Module – 1
Environment and Ecosystem

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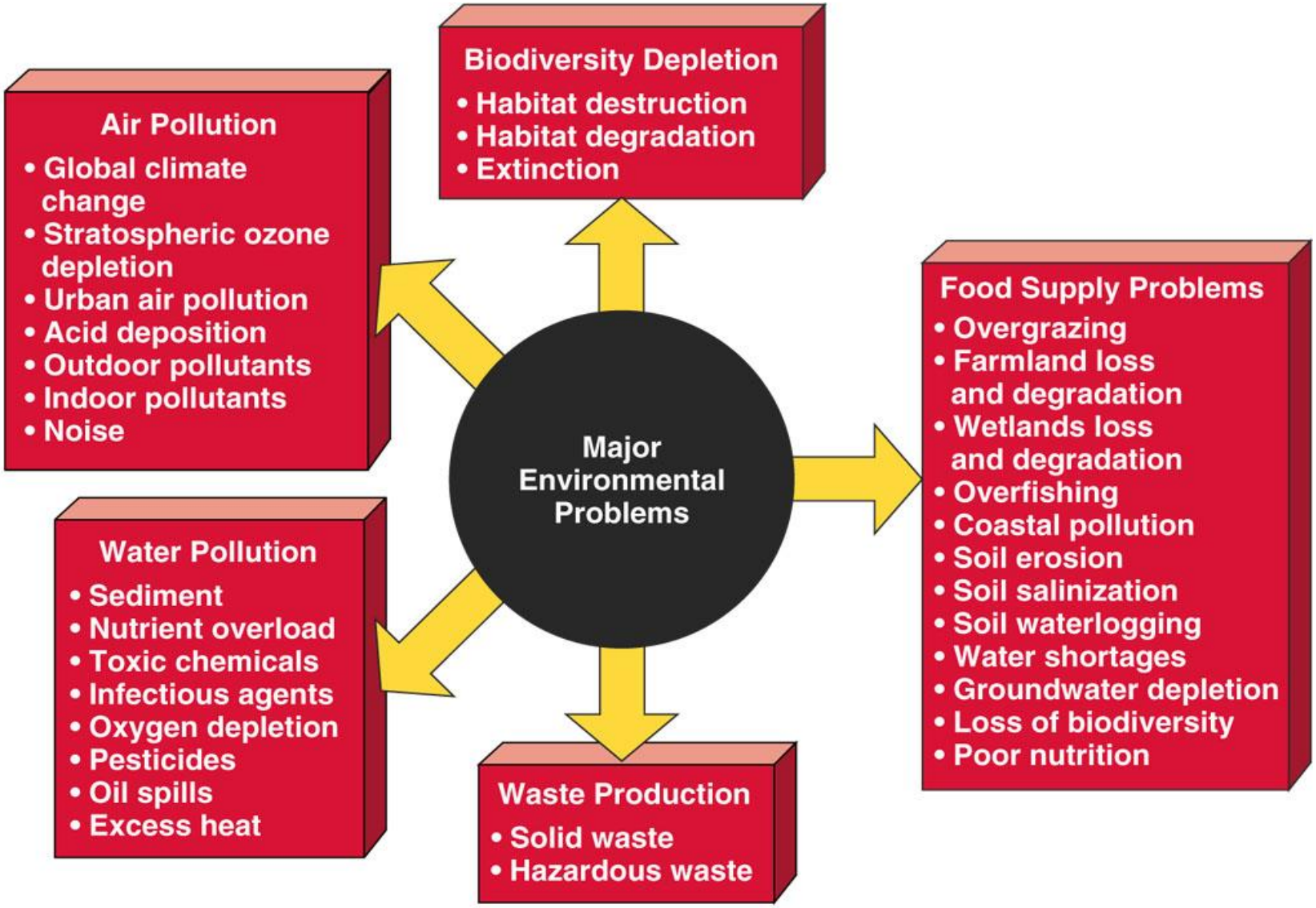
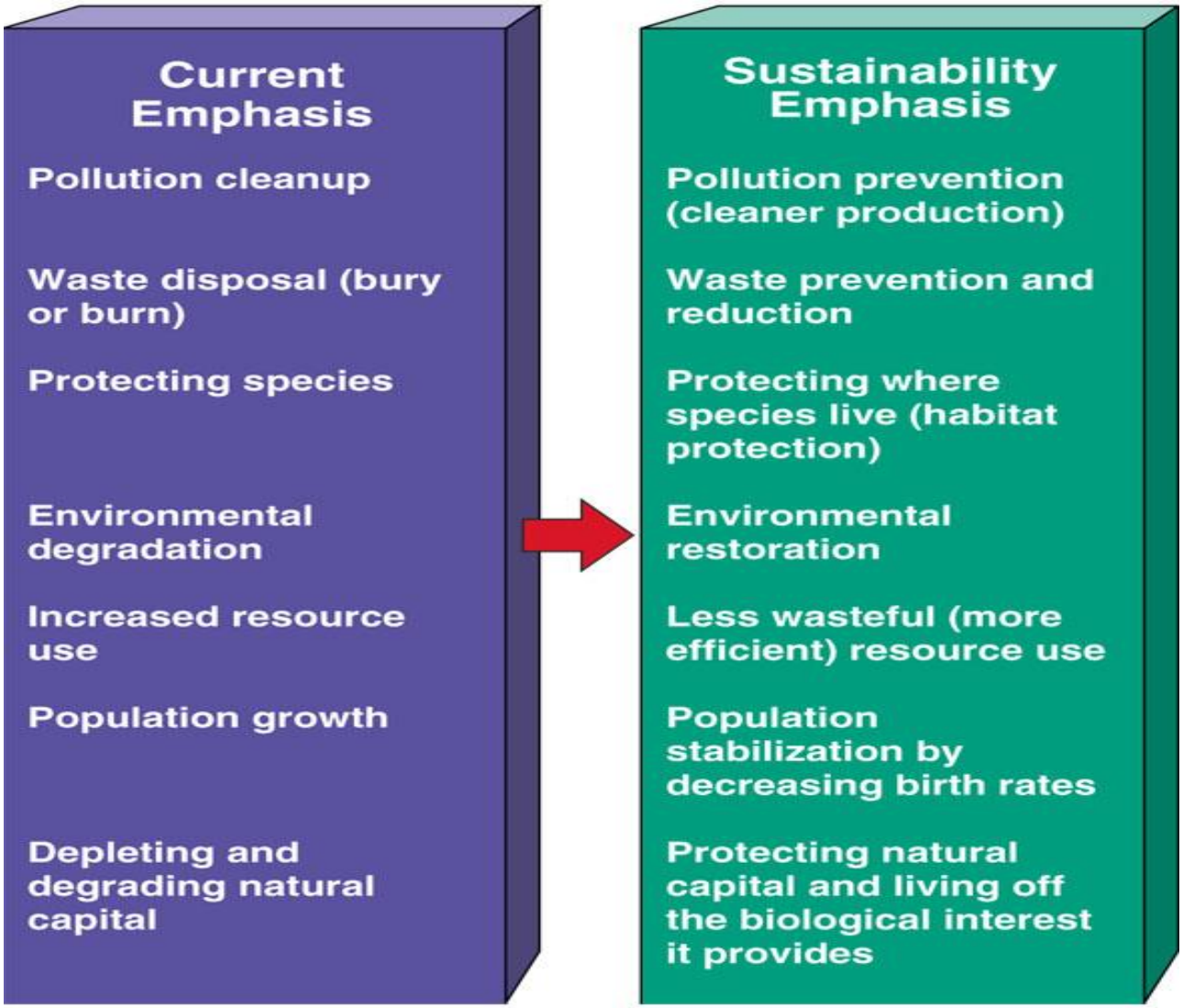
Topics

