Ecosystems

Their structure and how they function

Section outline

The ecosystem concept including energy flows

Variations in nutrient cycling between two biomes to show the size of stores and rates of flow

Levels of primary productivity linked to the presence of limiting factors including temperature, moisture, light and nutrient availability

Additional key features*

[*Other key features covered at beginning of course…]

Producers (autotrophs):

In the majority of ecosystems these are photosynthetic (‘green’) plants that fix incoming solar radiation in the process of photosynthesis

Consumers (heterotrophs):

Classified by what they consume, i.e. herbivores, carnivores, omnivores, detritivores (or decomposers)…

Energy flows

In most ecosystems, solar radiation is the primary source of energy.

This is converted to carbohydrates by green plants (*primary producers*) through photosynthesis.

However, a range of factors means that only c.25% of incoming solar radiation is available for photosynthesis (e.g. only c.50% of solar radiation is within the *photosynthetically active radiation* (PAR) waveband of c.400-700 nm).

The total amount of incoming solar energy thus absorbed = the ecosystem's **Gross Primary Productivity** (**GPP**).

But not all of this is converted to new plant tissue that can be consumed by herbivores – *why not*?

Energy flows

Because of this, a more useful measure is **Net Primary Productivity** (**NPP**)

This is the rate of addition of new plant material (**biomass**)* to the ecosystem.

Units are: g (dry weight)/m^2/yr – sometimes gC/m^2/yr indicating the addition of organically bound carbon.

It's a better measure than GPP as it doesn't include the energy fixed by plants that they use themselves.

NPP is ∴ a measure of the ecosystem's productivity at the producer level.

*[Strictly speaking, biomass is the total amount of living matter in an area but it's often only a measure of plant material (*why do you think this is?*)].

Biomass indicates the amount of energy that has been stored in the ecosystem [units: g/m^2 – also tonnes/ha].

Energy flows

NPP varies according to:

- The availability of:
  - Water
  - Light
  - Nutrients
  - Temperatures that facilitate photosynthesis
- Competition from other plants
- The age and health of the plants

1. *Explain how each of these factors will affect NPP*
2. *What characteristics would therefore produce the greatest NPP?*
3. *Where would you expect to find this?*

Energy flows

<u>Trophic Levels</u> [Greek *trophē* – nutrition]

These indicate the position at which energy is consumed within the ecosystem

The simplest system will have 3 levels:

