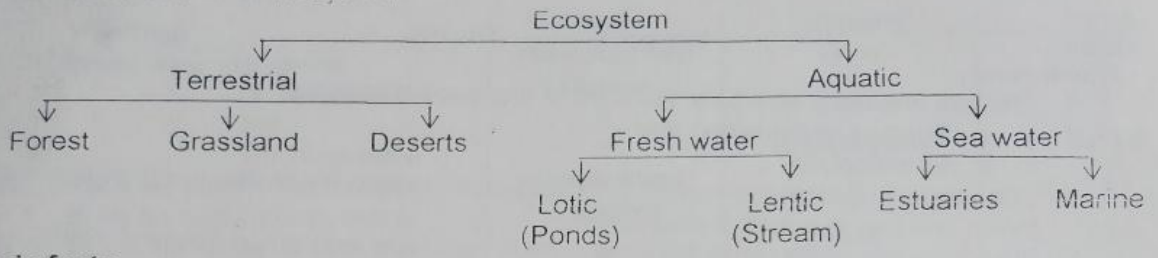
ECOSYSTEM

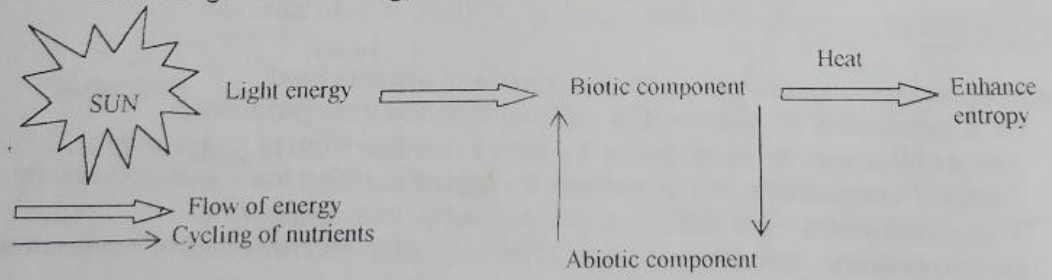
1. A.G. Tansley (1935) coined the term ecosystem and defined it "as the system resulting from the integration of all the living and nonliving factors of the environment"
2. Parallel terms are biocoenosis (Karl Mobius, 1877), microcosm (S.A.Forbes, 1887), geobiocoenosis (V.V.Dokuchaev, 1846-1903), holocoen (Friederichs, 1930), ecosom etc.
3. Ecosystem is the basic functional unit of nature, which includes both the organisms and the non-living environment, each influencing the properties of the other and both necessary for maintenance of life. Thus an ecosystem is an overall integration of whole mosaics of interacting organisms and their environment.