- Key environmental problems and their basic causes.
- Ecosystem, earth – life support system and ecosystem components.
- Energy flow in ecosystem.
- Ecological succession.
- Nutrient, water, carbon, nitrogen, cycles.
- Effect of human activities on these cycles.

Environmental Problems



Solutions


Current Emphasis
Pollution cleanup
Waste disposal (bury or burn)
Protecting species
Environmental degradation
Increased resource use
Population growth
Depleting and degrading natural capital
Sustainability Emphasis
Pollution prevention (cleaner production)
Waste prevention and reduction
Protecting where species live (habitat protection)
Environmental restoration
Less wasteful (more efficient) resource use
Population stabilization by decreasing birth rates
Protecting natural capital and living off the biological interest it provides

Environmental Impact

Developing Countries




Population (**P**) X Consumption per person (affluence, **A**) X Technological impact per unit of consumption (**T**) = Environmental impact of population (**I**)




Developed Countries

IPAT Equation
Paul Ehrlich and John Holdren Model

IPAT Is Another Environmental Impact Model

In the early 1970s, scientists Paul Ehrlich and John Holdren developed a simple model showing how *population size* (P), *affluence* (A), or wealth, as measured by rates of resource consumption per person, and the beneficial and harmful environmental effects of *technologies* (T) help to determine the *environmental impact* (I) of human activities. We can summarize this model by the simple equation:

$$\text{Impact (I)} = \text{Population (P)} \times \text{Affluence (A)} \times \text{Technology (T)}$$

IPAT – High/middle/low Income Countries

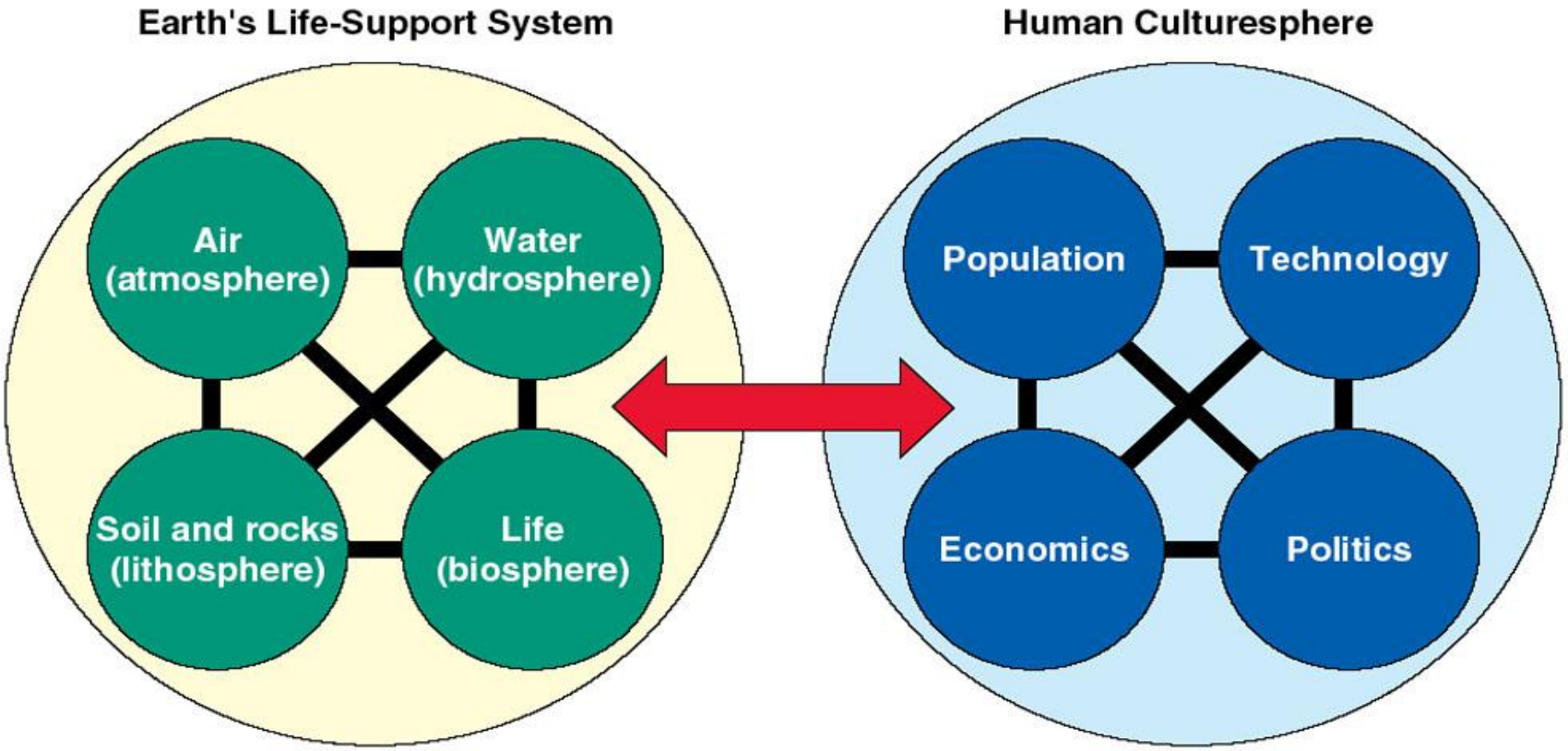
TABLE 1.1 Environmental Impact of Selected High-, Middle-, and Low-Income Countries

