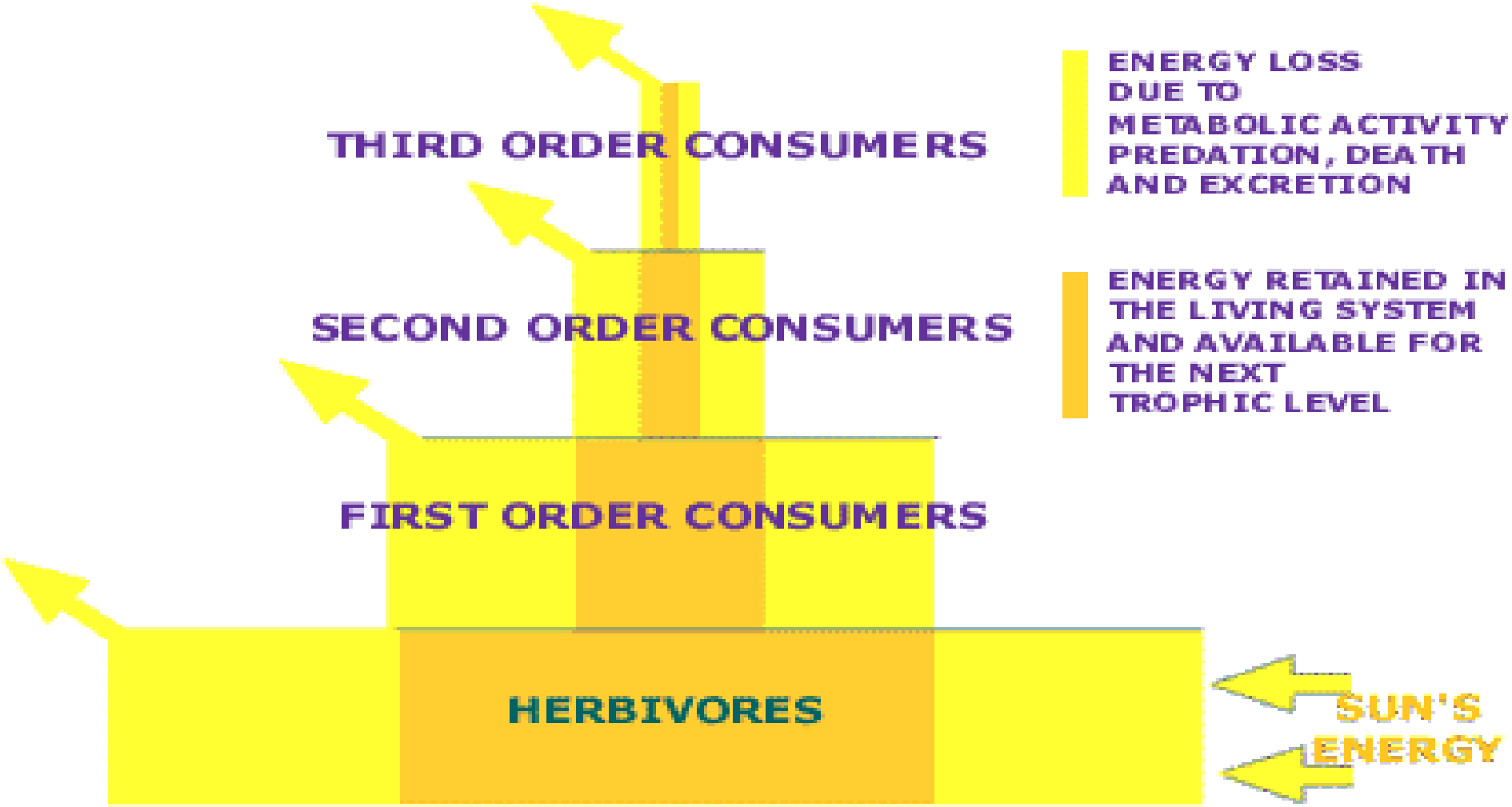
- at each higher trophic level, less and less of the original energy captured by producers is available
- ***WHY?*** Because some of the energy is used by the animal in daily activities (respiration, reproduction, heat, etc.)



- approximately **10% of the energy** at one trophic level can be used by animals at the next trophic level

  -ex: 10% of the plant's energy is stored in the tissues of **herbivores** (plant eating animals) & 10% of the energy in herbivores is stored in the tissues of **carnivores** (animal's that eat other animals)

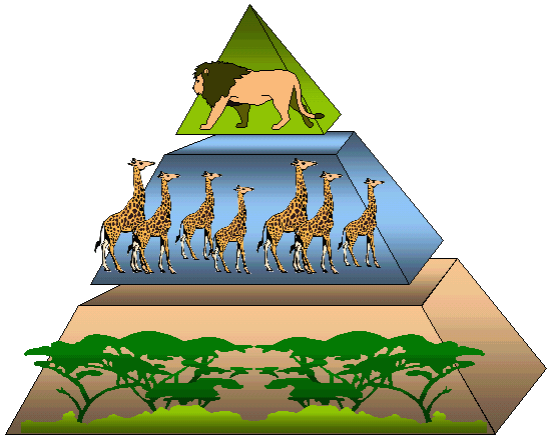



THIRD ORDER CONSUMERS
SECOND ORDER CONSUMERS
FIRST ORDER CONSUMERS
HERBIVORES
ENERGY LOSS DUE TO METABOLIC ACTIVITY PREDATION, DEATH AND EXCRETION
ENERGY RETAINED IN THE LIVING SYSTEM AND AVAILABLE FOR THE NEXT TROPHIC LEVEL
SUN'S ENERGY

ENERGY FLOW IN AN ECOSYSTEM

- only about 10% of the calories consumed by an organism is used for growth

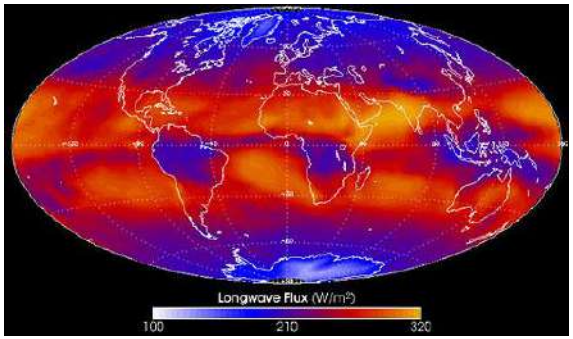
- the remaining food / energy consumed is used for cellular respiration or is passed out of the body as feces



ENERGY FLOW IN AN ECOSYSTEM

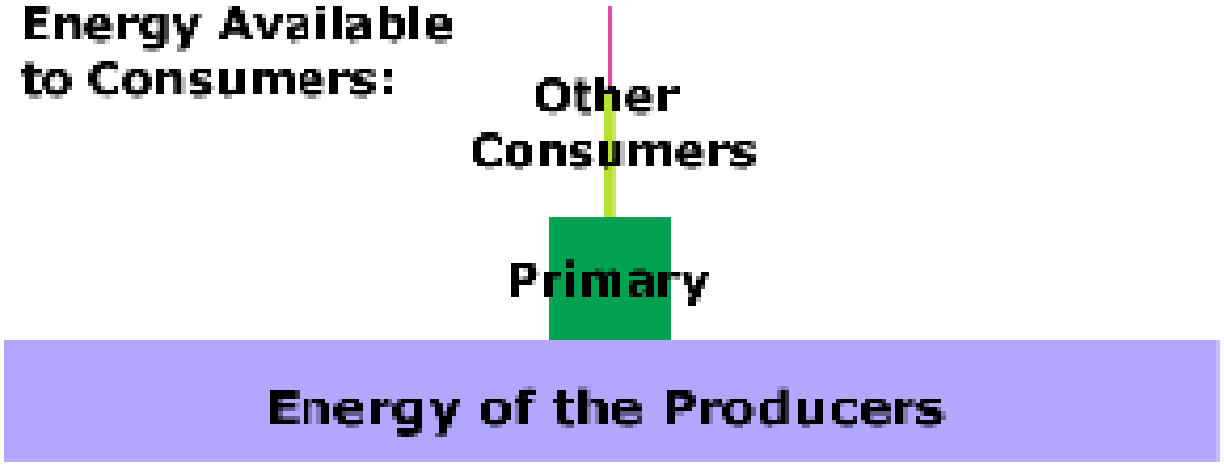
- The energy in the feces stays in the system and is consumed by detritovores & decomposers.

- The energy used in cellular respiration is lost from the system (<u>in the form of HEAT</u>).