4. Classification of ecosystem



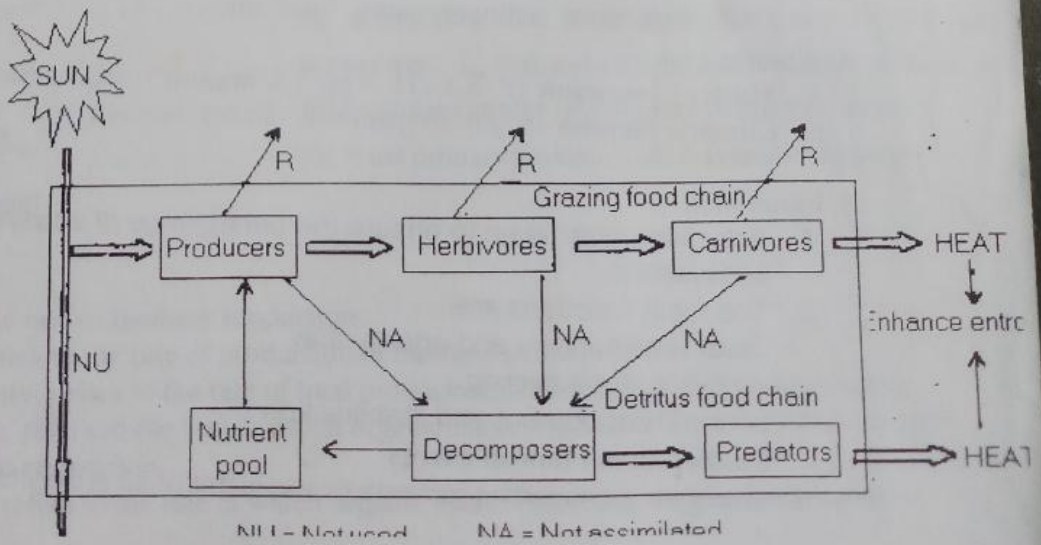
Basic facts

i. It is the basic functional unit of nature.
ii. It represents an overall integration of whole mosaics of interacting organisms and their environment.
iii. It focuses on the unidirectional flow of energy and cycling of nutrients.
iv. It introduces the concept of homeostasis i.e. tendency of the biological systems to resist change (homeo= same, stasis= standing).
v. It is a self-sustaining, self-regulating system that operates on feed back mechanism.
vi. It is powered by solar energy
vii. Fuel powered ecosystems of modern cities have brought many unwished for side effects such as global warming, ozone hole, acid rain etc.

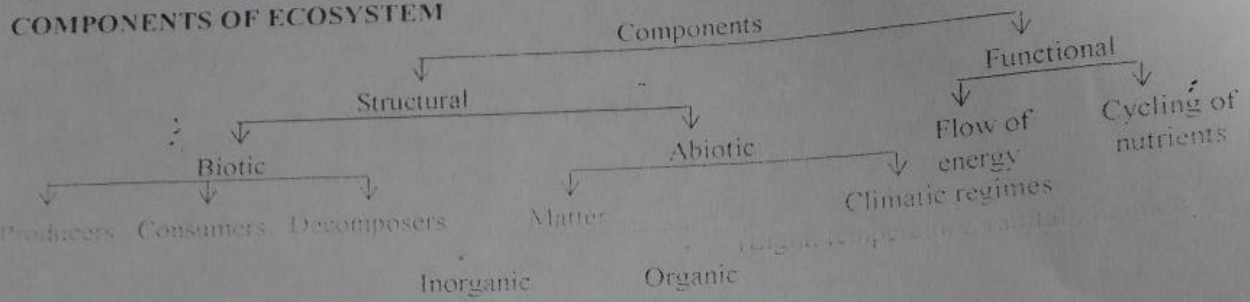


(Fig. Showing unidirectional flow of energy and cycling of nutrients)

viii. According to Miller (1991: ~~112~~) an ecosystem has six major features:
   a. interdependence,
   b. diversity,
   c. resilience,
   d. adaptability,
   e. unpredictability and
   f. limits.



COMPONENTS OF ECOSYSTEM



I. **Structural**

1. The two important structural features of any ecosystems are
   a. Species composition and
   b. Stratification
2. The species composition varies with ecosystems. Species diversity is high in a tropical rain forest and low in a desert ecosystem.
3. Standing crop: represents the amount of living matter present in different trophic levels at a given time
4. Standing state: represents the amount of nutrients present in the soil at any given time.

A. **Biotic** - Living organisms

a. **Autotrophs or Producers or transducers** - can synthesize their own food. They can be photoautotrophs or chemoautotrophs. Photoautotrophs can convert solar energy into chemical energy. The biochemical formula that describes photosynthesis are:

$$CO_2 + H_2O + \text{Solar energy} \xrightarrow{\text{CHLOROPHYLL}} (CH_2O)_n + O_2 \text{ (In green plants)}$$

$$CO_2 + H_2S + \text{Solar energy} \xrightarrow{\text{BACTERIOCHLOROPHYLL}} (CH_2O)_n + S \text{ (In bacteria)}$$

b. **Heterotrophs or Consumers** - require a source of organic food.
   i. **Pr. Consumers or Herbivores** - derive nutrition from producers
   ii. **Sec consumers or carnivores 1** - derive nutrition from pr. consumers
   iii. **Tertiary consumers or carnivores 2** - derive nutrition from sec. consumers
   iv. **Top consumers** - are not killed and eaten by other organisms.
   v. **Decomposers** - decompose dead organic matter and recycle the nutrients e.g. bacteria, actinomycetes, fungi etc.

B) **Abiotic**

a. **Matter** - **Inorganic** (P, S, C, H, N etc.) & **organic** (carbohydrates, fats, proteins, amino acids etc.)
b. **Climatic regimes** - Light, temperature, rainfall, humidity etc.