Country	Population Size	Population Growth Rate	Resource Use Per Person	Use of Harmful Technology	Use of Beneficial Technology	Overall Environmental Impact
High-Income Countries						
United States	316 million	Moderate (0.5%)	Very high	Moderate	High	High
Japan	128 million	Negative (−0.2%)	High	Moderate	High	Moderate
Germany	82 million	Negative (−0.2%)	High	Moderate	High	Moderate
Middle-Income Countries						
China	1.35 billion	Moderate (0.5%)	Low	High	Moderate	High
India	1.26 billion	High (1.5%)	Low	High	Low	High
Brazil	194 million	Moderate (1%)	Low	High	Moderate	Moderate
Low-Income Countries						
Nigeria	402 million	High (2.6%)	Very low	High	Low	Moderate
Bangladesh	228 million	High (1.6%)	Very low	High	Low	Moderate
Congo	194 million	High (2.8%)	Very low	High	Low	Moderate

Compiled by the authors using data from Population Reference Bureau, Global Footprint Network, World Wide Fund for Nature, and Earth Policy Institute.

Ecosystems

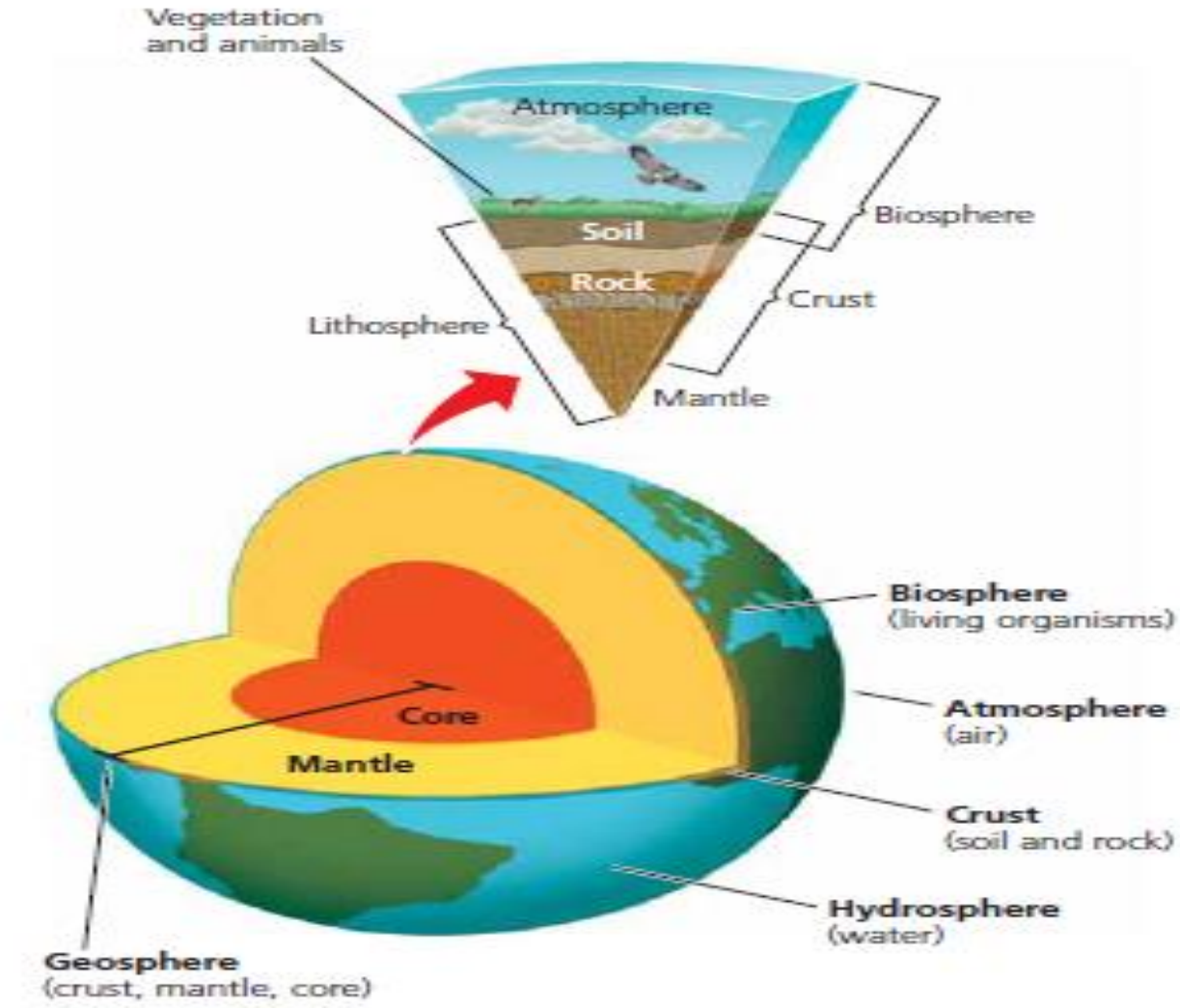
Goal for environmental science is to learn about these complex interactions



Earth's Life – support system

- Scientific studies reveal that the earth's life-support system
  - consists of four main spherical systems that interact with one another
  - the atmosphere (air),
  - the hydrosphere (water),
  - the geosphere (rock, soil, sediment) and
  - the biosphere (living things)