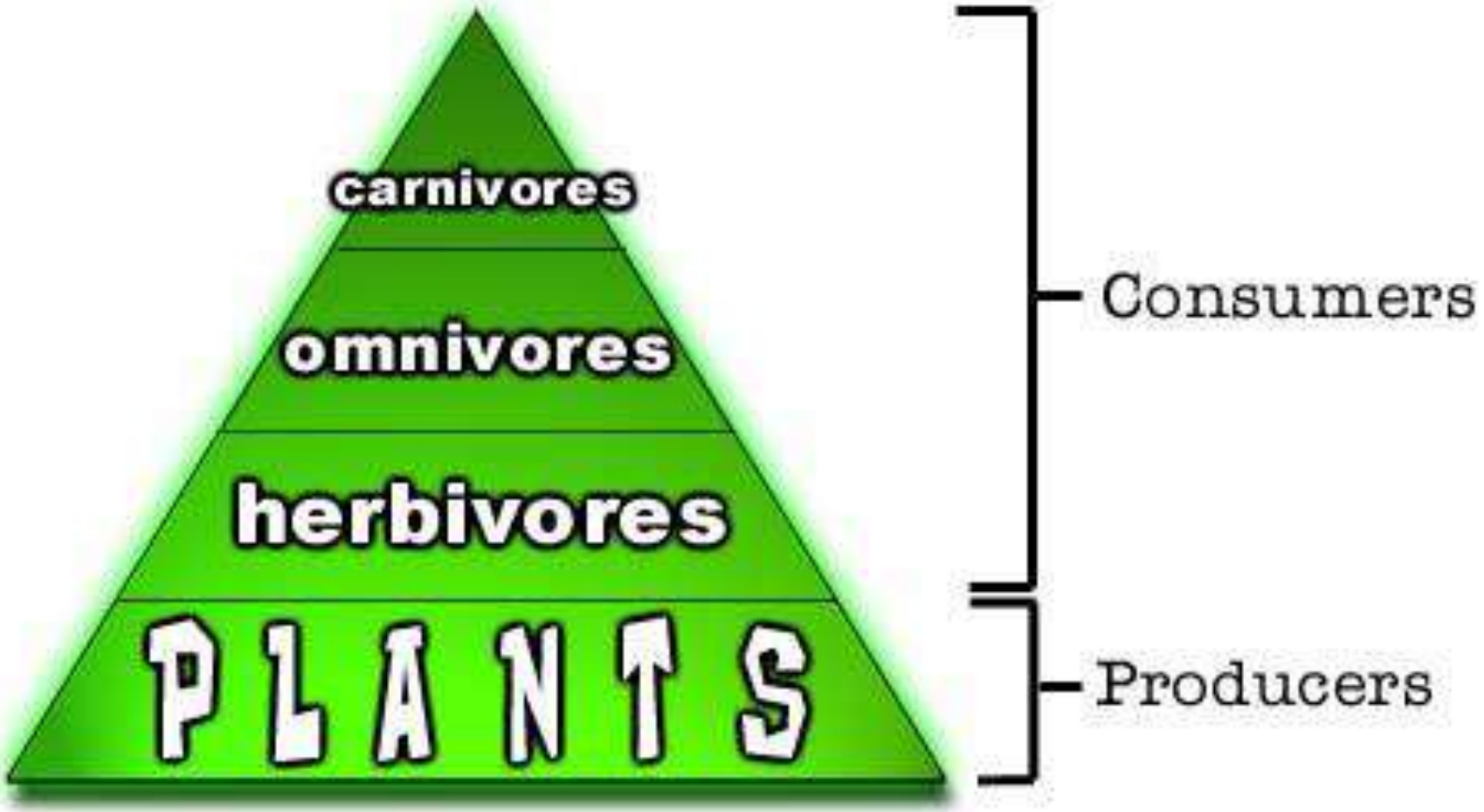
SO…

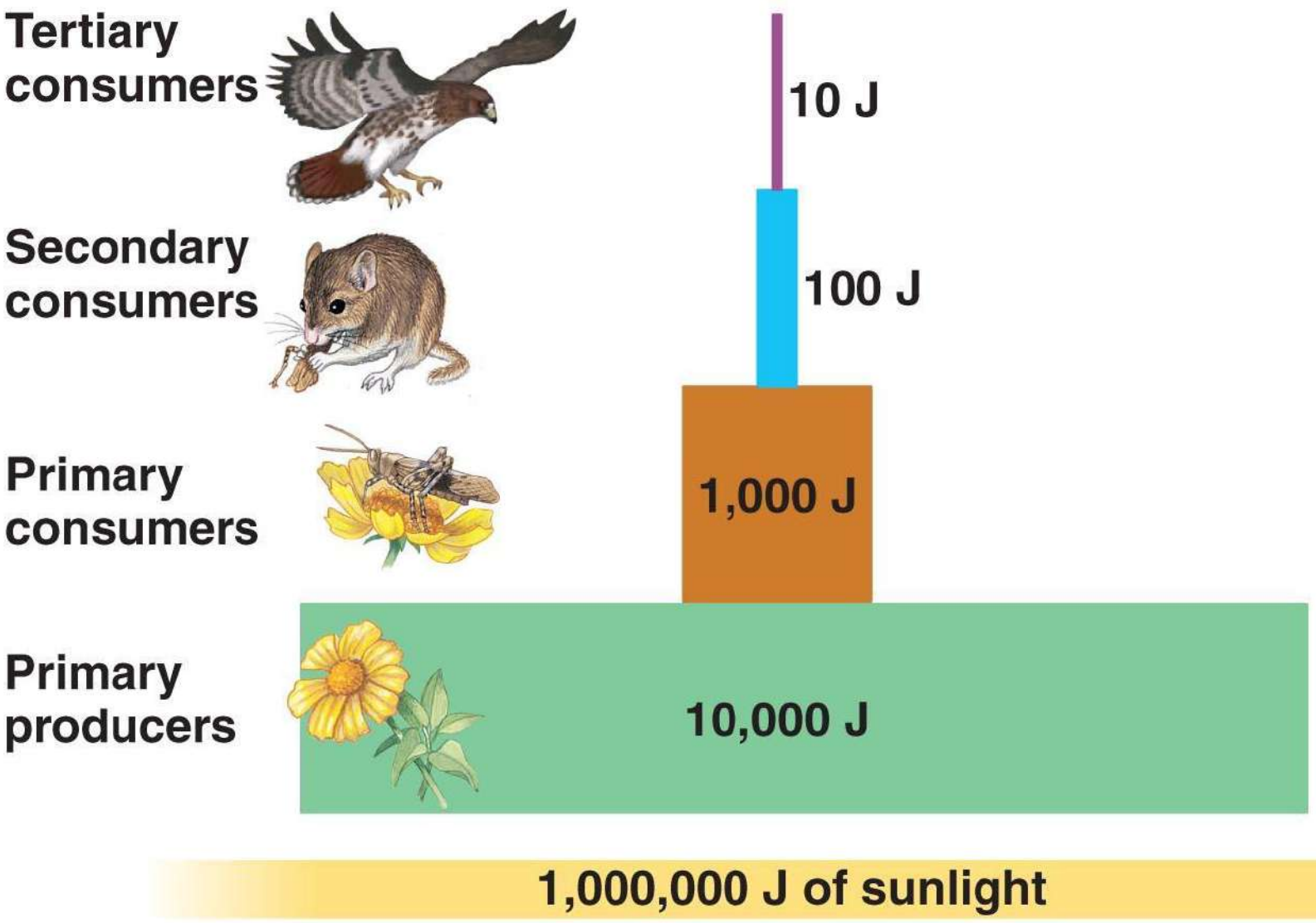
80-90% of the energy available at one trophic level ***NEVER TRANSFERS TO THE NEXT!!***



Pyramid of Energy

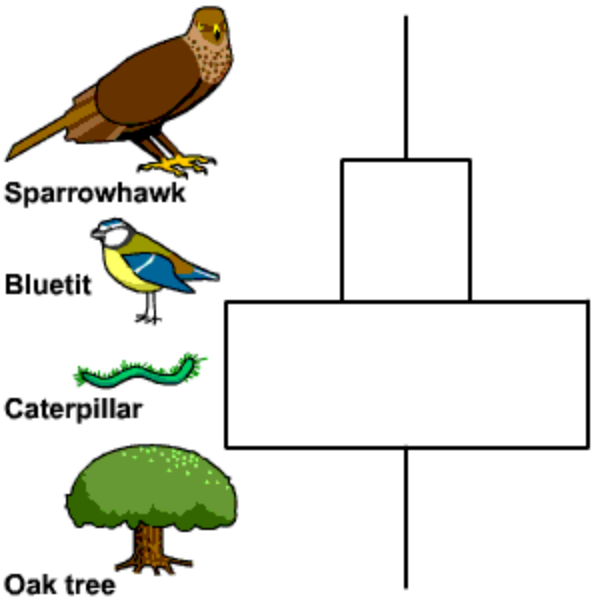
PYRAMID OF ENERGY: depicts the amount of energy available at each trophic level