II. **Functional**

1. Activities undertaken to ensure the persistence of ecosystems constitute the functions of ecosystems
2. The main functions are
   a. Productivity and energy flow
   b. Nutrient cycling
   c. Development and stabilisation

i. Unidirectional flow of energy

i. Energy is an important common denominator of all ecosystems.

ii Solar energy enters the biological world through producers by way of photosynthesis.

iii Next it moves through the ecosystem as negative entropy of food in order to sustain high level of organization in living beings as well as in the ecosystems.

iv The series of organisms through which food energy moves in an ecosystem by eating & being eaten is called the food chain. There are three types of food chain –

- **Grazing or predator food chain** (i.e. food energy goes from plants to herbivores to carnivores).
- Parasitic food chain (from larger living organisms to smaller ones)
- Detritus or saprophytic food chain (from dead organic matter to microorganisms to predators)

v Each step in the food chain is

= feeding)

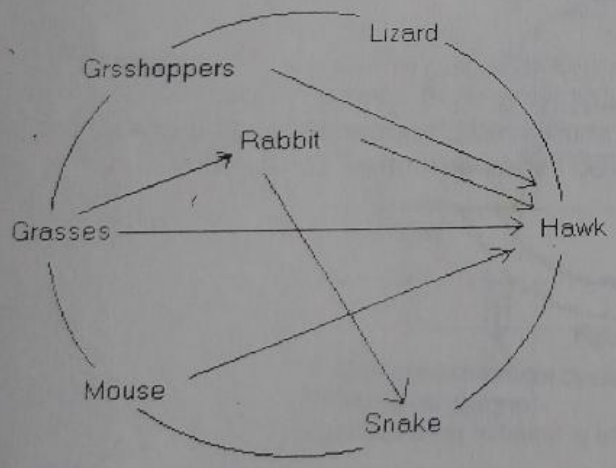
1st trophic level – Producers
2nd " " - Pr. Consumers
3rd " " - Sec. "
4th " " - Ter. consumers

vi There are usually 4 or 5 trophic levels but seldom more than 6.

vii This is due to **law of 10%** that states that maximum efficiency of energy transfer from plants to animals is 10% and from animals to animals 20%. Short food chain saves energy cost.

viii **Food web** – In nature what actually exists is not food chain but food web. Food web is the interlocking patterns formed by a series of interconnected food chains.

Pond	Grassland	Forest
Phytoplanktons Diatoms	Grass	Plants
⇩	⇩	⇩
Zooplanktons Copepods	Grass hoppers	Rabbit
⇩	⇩	⇩
Small fish	Frog	Fox
⇩	⇩	⇩
Large fish	Snake	Wolf
⇩	⇩	⇩
	Hawk	Lion



(Fig: Showing food web)

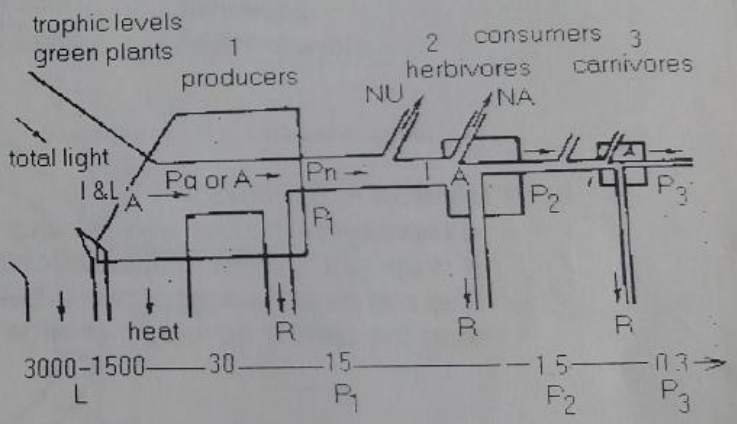


Fig energy flow in a food chain 3000 kcal of incident ligh
mz per day. L_a = absorbed light, *NA* - Non assimilated e
NU - unused energy P_g = gross primary production
Pn = net primary product A = assimilated energy,

ix. PRODUCTIVITY

a. Productivity: refers to the rate of biomass production.
b. Primary productivity: refers to the rate of production of biomass at the producer level.
c. Gross primary productivity: refers to the rate of total production of biomass at the producer level.
d. Net primary productivity: refers to the rate at which organic mass is stored at the producer level after allowing for losses due to respiration.
e. Secondary productivity: refers to the rate at which organic mass is stored at the consumer level.