The atmosphere



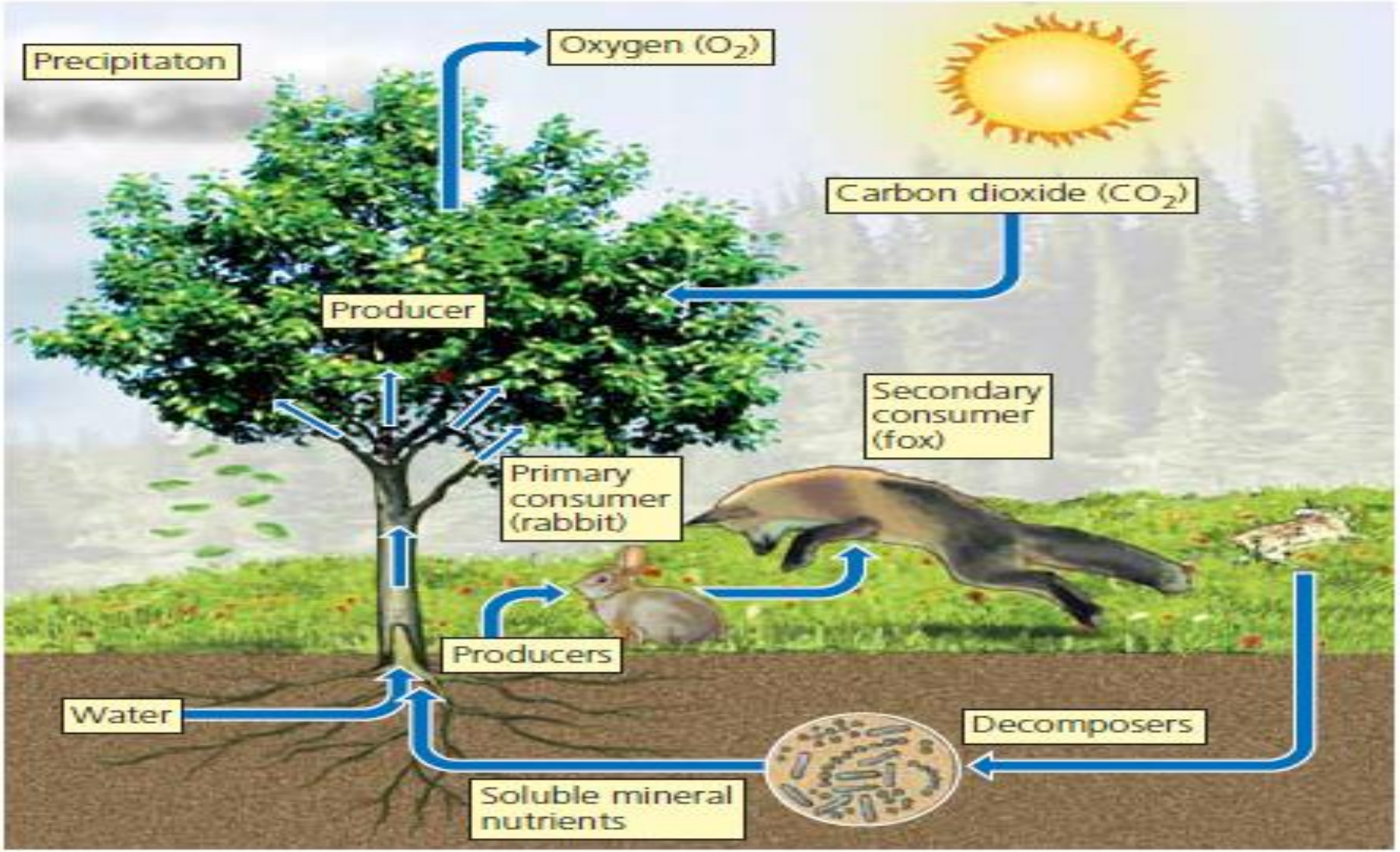
- The atmosphere is spherical in shape.
  - Inner troposphere: 17 Kms above sea level.
  - 78% of nitrogen and 21 % of oxygen, 1% of air includes water vapor, CO_2, methane. – green house gases.
  - Stratosphere (11-31 miles) above earth's surface.
  - Its lower portion is ozone. (UV radiation)
  - Hydrosphere: earth's water. Found as ice bergs, liquid water, water is in form of ocean.

  - Geosphere: consist of hot core, mantle, outer crust.
  - Lithosphere is the earth's solid crust and upper mantle.
- Biosphere occupies the atmosphere, hyrosphere and geosphere – life is found.
- Ecology is the interaction in thin layer of water, air, soil and organism.