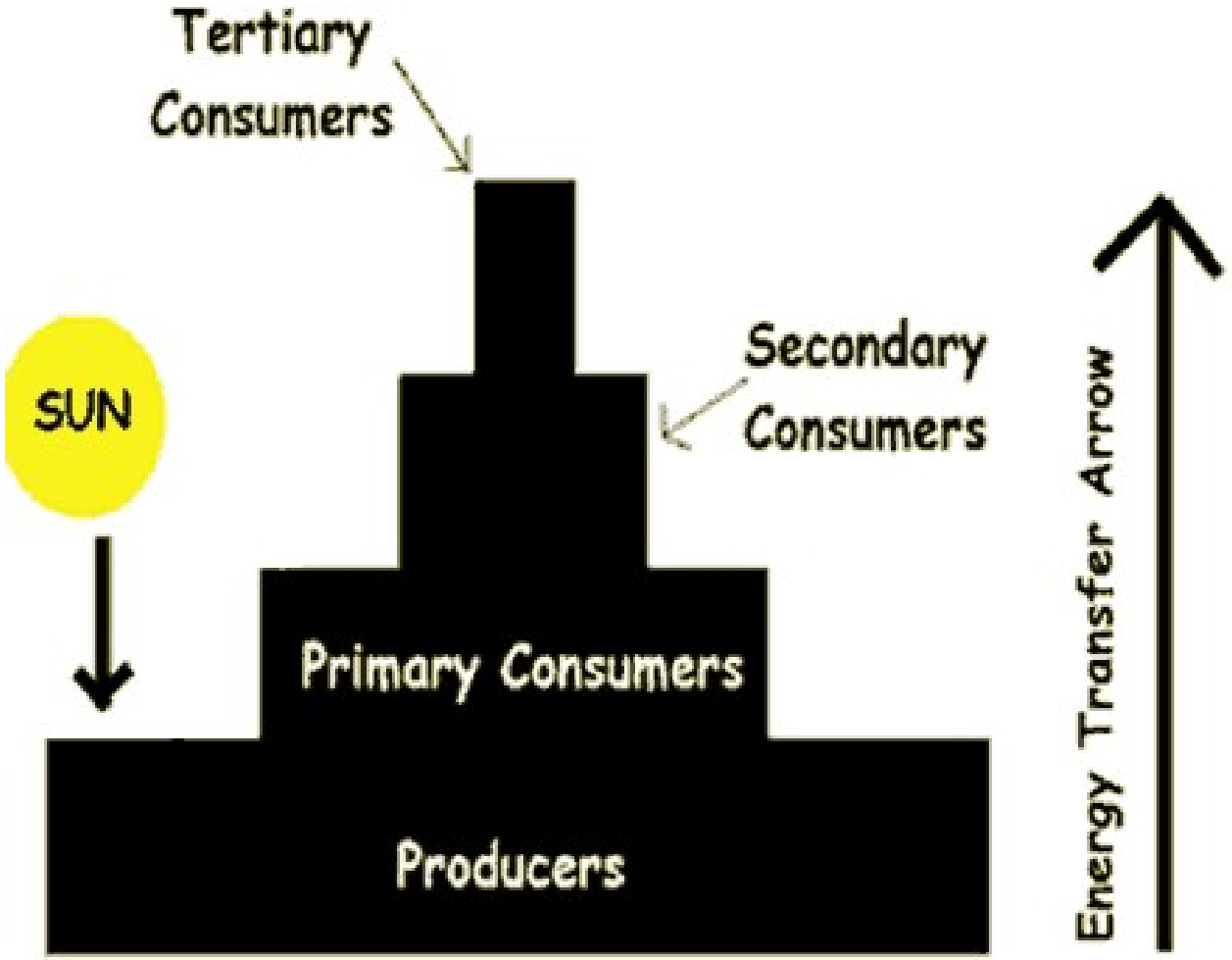
Primary Producers

Herbivores (Primary Consumers)

Carnivores (Secondary Consumers)

