Nutrient stoichiometry – Redfield ratios

➢ Nutrient Stoichiometry

- **Stoichiometry**: the calculation of **quantitative** (measurable) relationships of the reactants & products in a balanced chemical equation
- **Nutrient** : any needed substance that an organism obtains from its environment except O_2, CO_2, & H_2O
- **Ecological stoichiometry**:
  - Ecological stoichiometry considers how the **balance of energy** & **elements affect** & are **affected by organisms** & **their interactions** in ecosystems.
  - seeks to **discover how the chemical content of organisms shapes their ecology**.
  - Ecological stoichiometry has been applied to studies of **nutrient recycling**, resource **competition**, **animal growth**, & **nutrient limitation patterns** in whole ecosystems.
  - This research area in ecology has recently gained momentum by explicitly linking the elemental physiology of organisms to the their food web interactions & ecosystem function.
  - Ecological Stoichiometry equally considers phenomena at the sub-cellular level, such as the P-content of a ribosome, as well as phenomena at the whole biosphere level, such as the oxygen content of Earth's atmosphere.
  - Ecological stoichiometry has a long history in ecology with early references to the constraints of mass balance made by **Liebig**, **Lotka**, & **Redfield**.
  - The **Redfield ratio** of the world's oceans is one very famous application of stoichiometric principles to ecology.

➢ Redfield Ratio

- **History of the Redfield Ratio**
  - In 1934, **Alfred C. Redfield**, first described the ratio in an article in which he analyzed thousands of samples of marine biomass from all ocean regions.
  - **Redfield** described the remarkable congruence between the chemistry of the deep ocean & the chemistry of living things in the surface ocean.
  - He found that globally the elemental composition of marine organic matter (dead & living) was remarkably constant.
  - The ratios of **carbon** to **nitrogen** to **phosphorus** remained the same from coastal to open ocean regions.
  - **Redfield** thought it wasn't purely coincidental that the vast oceans would have a chemistry perfectly suited to the requirements of living organisms.
  - He considered how the cycles of not just N & P but also C & O could interact to result in this match.
  - This suggests that the chemical composition of the ocean would be much different if it was devoid of life
  - The concept of **Redfield Ratios** has been fundamental to understanding the biogeochemistry of the oceans ever since
  -
- **Redfield Ratio**
  - a.k.a. Redfield Stoichiometry, Redfield-Richards Ratio
  - the **molecular ratio** of **Carbon** (**C**), **Nitrogen** (**N**) & **Phosphorus** (**P**) in **phytoplankton**
  - When nutrients are **not limiting**, the **molar element ratio C:N:P** in **most phytoplankton is 106:16:1**
  - Redfield ratio enables scientists to study the biochemical cycles & **determine which nutrient** might be **limiting** in the system or if the nutrients in system are well balanced.
  - The **stoichiometric ratio of ocean waters follows this ratio** as well leading scientists to believe that **phytoplankton controls nutrient chemistry of oceanic waters** through **cycling** & **regeneration** of **nutrients**.
  - By comparing the nutrient ratios of the Mississippi River & the northern Gulf of Mexico with the Redfield ratio, scientists can better understand the formation of phytoplankton blooms & subsequently hypoxia.