carnivores
omnivores
herbivores
PLANTS
Consumers
Producers



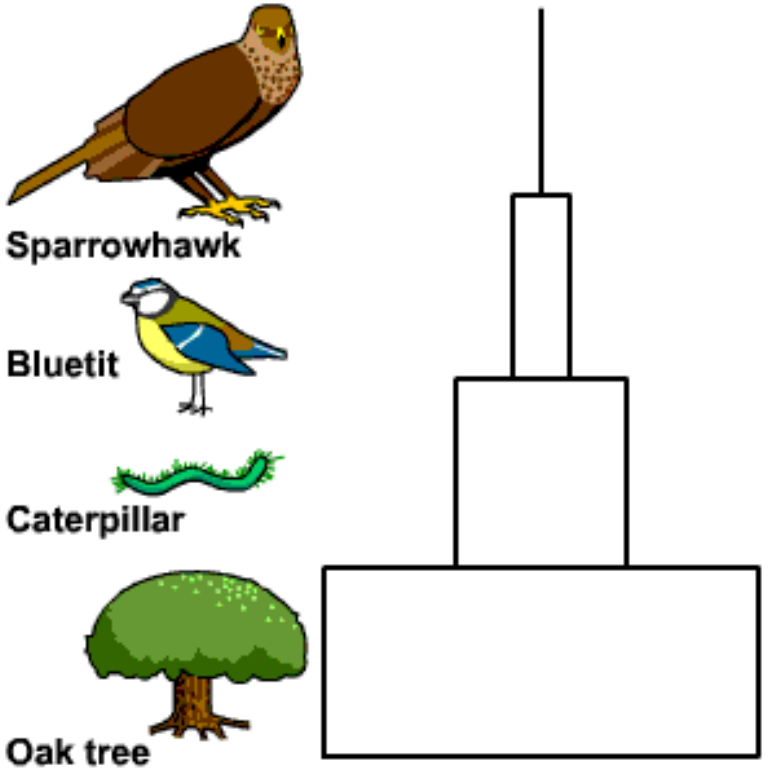
PYRAMID OF NUMBERS:

- based on the **population sizes** of organisms at each trophic level
- usually have big numbers at the base of the pyramid and small numbers at the top
- possible for these pyramids to be inverted (e.g. 1 tree can feed 50,000 insects)

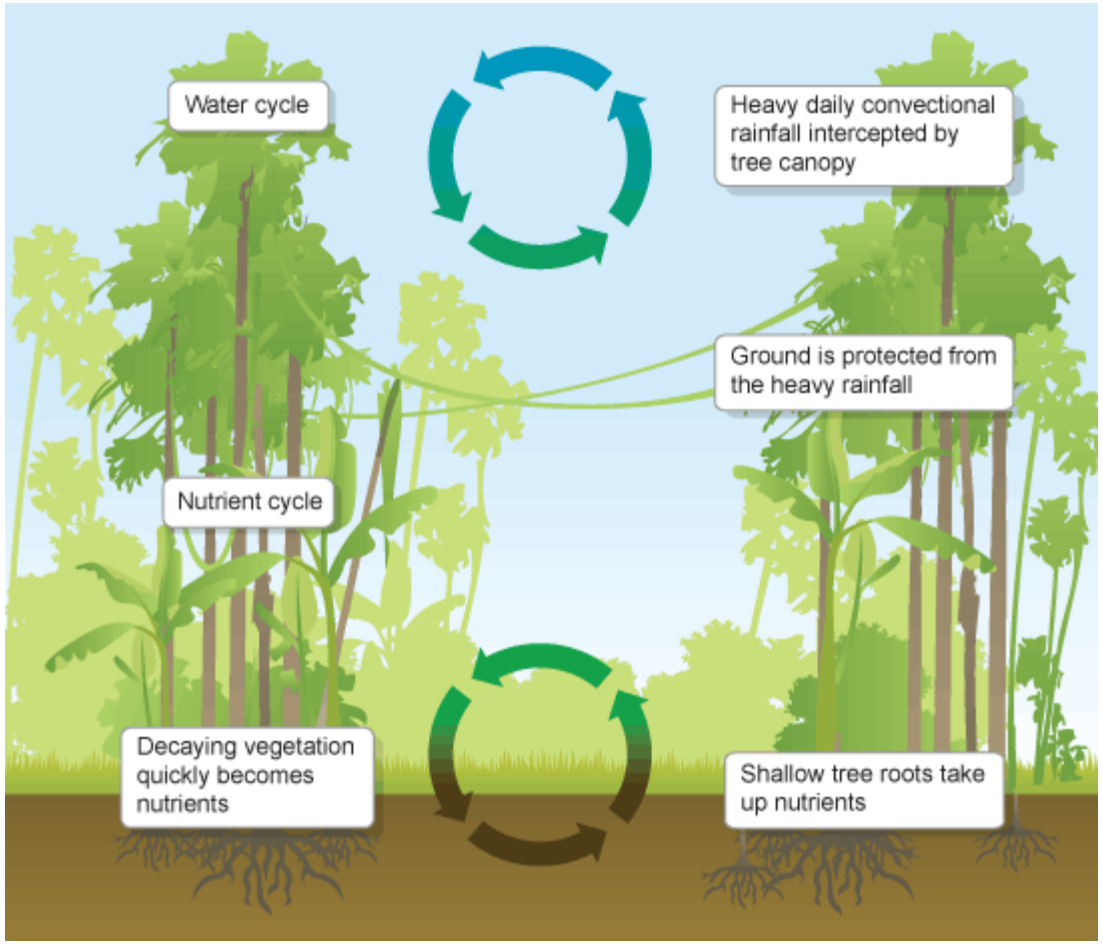


PYRAMID OF BIOMASS:

- expresses the **weight of living material** available at each trophic level



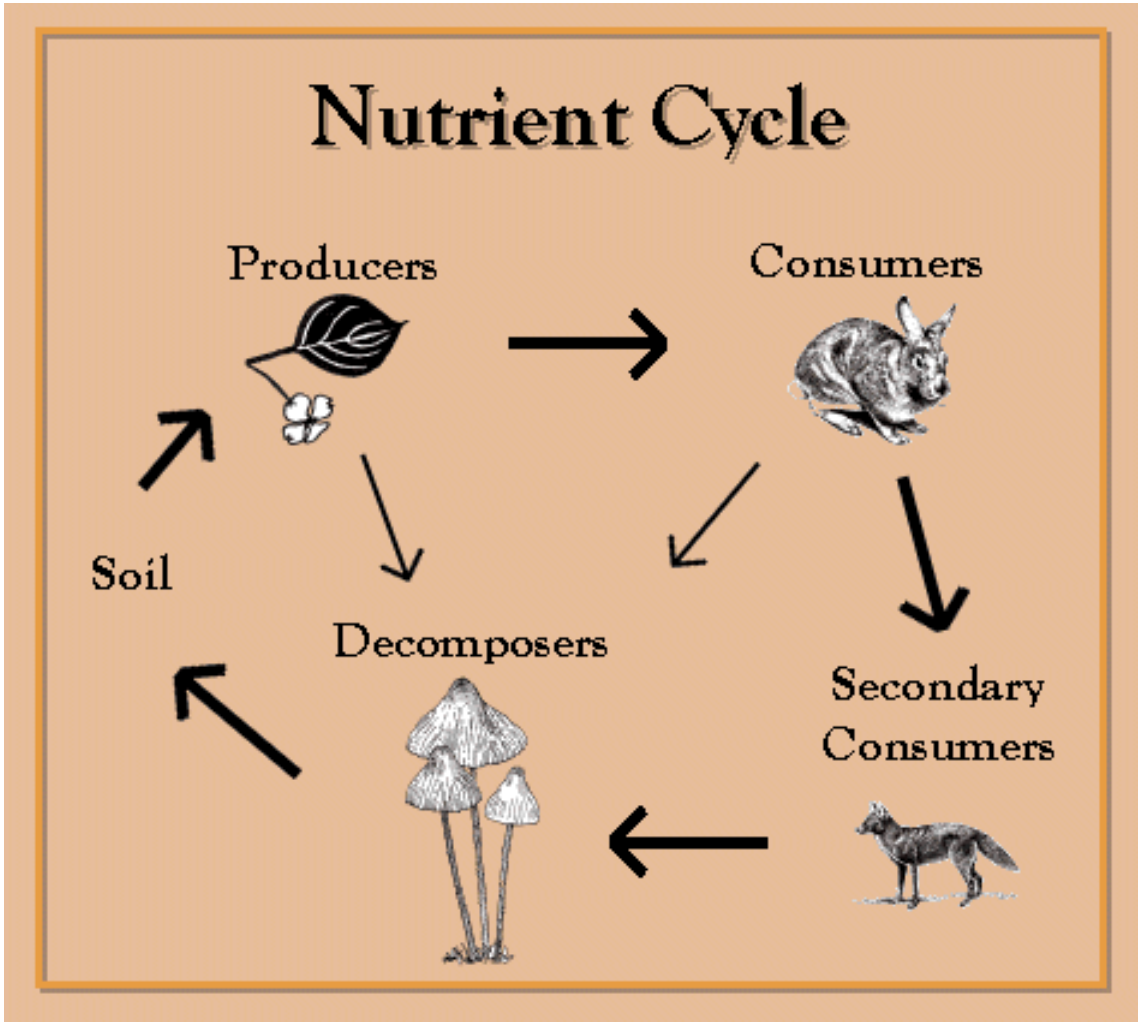
NOTES: 3.4 –
Cycles of Matter



VOCABULARY:

Nutrient cycles
Evaporation
Transpiration
Condensation
Precipitation
Infiltration
Assimilation
Denitrification
Nitrogen fixation

- although energy moves in a one-way direction through an ecosystem, **<u>nutrients are recycled!</u>**



NUTRIENT CYCLES

- Minerals are also moved through trophic levels but they cannot be replenished by the sun…

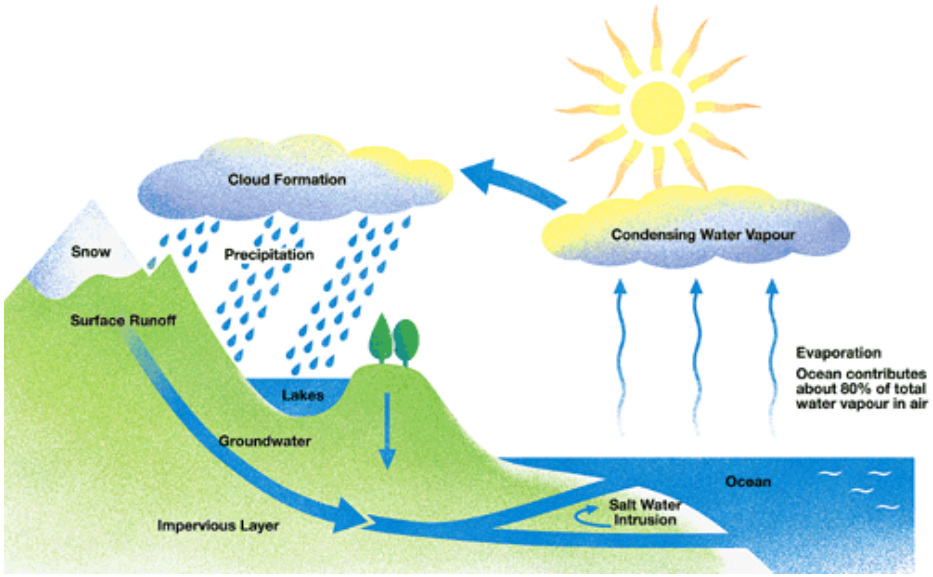
  -therefore minerals need to be recycled

  -this is done by:

  - **Water cycle**
  - **Nitrogen cycle**
  - **Carbon cycle**
  - **Phosphorus cycle**

WATER CYCLE:

- Life depends on water
- 6 steps to the water cycle
  - **-Precipitation**
  - **-Evaporation**
  - **-Transpiration**
  - **-Condensation**
  - **-Infiltration**
  - **-Runoff**

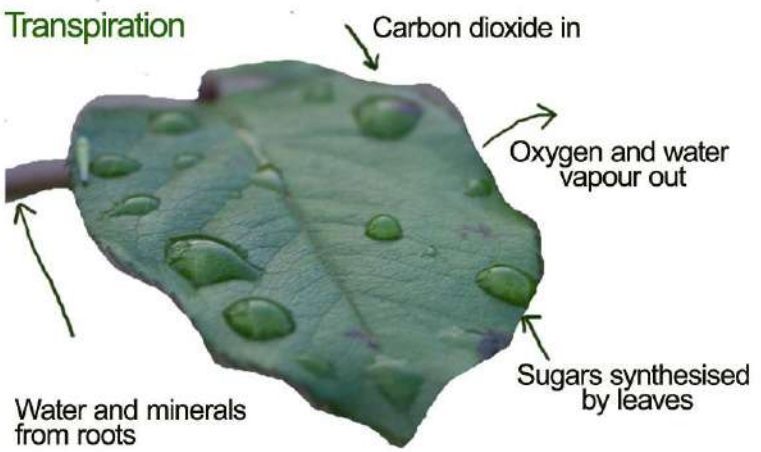


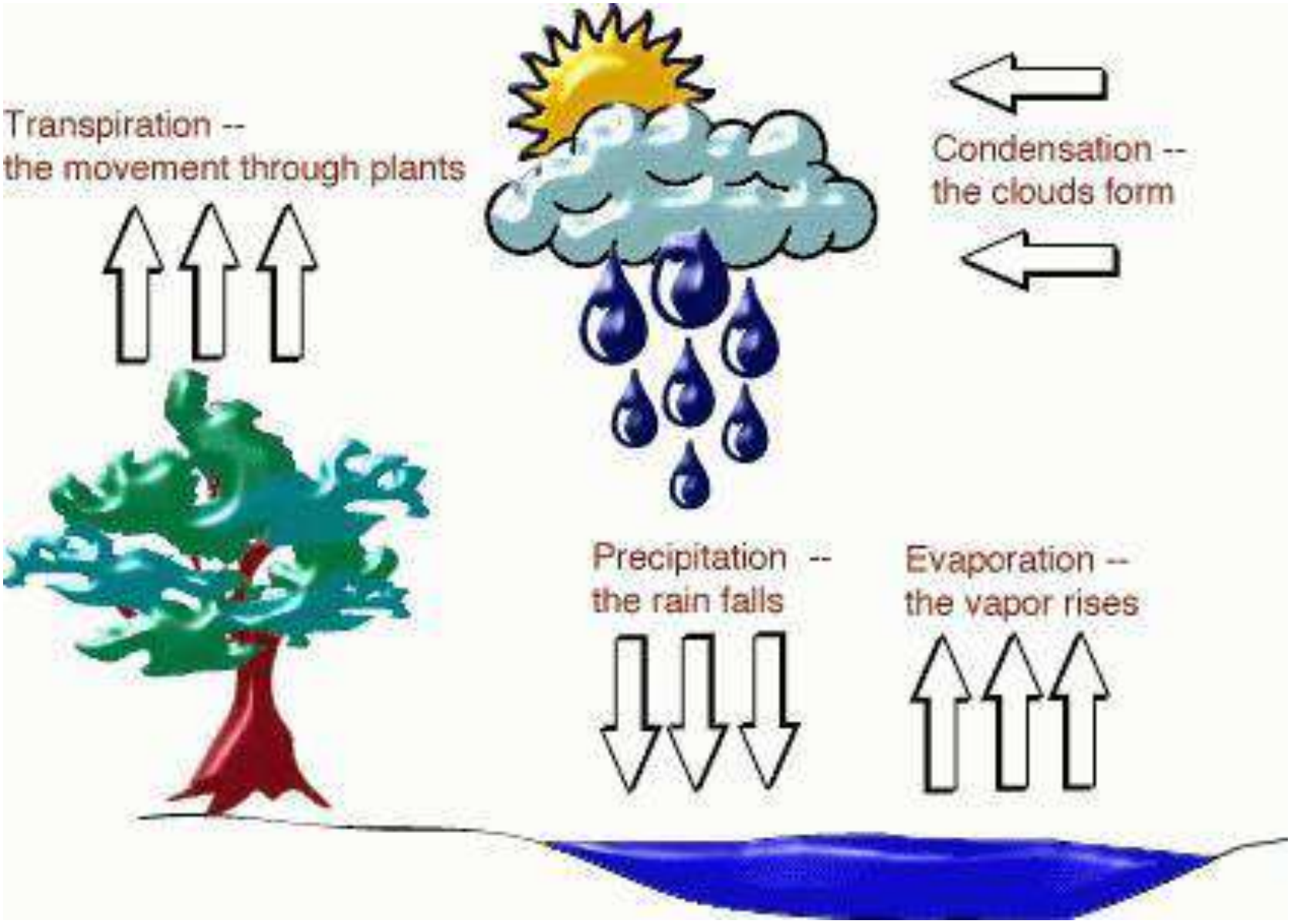
- **PRECIPITATION:**

  -falling products of condensation in the atmosphere

  -4 types
    - **Rain**
    - **Hail**
    - **Sleet**
    - **Snow**

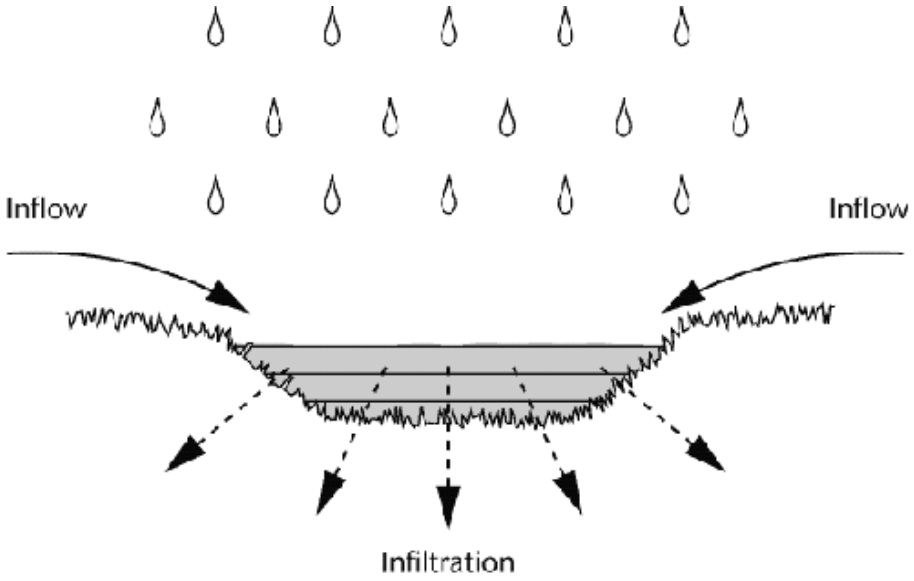
- **CONDENSATION:**
  -process where water vapor condenses to droplets to form clouds or fog
- **EVAPORATION:**
  -changing from a liquid to a gas (water vapor)
- **TRANSPIRATION:**
  -passage of water from plant leaf to atmosphere




Transpiration --
the movement through plants
Condensation --
the clouds form
Precipitation --
the rain falls
Evaporation --
the vapor rises

Water Cycle (cont.)