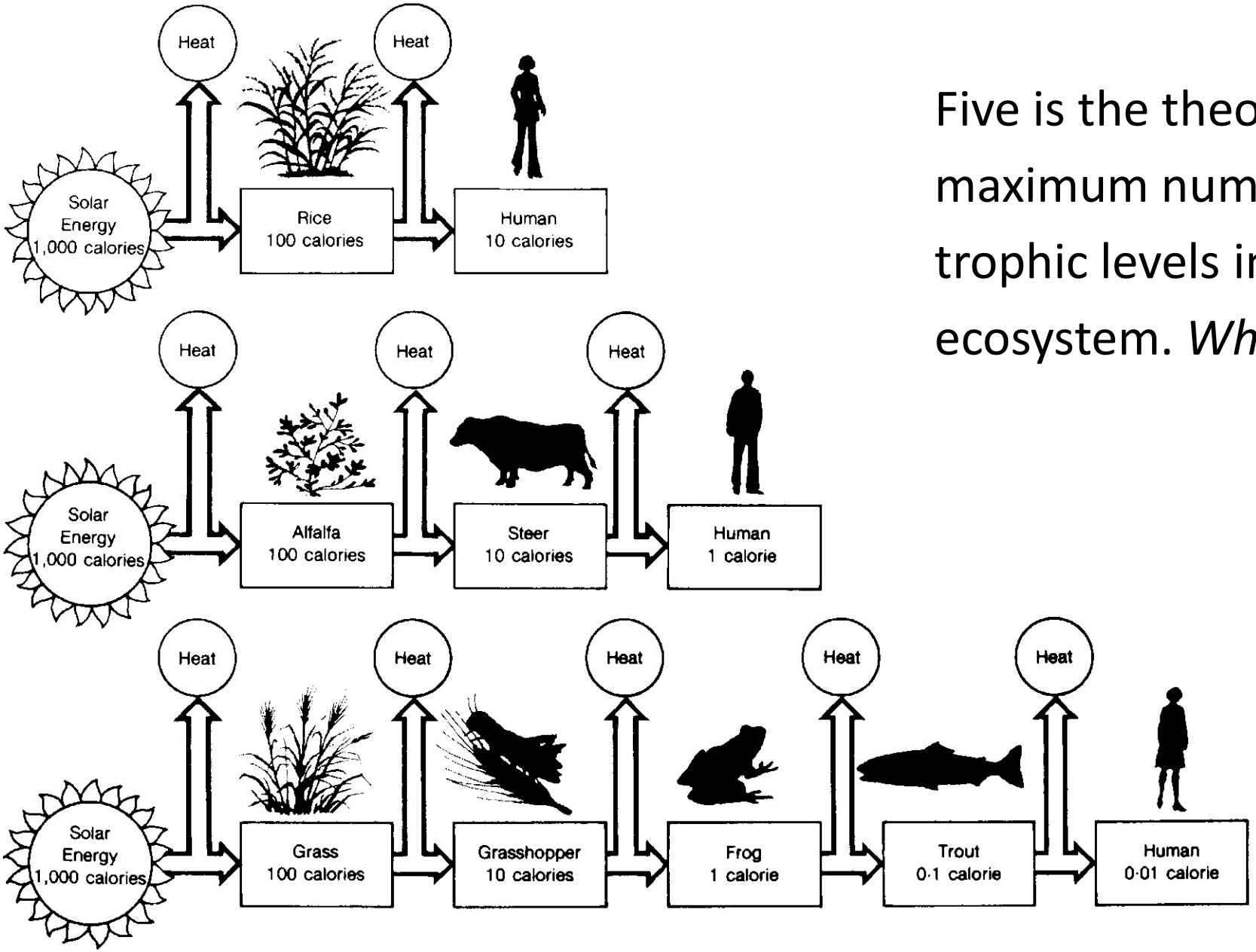
Energy flows

Trophic levels can be arranged as a pyramid:



Why is each succeeding level smaller than the one below it?

