Introduction to Ecology

as far as we know; only earth harbors life

one of the most basic **characteristics of life** is that living organisms are constantly **interacting** with their environment and with each other

can't study the diversity of life on earth without knowing something about a few ecological principles that affect them

even on earth, life is contained within a thin veneer near the earth's surface

Biosphere:

=the total living world **and** all aspects of the nonliving environment with which life directly interact

from ~ 7 miles (11,000M) below the surface of ocean to ~ 6 miles (9,000M) above sea level

eg. if earth were the size of an apple the biosphere would be the thickness of its skin

these general conditions have molded animals along similar patterns & designs throughout earth's history

yet in this range, each kind of animal has developed a different set of **tolerances** for a variety of environmental conditions

eg. <u>Temperature of liquid water</u>

most animals are adapted to temperatures between 68-104ºF (20º-40ºC)

life requires **liquid water**

all life is made mostly of water

eg. humans 60-70 %

life is basically a series of chemical reactions

=metabolism

and you can't have chemical reactions unless the chemicals are dissolved in liquid

→no water no metabolism

however, some animals can temporarily stop metabolism when there is no water yet still survive

eg. tardigrades, nematodes

frozen water is the same as no water at all

→ there can be no metabolism

→ also freezing **kills** because sharp ice crystals expand and break the cells open

yet some animals are able to survive below freezing as long as they can keep some of the water liquid

water is kept liquid by

→ **high salts** (eg. making ice cream or salt melting snow → keeps water liquid *below* freezing temperatures)

eg. there are a few brackish pools in Anarctica where water remains fluid at –5º F (-20.6º C)

→ "**antifreeze**" compounds like glycerol (car antifreeze) or other alcohols

eg. numerous insects survive freezing in tundra by producing glycerol in their cells

eg. human, after 7 hrs exposure to freezing temperatures whose body temp fell to 77ºF, were revived; such survivors were often drunk

but high temperatures can also be dangerous

some of the large, complex organic molecules (proteins and DNA) are very sensitive to higher temperatures:

→above ~ 120ºF (50º C) proteins are destroyed and

cell membranes begin to break down

→DNA melts above 150ºF (65-75º C)

yet some fish are able to survive in hot springs and some marine invertebrates thrive at hot thermal vents

eg. <u>Salt /Water Concentration at ~3%</u>

the relative concentration of salt in water is referred to as its **salinity**

most animal cells have a salinity of 3%

in environments with too little or too much salt animals will die without special adaptations

eg. marine animals generally can't tolerate freshwaters and freshwater animals generally cannot tolerate ocean water

the salinity of the open ocean is a very constant 3%

invertebrates that live in the ocean usually have no problems with salinity variations since their bodies are the same salinity as the ocean water

marine **vertebrates** (mainly fish) have cells that are slightly less salty than seawater

→ since they naturally absorb lots of salts they must continually remove salts (usually from gills or kidneys) to survive

very few animals can live in extremely high salt concentrations such as those found in the great salt lake or the dead sea

eg. brine flies

animals that live in freshwaters and on land often have trouble getting salt

eg. freshwater fish have perfected the ability to conserve salts from the food they eat while constantly getting rid of excess water

eg. large land animals such as deer tend to congregate at natural "salt licks"

hunters put out salt to attract deer

eg. <u>pH Range near Neutral</u>

pH is a measure of the **balance** between acids and bases

examples of acids: lemon juice, carbonated drinks, coffee, battery acid, etc

examples of bases: bleach, drain cleaner, oven cleaner cement,

a pH of 7 is neutral

→above 7 means more bases, fewer acids

→below 7 means more acids, fewer bases

the fluid inside most animal cells is near neutral

like salts, too much or too little acidity can affect large organic molecules

eg. destroys proteins

eg. humans body fluids pH=7.4; <7.0 and >7.8 → death

a few fish can tolerate pH's near 4, but cannot reproduce in such environments

eg. acid rain in northern lakes kills fish

animals can rarely grow in environments above pH of 10.5

eg. <u>Pressure Range Near 1 atm</u>

most animals live at a pressure near that at sea level

but mountain and deep sea pressures vary greatly

the main effects of **lower pressures** (at higher elevations) relates to the amount of O_2 available to air breathing animals

→ too little pressure → not enough O_2

eg. the lowest pressure humans can survive is about $1/5^{th}$ of an atmosphere (~22,000' above sea level)

→would become starved for oxygen

only a few animal species live regularlyabove 22,000 ft elevation

the main effect of **higher pressures** (deep in the ocean) is felt on gasses trapped in lungs and air sacs of animals