- **INFILTRATION:**
  - -seepage of water into rock or soil
  - -how water gets back into the ground
- **RUNOFF:**
  - -water that drains or flows into streams or other bodies of water



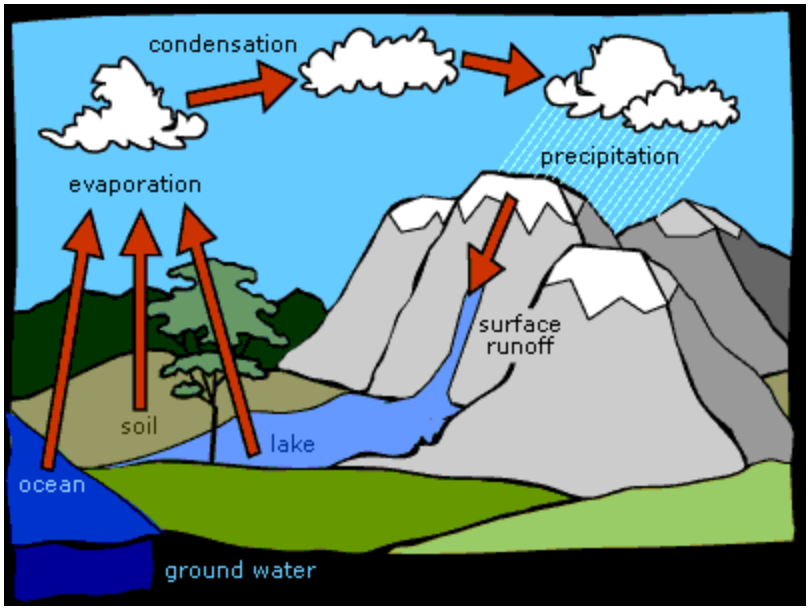
- Where does the water cycle start?

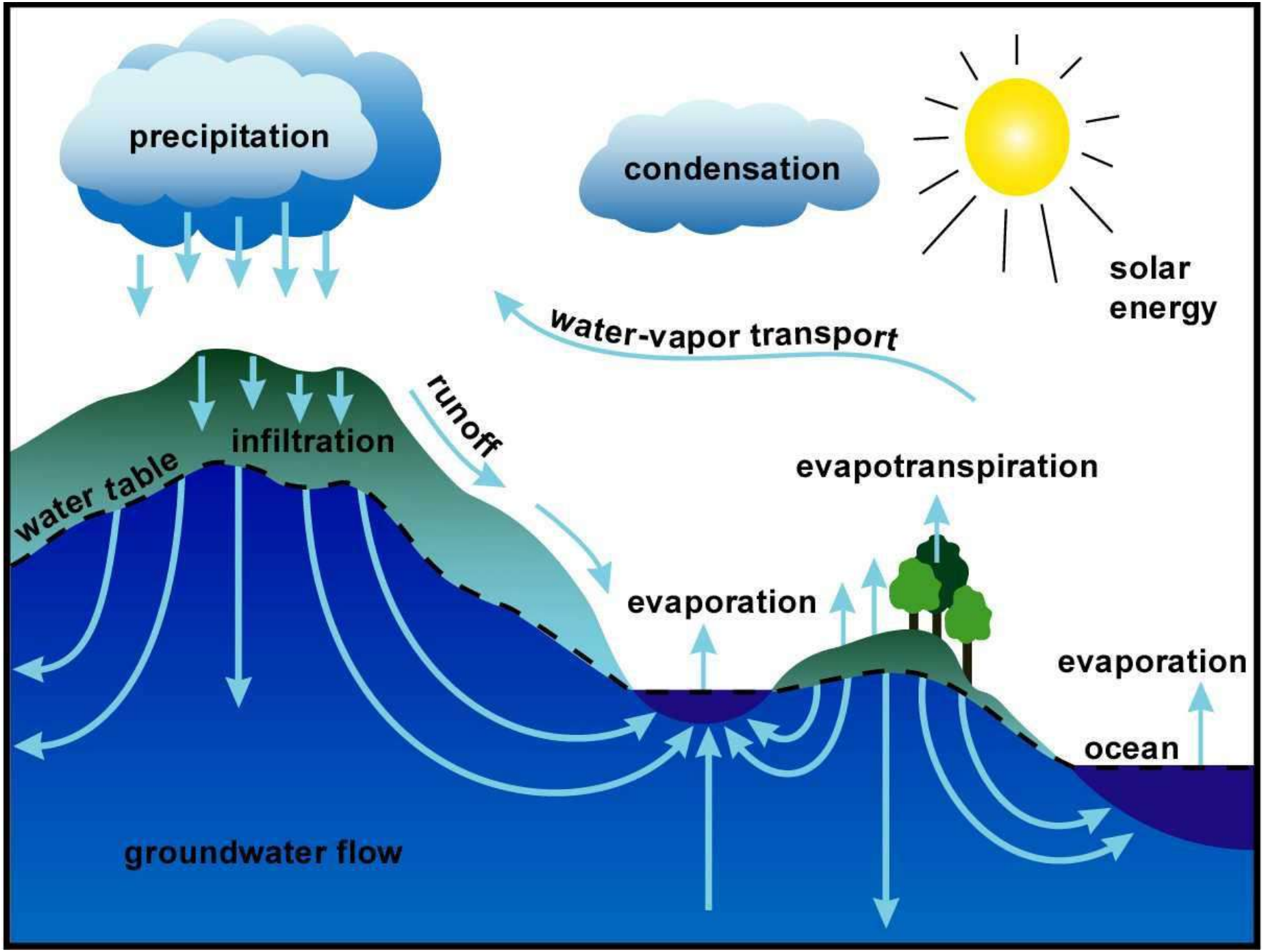
  -at any of the 6 stages

- Does the water cycle go in the same order?

  -No…

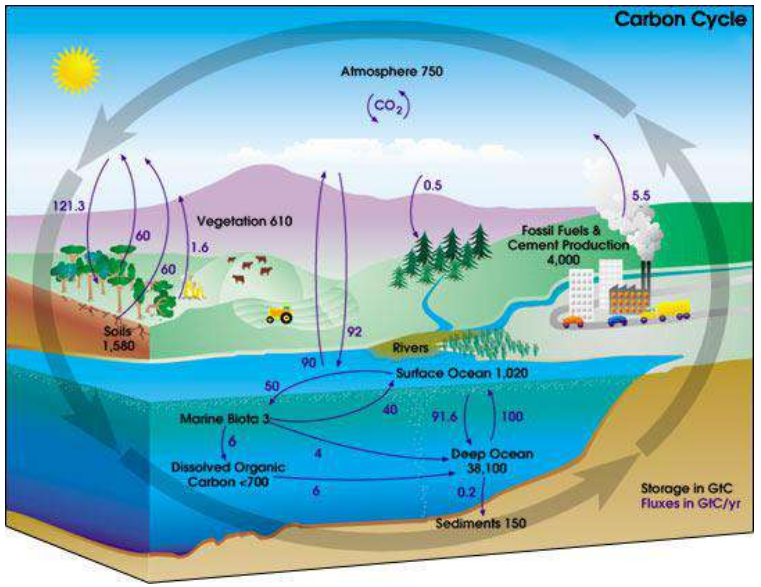
  - some water droplets stays frozen for years (glaciers, snow capped mountains)
  - some water droplets may evaporate then condense repeatedly
  - some water may stay in the ground for year (aquifers)…etc.




precipitation
condensation
solar
energy
water-vapor transport
runoff
infiltration
water table
evapotranspiration
evaporation
evaporation
ocean
groundwater flow

THE CARBON CYCLE:

- Carbon is the 4th most abundant element
- All organisms need carbon
- Not including water, people are about half carbon
- 3 ways carbon is moved through an ecosystem
  - -Photosynthesis
  - -Respiration
  - -Combustion