Energy Flows

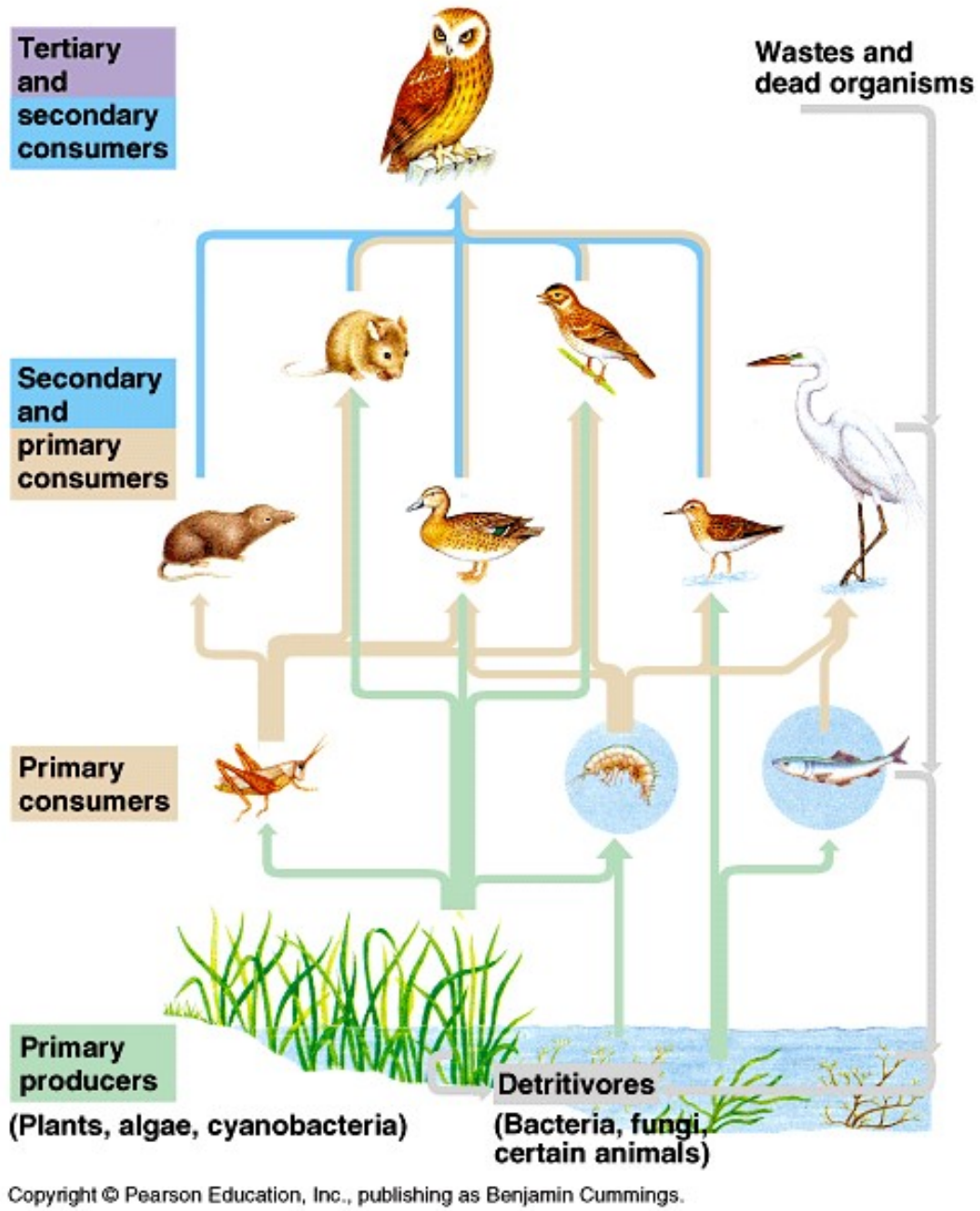


Five is the theoretical maximum number of trophic levels in an ecosystem. *Why?*

Energy Flows

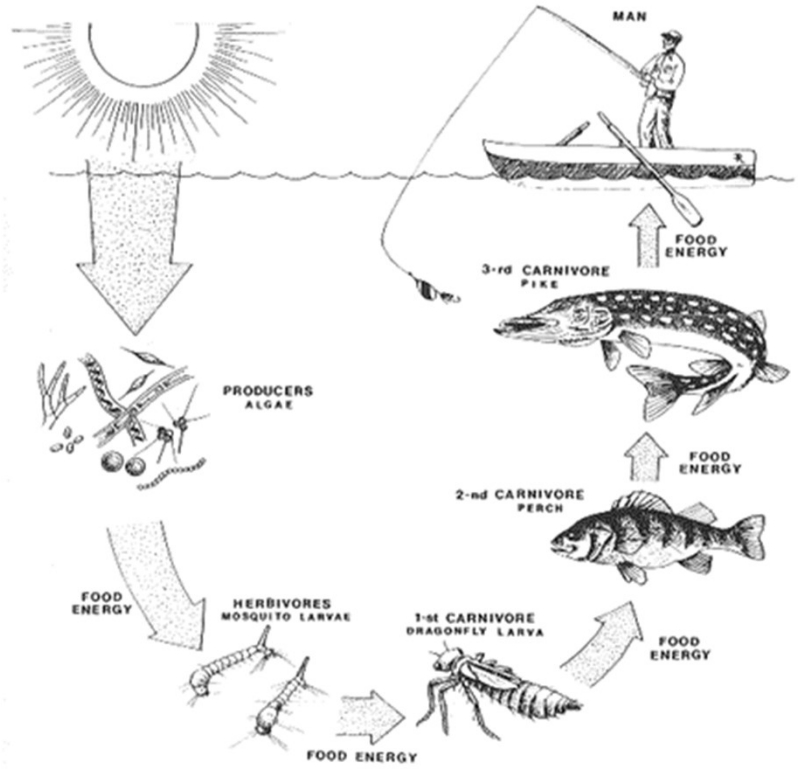
The trophic levels can also be arranged as a food chain…