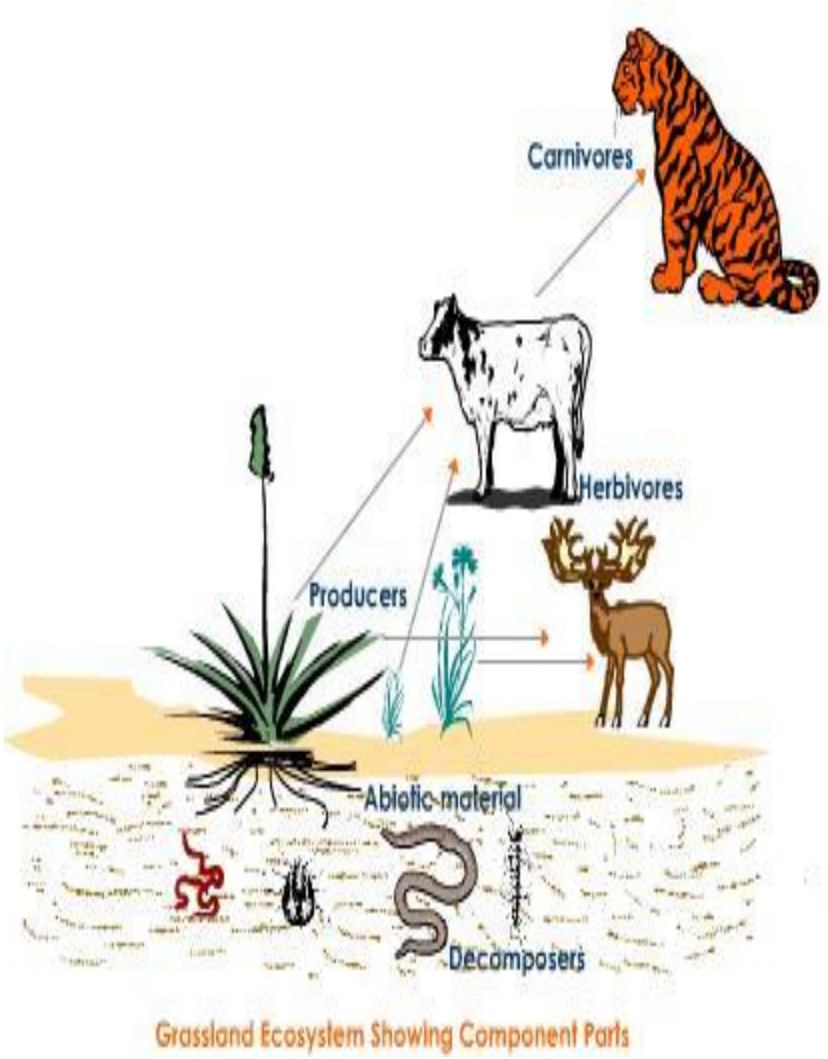
Life exist on land and water

- Classification: two types
  - **Biomes**: eg: forest, deserts, grasslands, with different where species live in.
  - Aquatic life zone:
    - Fresh water life zones: lakes, streams
    - Marine life zones- coral reefs, estuaries, deep ocean.

Major component of ecosystem



Major component of ecosystem
Biotic Structure



Grassland Ecosystem Showing Component Parts

- Producers
- Consumers
- Decomposers

Producers

carbon dioxide + water + **solar energy** → glucose + oxygen

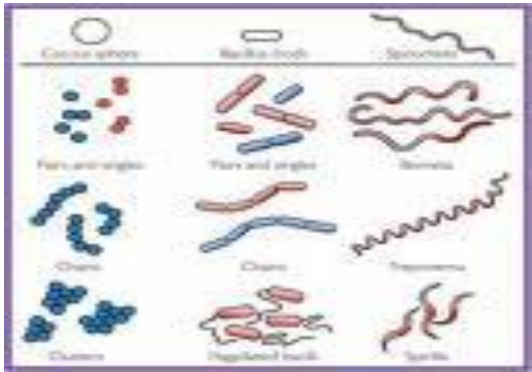
$6\,CO_2 + 6\,H_2O$ + **solar energy** → $C_6H_{12}O_6 + 6\,O_2$

- Photo Autotrophs: Auto- Self, Trophs- Food, Photo- Light.

  Eg. Green Plants

Chemo-autotrophs: which produces the organic matters- oxidation, in absence of sun light.

Eg. Micro – Organisms.



Consumers

- Herbivores: they directly feed on producers.

- Carnivores: they feed on other consumers.

- Called as secondary consumers.