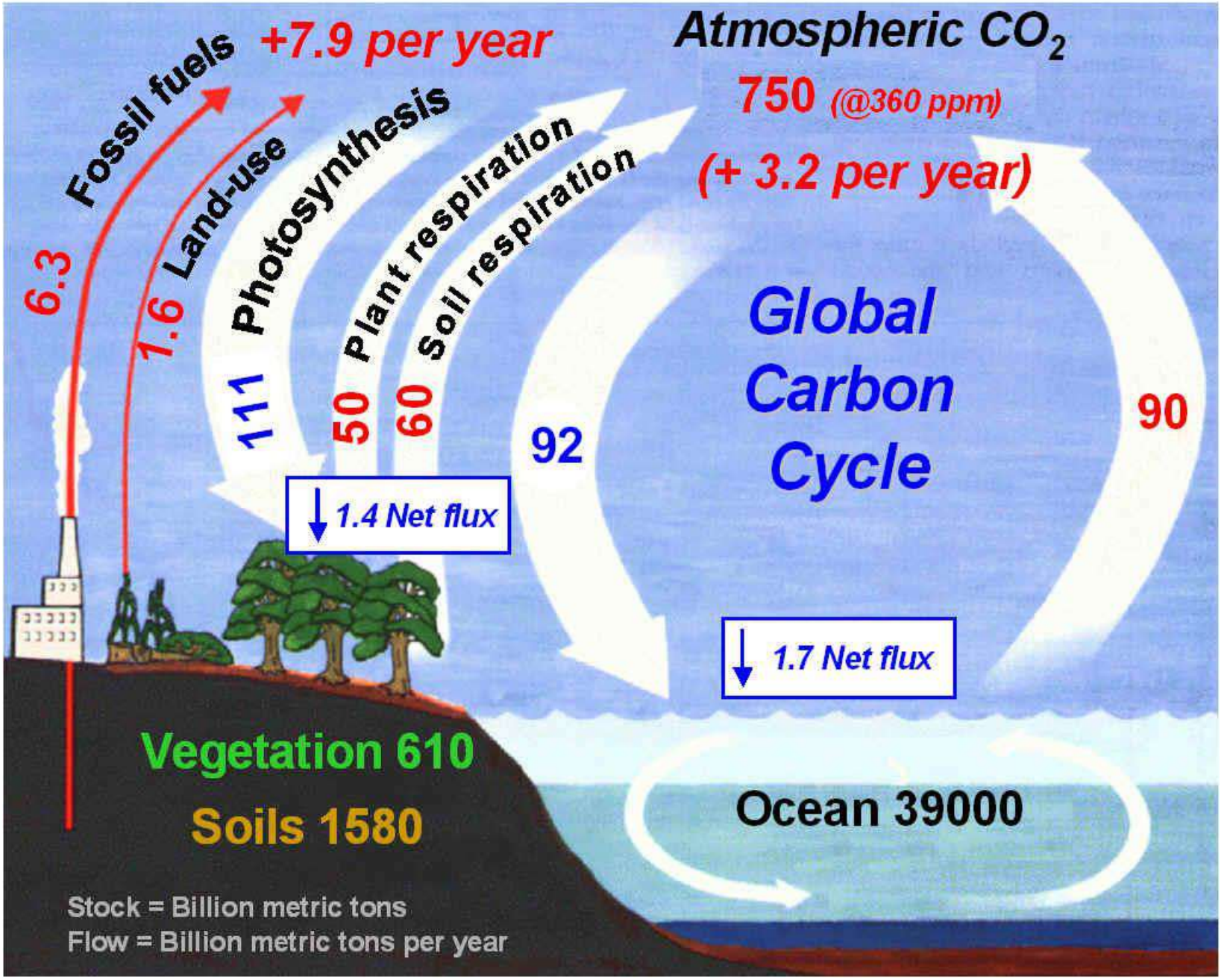


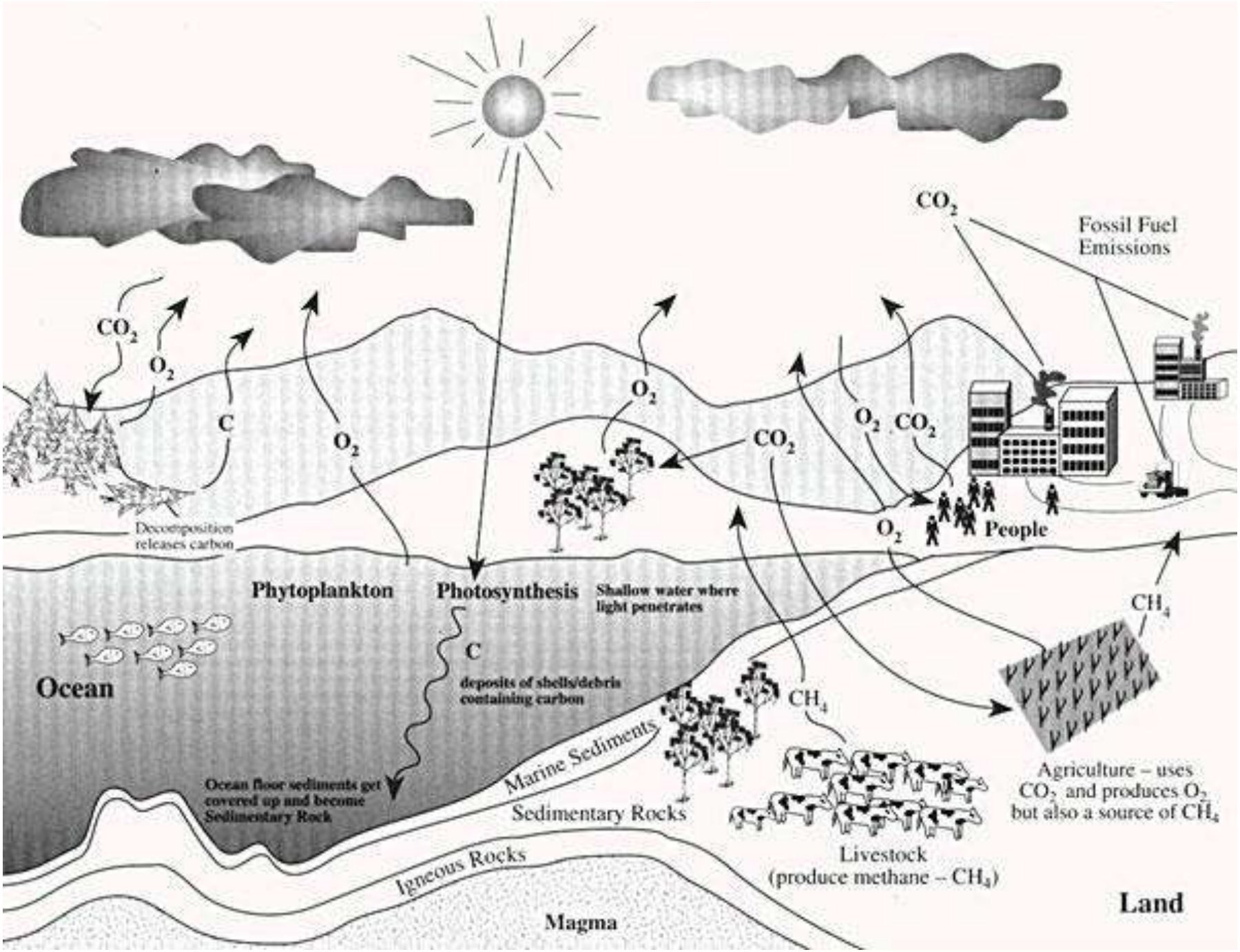
CARBON CYCLE:

- **PHOTOSYNTHESIS**: autotrophs take in CO_2 and convert solar energy into carbohydrates (sugar)

- **RESPIRATION**: cells break down glucose to release the energy and give off CO_2