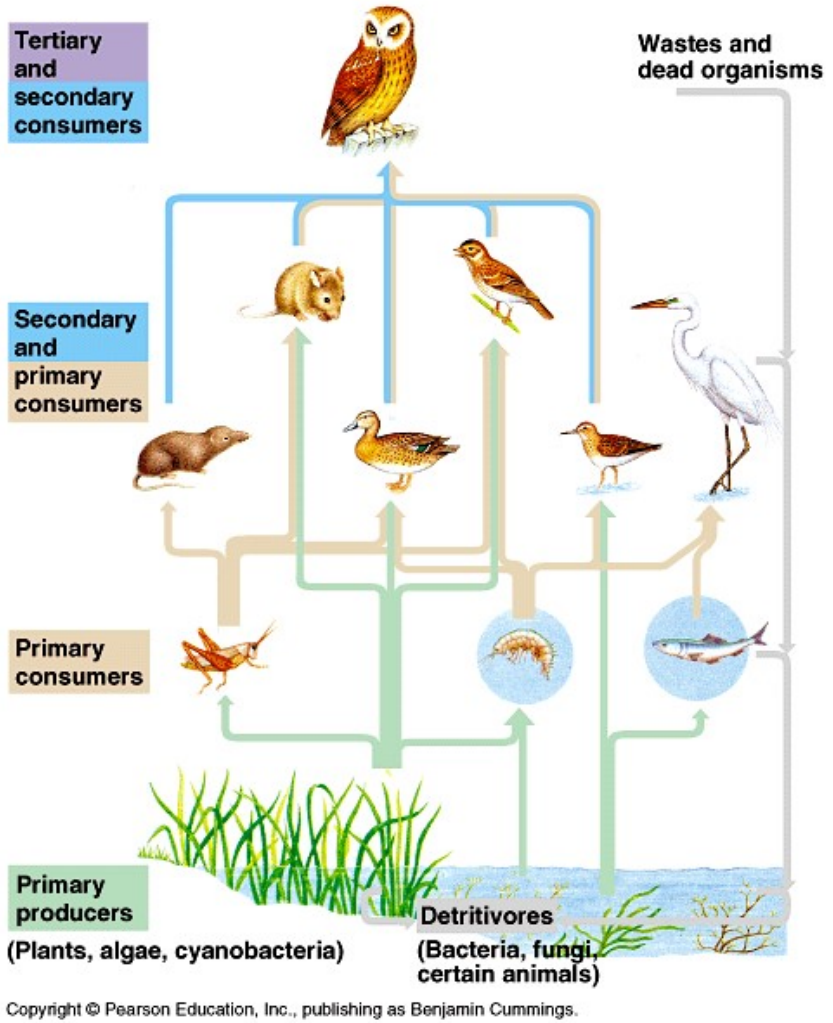
… or better, a food web:



Energy Flows

Why is a food web a better representation of an ecosystem than a food chain?