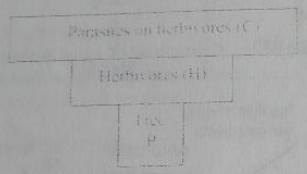
f. High level of net primary productivity (>20 t / ha / year) has been recorded for tropical rain forest
the least productivity is recorded from deserts (< 1 t / ha / year)
g. In aquatic ecosystems, productivity is limited by light, which decreases with increasing water depth
h. ECOLOGICAL EFFICIENCIES. It represents the efficiency with which organisms exploit their food resources and convert the food into biomass

ECOLOGICAL PYRAMIDS

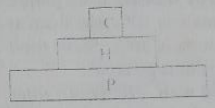
1) Charles Elton (1927) gave the concept of ecological pyramid
2) It can be defined as a graphic representation of the food relationships of a community at each representing consumers of higher trophic level.
3) It can be shown in terms of their number, biomass and energy contents

a. PYRAMID OF NUMBERS

i. Number of individuals is shown at each trophic level
ii. It is generally upright i.e. producers outnumber the herbivores and herbivores outnumber the consumers e.g. forest and grassland ecosystems.
iii. It is inverted in case of a tree ecosystem. A single large-sized tree can provide food to several herbivores (e.g., birds, squirrels) which support a few carnivores. Herbivores support a large number of ectoparasites.



(Inverted pyramid of tree ecosystem)

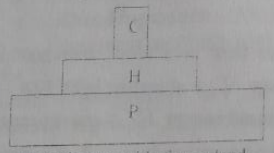


(Upright pyramid of grassland and forest ecosystem)

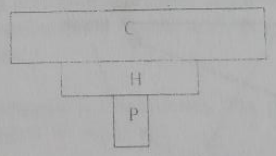
P = Producers, H = Herbivores, C = Consumers

b) PYRAMID OF BIOMASS

i. It represents the biomass (= weight of living matter) in various trophic levels
ii. It is upright, except in aquatic food chain involving short lived phytoplanktons
iii. The combined weight of numerous small short lived phytoplanktons at a given time is less than the combined weight of large long lived fishes and other consumers



(Upright pyramid of grassland and forest ecosystem)

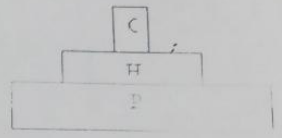


(Inverted pyramid of pond ecosystem)

c) PYRAMID OF ENERGY.

i. It gives graphic representation of amount of energy trapped by different trophic levels per unit area.
ii. It expresses mainly the rate of food production
iii. It is always upright because during transfer of energy from one trophic level to the next, a lot of wastage occurs in feeding, digestion, assimilation and respiration.

iv. It emphasises that total energy flow at successive trophic level always decreases, compared to the preceding trophic level. Amongst the three kinds of ecological pyramids, the pyramid of energy, can be considered most representative of the functional characteristics.

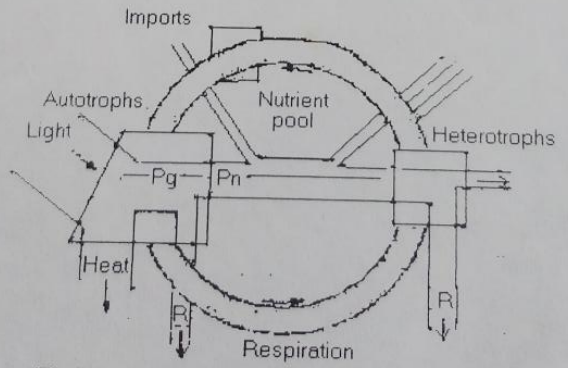


(Fig. Always upright in all ecosystems)

Biogeochemical cycles

i. Cycling of nutrients between the non-living environment and living organisms is called biogeochemical cycles.
ii. It renews supply chemical elements in the ecosystem.
iii. Barring catastrophic event.s biogeochemical cycles remain in a state of dynamic equilibrium.
iv. Living beings that constitute the small reservoir pool are the worst affected lot by any such change in the movement of nutrients.
v. Nature tries to repair the damage through negative feedback.
vi. Any change in the movement of nutrients along one pathway is quickly compensated by adjustments along other pathways.
vii. But some times when the damage crosses the threshold level it gets magnified and becomes uncontrollable (runaway positive feedback).
viii. So one role of environment management is to watch for such threats that lead to runaway reactions
ix. Over 30 biogeochemical cycles are known. A few crucial ones are listed below:

Biogeochemical cycle	Elements	Cycle time	Regementration
1. Gaseous	HO, N, CO, O, etc	Short	Renewable
2. Sediment	Ca, S, P etc	Long	Non-renewable



(Fig Biogeochemical cycle (circle) superinposed oh energy flow diagrm)