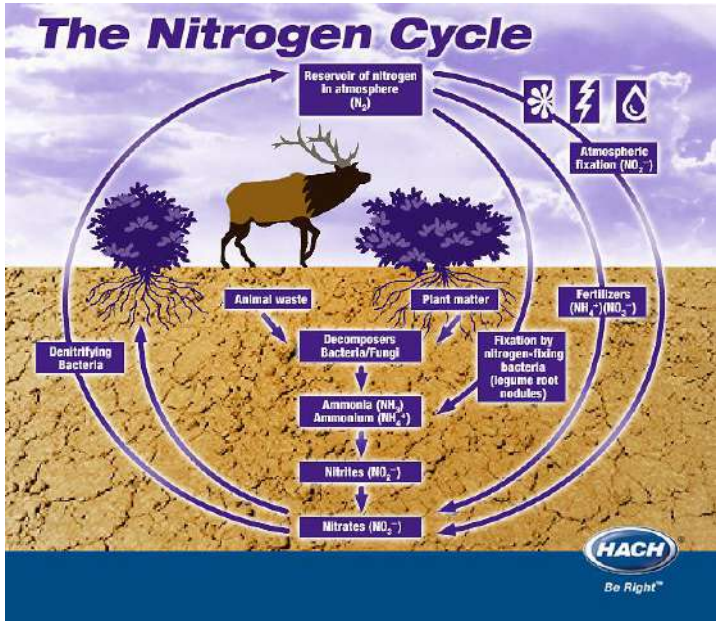
- **COMBUSTION**: burning

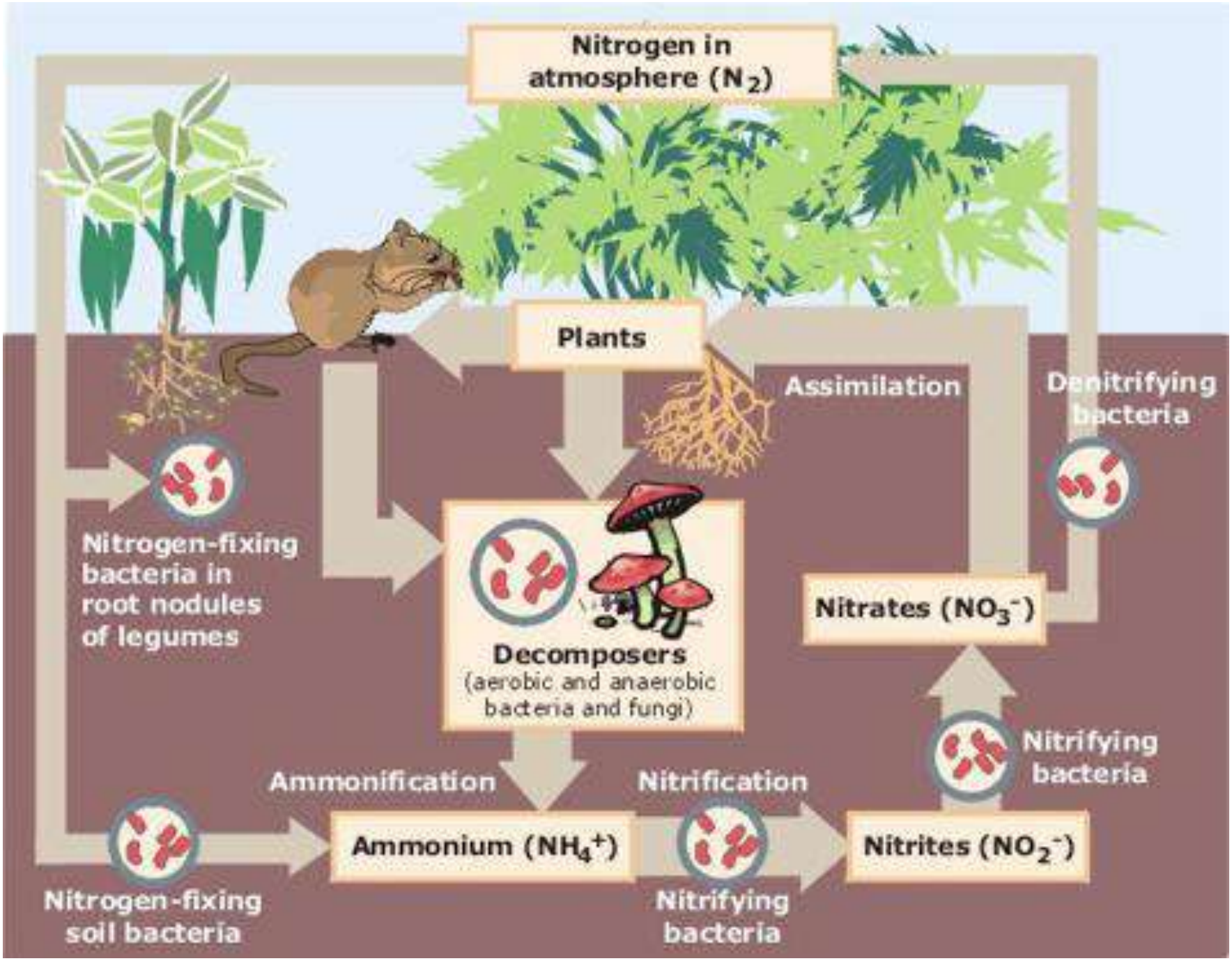

Fossil fuels
+7.9 per year
Atmospheric CO_2
750 (@360 ppm)
(+ 3.2 per year)
6.3
Land-use
1.6
Photosynthesis
111
Plant respiration
50
Soil respiration
60
92
90
Global Carbon Cycle
1.4 Net flux
1.7 Net flux
Vegetation 610
Soils 1580
Ocean 39000
Stock = Billion metric tons
Flow = Billion metric tons per year


CO_2
Fossil Fuel Emissions
CO_2
O_2
C
O_2
O_2
CO_2
O_2 CO_2
Decomposition releases carbon
O_2
People
Phytoplankton
Photosynthesis
Shallow water where light penetrates
CH_4
C
deposits of shells/debris containing carbon
Ocean
CH_4
Marine Sediments
Ocean floor sediments get covered up and become Sedimentary Rock
Sedimentary Rocks
Agriculture – uses CO_2 and produces O_2 but also a source of CH_4
Igneous Rocks
Livestock (produce methane – CH_4)
Land
Magma

NITROGEN CYCLE:

- 78% of the air is nitrogen;
- all organisms need nitrogen for structure and function;
- nitrogen in the air is not useable
- so how do organisms get the nitrogen they need?

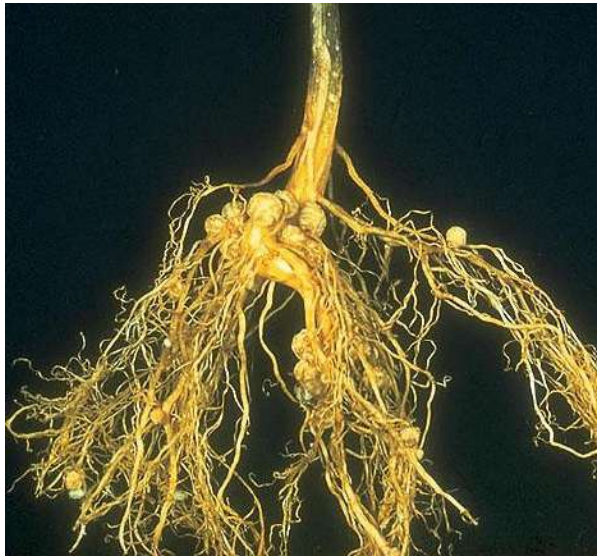


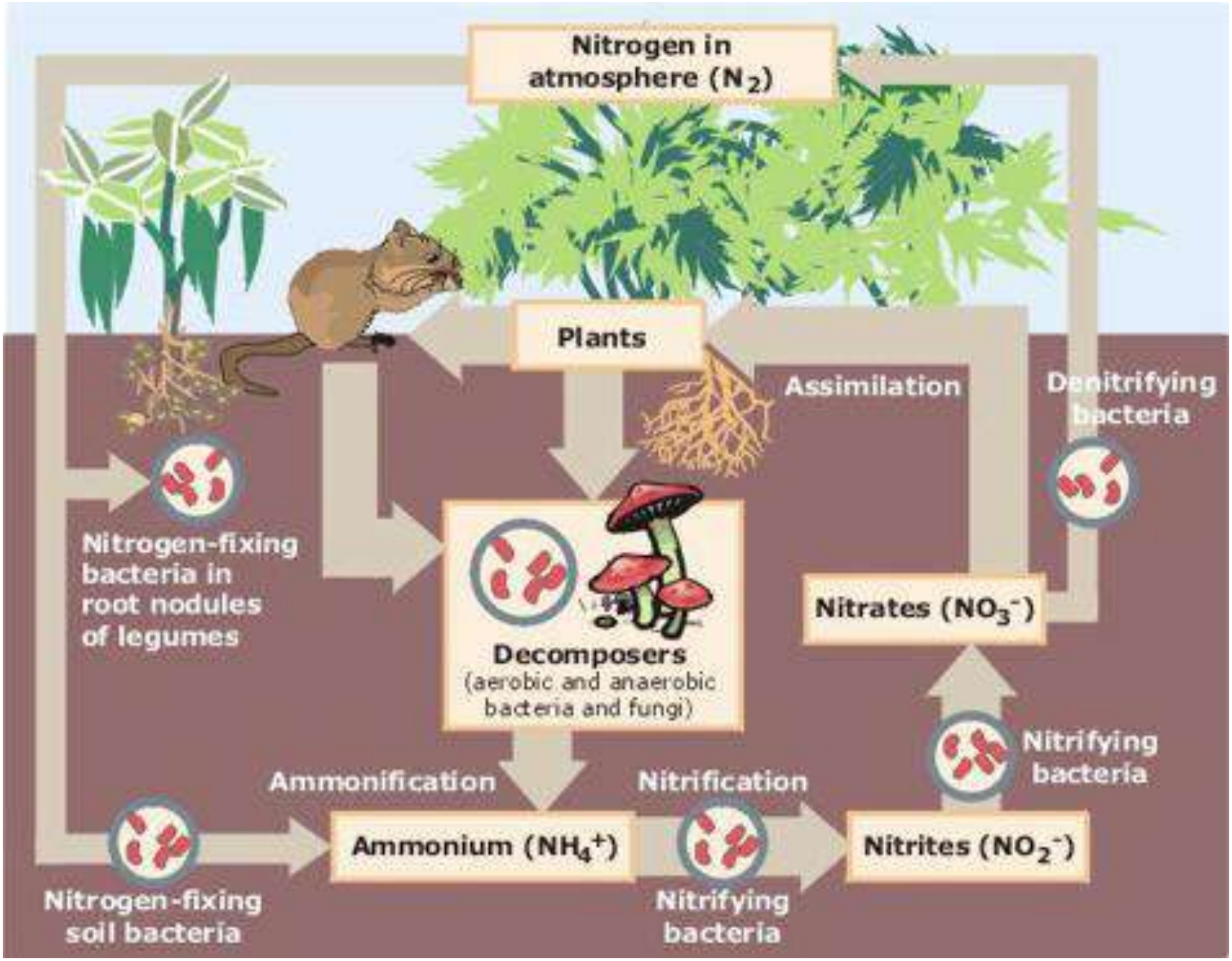

Nitrogen in atmosphere (N_2)
Plants
Assimilation
Denitrifying bacteria
Nitrogen-fixing bacteria in root nodules of legumes
Decomposers
(aerobic and anaerobic bacteria and fungi)
Nitrates (NO_3^-)
Nitrifying bacteria
Ammonification
Nitrification
Ammonium (NH_4^+)
Nitrites (NO_2^-)
Nitrogen-fixing soil bacteria
Nitrifying bacteria