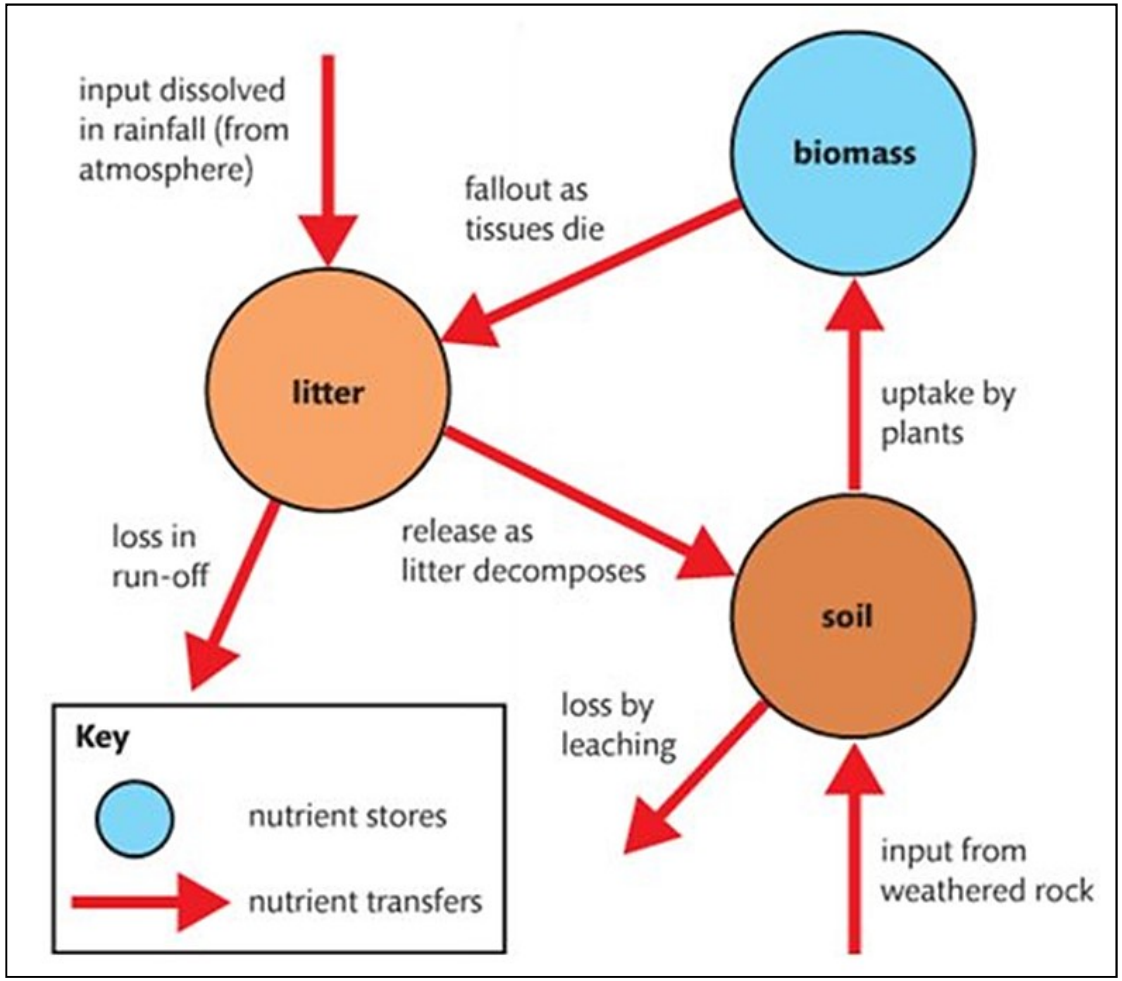
Nutrient Cycles

Chemicals needed to produce organic materials are circulated around the ecosystem and recycled continually.

This cycling of nutrients in ecosystems can be shown using diagrams devised by Gersmehl. He identified three main nutrient stores using circles (biomass, litter and soil), and indicated the flow of nutrients using arrows:

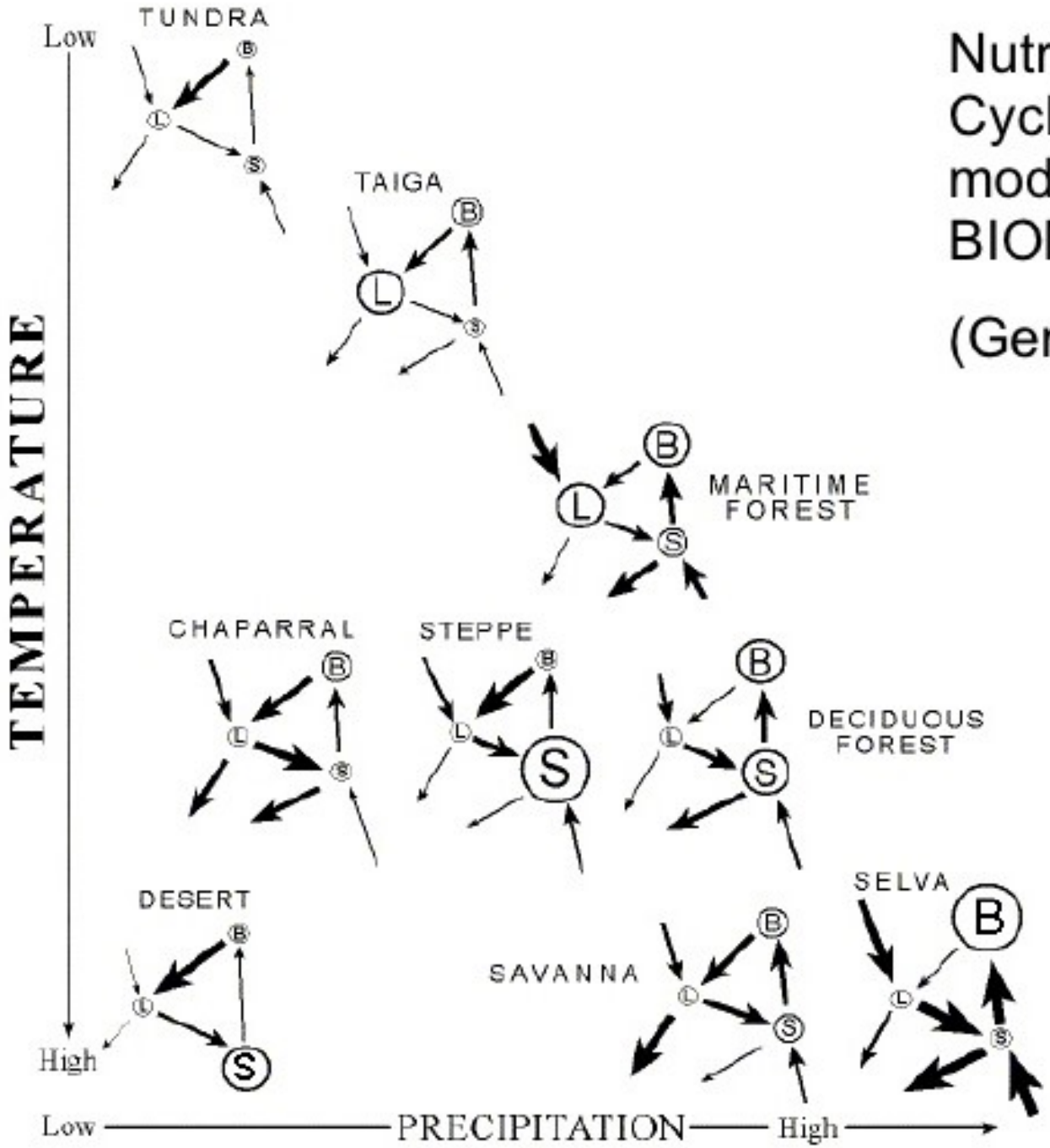
Circle size shows amount of nutrients in that store.

Arrow width shows nutrient flow as percentage of nutrients stored in source store.



