High C:N ratios show that plants are relatively rich in carbon and poor in nitrogen.

Low C:N ratios show that animals, fungi, and bacteria are relatively rich in nitrogen.

Woody tissues of pine trunks and branches display high C:N ratios.

The C:N ratio of pine needles is much lower and similar to that of herbaceous plants growing in the forest understory.
Sterner & Elser 2001
“Ecological Stoichiometry”

a Stoichiometry in chemistry

\[ 3\text{CaCl}_2 + 2\text{Na}_3\text{PO}_4 \leftrightarrow \text{Ca}_3(\text{PO}_4)_2 + 6\text{NaCl} \]

b Stoichiometry in biology (respiration)

\[ \text{C}_6\text{H}_{12}\text{O}_6 + 6\text{O}_2 \rightarrow 6\text{CO}_2 + 6\text{H}_2\text{O} \]

c Stoichiometry in ecology (predator–prey interaction with nutrient recycling)

\[
\begin{align*}
\text{Q}(N_{x\text{ P}_y})_{\text{predator}} + (N_{a\text{ P}_b})_{\text{prey}} & \rightarrow Q(N_{x\text{ P}_y})_{\text{predator}} + (N_{a\text{ P}_b})_{\text{waste}}
\end{align*}
\]

N:P balance of different biotic components
(where they keep N and P)

(Elser et al. 1996)
H_{375,000,000} O_{132,000,000} C_{85,700,000} N_{6,430,000} Ca_{1,500,000} P_{1,020,000} S_{206,000} Na_{183,000} K_{177,000} Cl_{127,000} Mg_{40,000} Si_{38,600} Fe_{2,680} Zn_{2,110} Cu_{76} I_{14} Mn_{13} F_{13} Cr_{7} Se_{4} Mo_{3} Co_{1} 

Heterotroph growth equation

\[ G = \text{IN} - (\text{EG} + \text{EX}) \]

\( G \) = growth of the organism  
\( \text{IN} \) = ingestion rate  
\( \text{EG} \) = egestion rate (unassimilated)  
\( \text{EX} \) = excretion rate (metabolic waste)

GGE = G/IN gross growth efficiency

What about the stoichiometric quality of the food?

Must take in C N P etc. in appropriate proportions…
Problem: C:N ratio of phloem sap is very high compared to the C:N of aphids. (nutritional imbalance)

Solution: excrete excess C as "honeydew" which is sometimes collected by ants who guard aphid livestock.

(maintain C:N homeostasis)
Stoichiometric homeostasis?
In a plant?
In animals?

Light response curve of a plant

Too little light for photosynthesis

As photosynthetic flux density increases, the rate of photosynthesis by a plant, alga, or photoautotrophic bacterium increases until it levels off at some maximum rate.

$P_{max}$ is the maximum rate of photosynthesis.

$I_{sat}$ is the light intensity at which the photosynthetic system is saturated.

Fig. 2 Dependence of N : P ratios in the shoot biomass of Carex curta on the N : P ratio of the nutrient solution for plants grown during 6 months in an open glasshouse with c. 45% daylight (high light, HL) or in a closed, shaded glasshouse with c. 10% daylight (low light, LL). Variation in N : P supply ratios was created through inverse variation in N and P supply to maintain the geometric mean of N and P at a fixed level, which was 14.3 mg per plant for high nutrient level (HN) and 4.8 mg per plant for low nutrient level (LN). For each combination of light and nutrient levels the regulatory coefficient $H$ was calculated as the inverse slope of a regression line fitted to log-transformed variables (regression lines not shown). Coefficients > 1 indicate homeostasis. (S. Güsewell, unpublished data.)
Functional response - ingestion rate depends on food availability

What sort of functional response was the plant light response curve?

The photosynthetic response curve of *Adiantum decorum*, a fern that grows in the dim light of the forest understory, levels off at low light levels.

In contrast, the response curve of *Encelia farinosa*, a small shrub that lives in hot deserts, levels off at very high light levels.

The forest understory plant has a higher photosynthetic rate at very low light levels.

The three curves differ mainly in how food intake by the consumer changes at low food densities.

All three curves level off at medium to high prey density.

Sit and wait

Constant search

Prey Switching
Moose feeding in a controlled experimental setting show a type 2 functional response.

Wolves feeding on moose in the wild have a type 2 functional response to increased moose density.