3 processes that recycle nitrogen:

- **ASSIMILATION**: process of absorbing raw material (i.e. minerals)

  -plants absorb nitrogen-compounds from the soil and incorporate it into their cells/tissues

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Nitrogen-fixing soil bacteria
Nitrifying bacteria

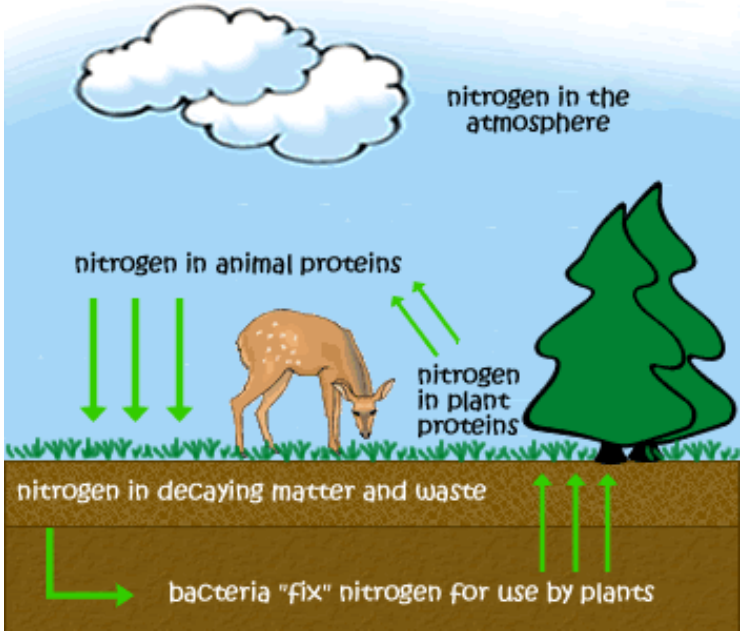
3 processes that recycle nitrogen:

- **NITROGEN FIXATION**: process where bacteria convert atmospheric nitrogen into useable forms for plants

  -Bacteria found in plant root nodules

  -Fertilizers (contain already "fixed" forms of nitrogen: nitrates, nitrites, ammonia, ammonium)

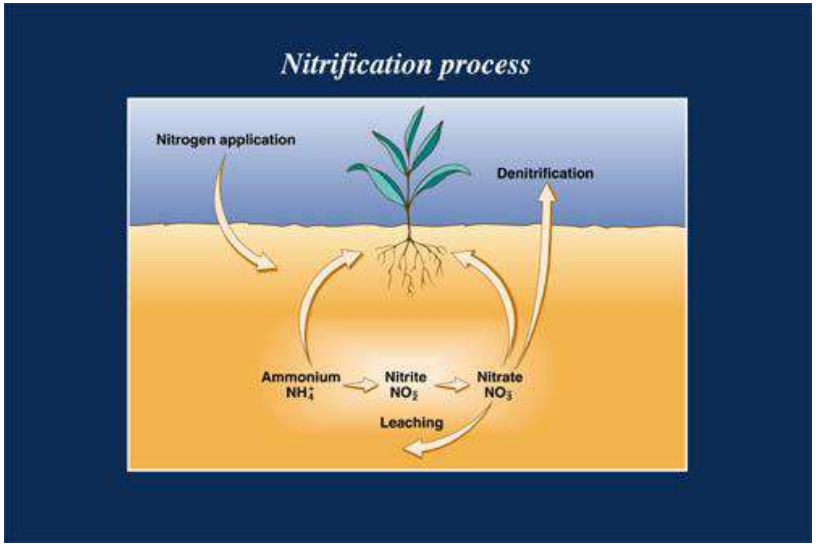
  -Lightning

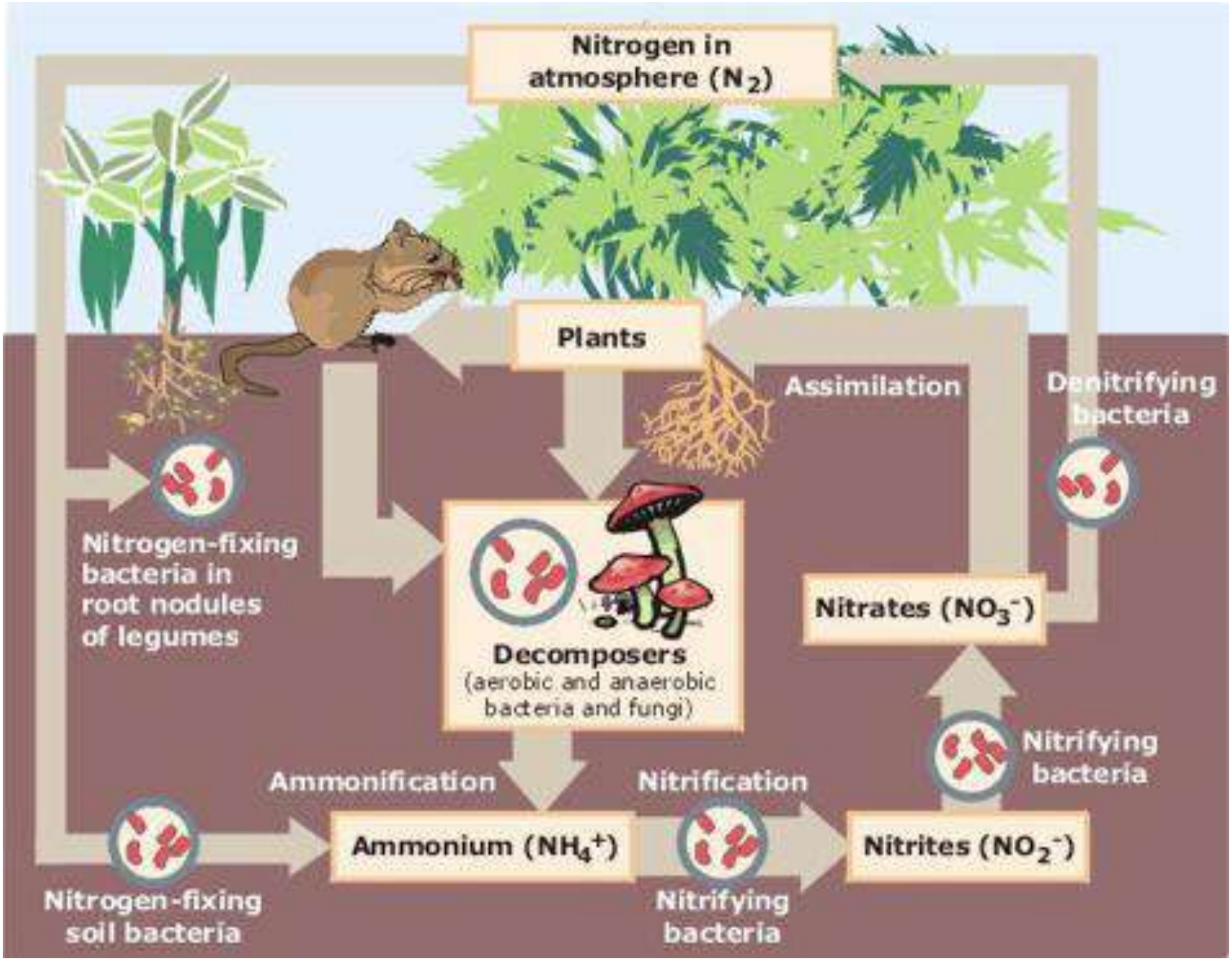


3 processes that recycle nitrogen:

- **DENITRIFICATION**: releasing nitrogen into the atmosphere

  -Bacteria in soil break down nitrogen wastes in the soil and release nitrogen back into the air

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Nitrogen-fixing soil bacteria
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NITROGEN CYCLE:

- Other ways to get nitrogen back into the cycle

  -animal wastes

  -dead organisms decaying