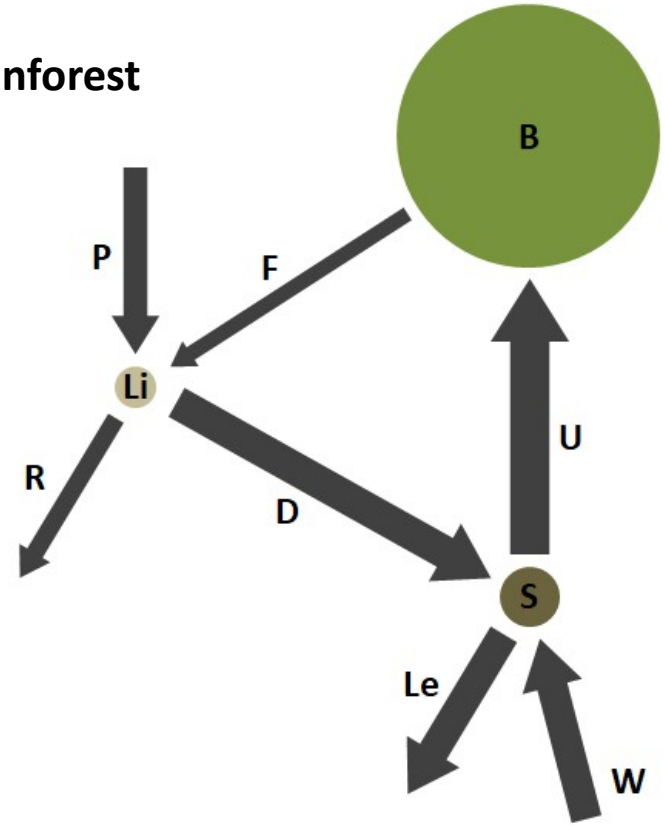
Nutrient Cycling models for BIOMES

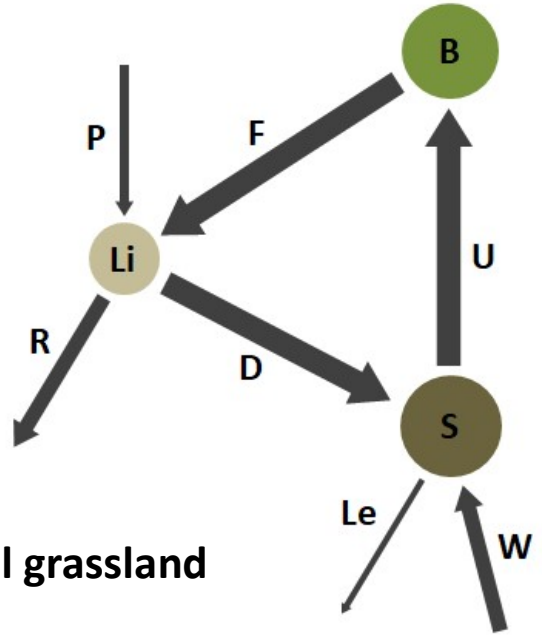
(Gersmehl)



A comparison of the relative sizes of the 3 stores and the flows between them is important in understanding processes within the biomes and the factors affecting them

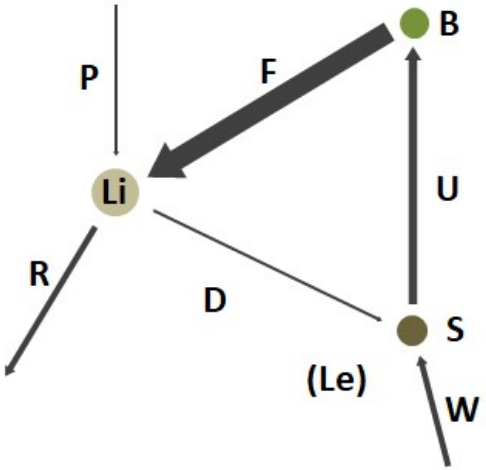
Tropical rainforest





Tropical grassland

Tundra



For all 3 biomes.

- *Compare the relative sizes of stores and flows of nutrients*
- *Conduct research to help you explain why they are different.*
- *To what extent is nutrient cycling affected by climate?*
- *What other factors might have an influence on nutrient cycling here? Give reasons*

Based on diagrams from **Soils, Vegetation, Ecosystems**; G O'Hare; Oliver & Boyd; London; 1990