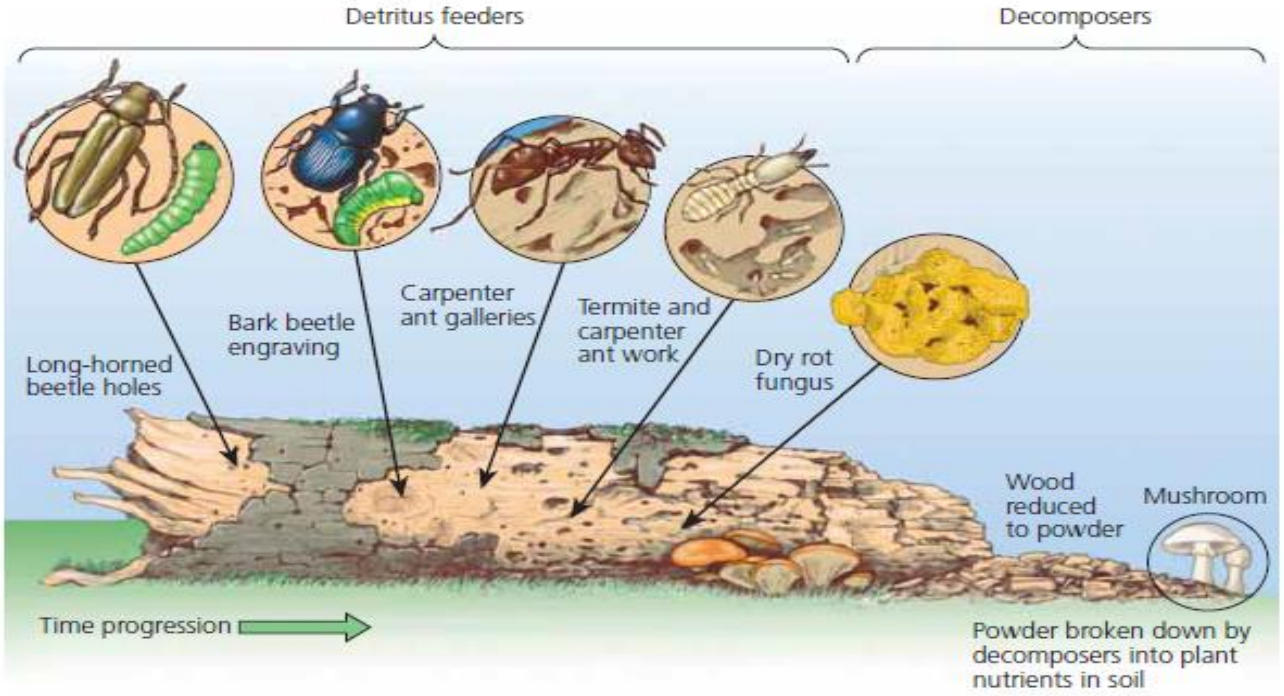
Consumers contd..

- Omnivores: they feed on both plants and animals.

- Detritivores: feed on dead organism, wastes of living organism.

Detritus feeders

- These feed on dead organism/ dead bodies of other organism called detritus.
  - Eg: earthworm, insects, larger scavenger- vultures.
  - These organism extract some of the chemical energy stored in dead organic matter, bodies, wastes in turn serve as food for detritus.



Aerobic respiration

- Some producer , consumer and decomposer use the chemical energy stored in glucose and other organic compounds to their life process.
- The most of cells energy is released by aerobic respiration,

glucose + oxygen → carbon dioxide + water + **energy**

$C_6H_{12}O_6 + 6\,O_2 \rightarrow 6\,CO_2 + 6\,H_2O$ + **energy**

Anaerobic respiration

- Some decomposers get energy by breaking done glucose in absence of oxygen.
- This form of cellular respiration is called **anaerobic respiration/ fermentation.**
- The end products are methane gas, ethyl alcohol, acetic acid- vinegar, hydrogen sulfide.
- Note: all organism get their energy from aerobic or anaerobic respiration, but plants – photosynthesis.

Major component of ecosystem

Abiotic Structure

the physical and chemical components

- Physical factors: sunlight, shade, average temperature, max-min. temperature, rainfall, etc..
- Chemical Factors: carbon, nitrogen, phosphorus, hydrogen, oxygen, sulphur….
- Organic substances present in the soil influences the functioning of the ecosystem.

Functional Attributes

- Food Chain, food webs and trophic structure.
- Energy flow.
- Cycling of nutrients.
- Primary and secondary production.
- Ecosystem development and regulation

Definitions to know

- Food Chain: the flow of energy is mediated through a series of feeding relationships in a definite sequence.
- Tropic structure: the producers and consumers are arranged in the ecosystem in a definite manner and their interaction along with the population size.
- **Tropic level:** each food level.
- **Standing crop/ standing biomass:** the amount of living matter at each tropic level at a given time.