→ too much pressure pushes extra gasses into blood nitrogen narcosis

→ too quick of a return to lower pressures produces gas bubbles in blood

deep diving mammals can collapse their lungs to prevent these problems

<u>Ecosystems</u>

variations in the above factors (and others), throughout the **biosphere** produce distinctive sets of environmental conditions and results in distinctive living **communities**

ie, **ecosystems**

an **ecosystem** is a portion of the biosphere with similar environmental conditions supporting a characteristic and distinctive group of species

other terms for ecosystems: biomes, ecoregions, life zones

different ecosystems are usually easily recognizable

eg. rainforest, desert, tundra, etc

the study of these distinctive patterns throughout the biosphere is called **"ecology"**

ecology: the study of organisms' interactions with their environment & with each other

<u>General Kinds of Ecosystems</u>

all the world's ecosystems can be grouped into just a two broad categories that share many similar characteristics that life in them must adapt to:

A. Aquatic Ecosystems (~73% earth's surface)

B. Terrestrial Ecosystems (27% earth's surface)

A. <u>Aquatic Ecosystems</u>

water based

most **stable** overall (most of ocean is 2º C)

buoyancy of water reduces need for support

less oxygen in water than in air

→larger animals need more efficient extraction

eg. gills

heavy dependence on chemical senses and ability to detect vibrations in water

water is an ideal medium for reproduction
- spawning
- motile larvae for dispersal
- doesn't require internal fertilization

two different kinds of aquatic ecosystems:
1. **Marine**
2. **Freshwater**

Marine Ecosystems

eg. oceans, seas, bays, estuaries, intertidal shores, deep trenches

oceans dominate the biosphere:

71% of area of earth; 99% of volume of biosphere

salt concentration roughly the same as most cells

→ no need for salt/water regulation

most of the ocean gets NO light from the sun

algae, seaweeds, and blue green bacteria are only found in the upper layers

organic material rains down from above

Freshwater Ecosystems

eg. streams, rivers, lakes, ponds

(<2% earth's surface = less than the area of Europe)

more variable in temperature, amount of light, nutrients, etc than marine

very few salts in water

FW systems are disproportionately rich in species and disproportionately imperiled

FW ecosystems encompass <2% of earth's surface

→they contain 12% of all animal species

→ including 41% of all fish species

but a much greater proportion of fw species are now endangered, threatened or at risk

eg. 20-36% of all fw fish species
eg. 67% fw clams
eg. 64% crayfish species
eg. 35% amphibians

[compare to terrestrial:eg. 17% of mammals; 11% of birds are at risk]

B. <u>Terrestrial Ecosystems</u> (~27% earth's surface)

eg. forests, marshes, deserts, rainforests, savannahs, praries, etc

harshest, most variable environment

animals living on land must be resistant to drying or be able to store water

oxygen more freely available

eg. air contains 20x's more oxygen than water

but respiratory organs must be protected inside body to avoid drying out

eg. lungs, book lungs, tracheae

on land animals need considerably more support

water is 800x's more dense than air

water is harder to move through but does buoy up the body

the largest animals that ever existed are aquatic animals

land animals need strong skeleton & muscular system to get around

land based life must adapt to extreme changes in temperature throughout the seasons

water fluctuates little in temperature

ocean temperatures are constant

land has harsh cycles of freezing and drying

on land reproduction become more complicated

animals must be able to get sperm cells to egg cells

animals must find mates

→ often more elaborate mating behaviors than in aquatic animals

<u>Community Interactions</u>

in addition to interactions between the living and nonliving parts of an ecosystem, there are also numerous interactions between the living organisms themselves

plants vs **herbivores**

some animals have very specfic food needs

eg. Panda eat only bamboo

eg. many insects eat only a certain species of plant

predators vs **prey**

symbiosis = when two organism are usually found together and are interdependent on each other

not the same as predator/prey or food chain relationships

is a closer more specific kind of interdependence

ALL living organisms including all animals form symbioses with other animals and other lifeforms

Kinds of Symbioses

a. mutualism
b. commensalism
c. parasitism

a. Mutualism

both organisms benefit from the relationship

eg. symbiotic algae in corals and sponges

eg. protozoa in gut of termite

eg. some gut bacteria protect us from disease and pathogens

b. Commensalism

one organism benefits, the other neither benefits nor is harmed (neutral effect)

eg. follicle mites

eg. many gut bacteria

c. Parasitism

most common form of symbiosis

eg. 20-50% of all animal species are parasitic

one organism benefits at the other's expense

ie. the other is harmed in some way

eg. tapeworms, liver flukes, fleas, ticks, etc