

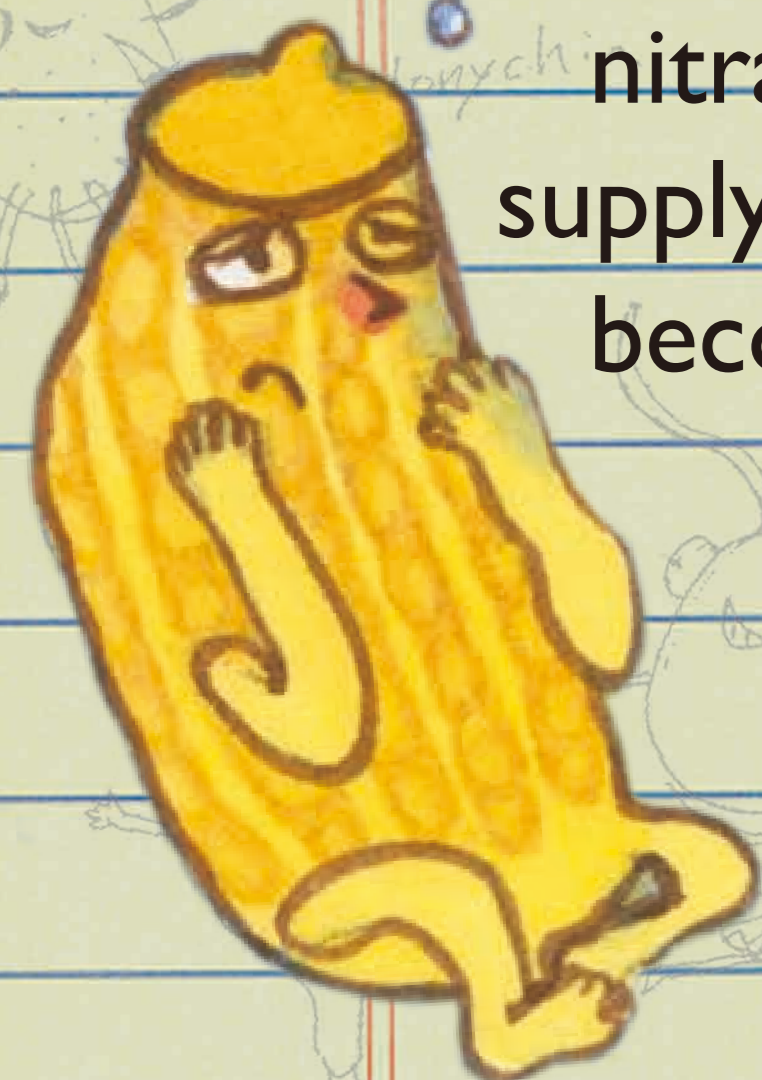
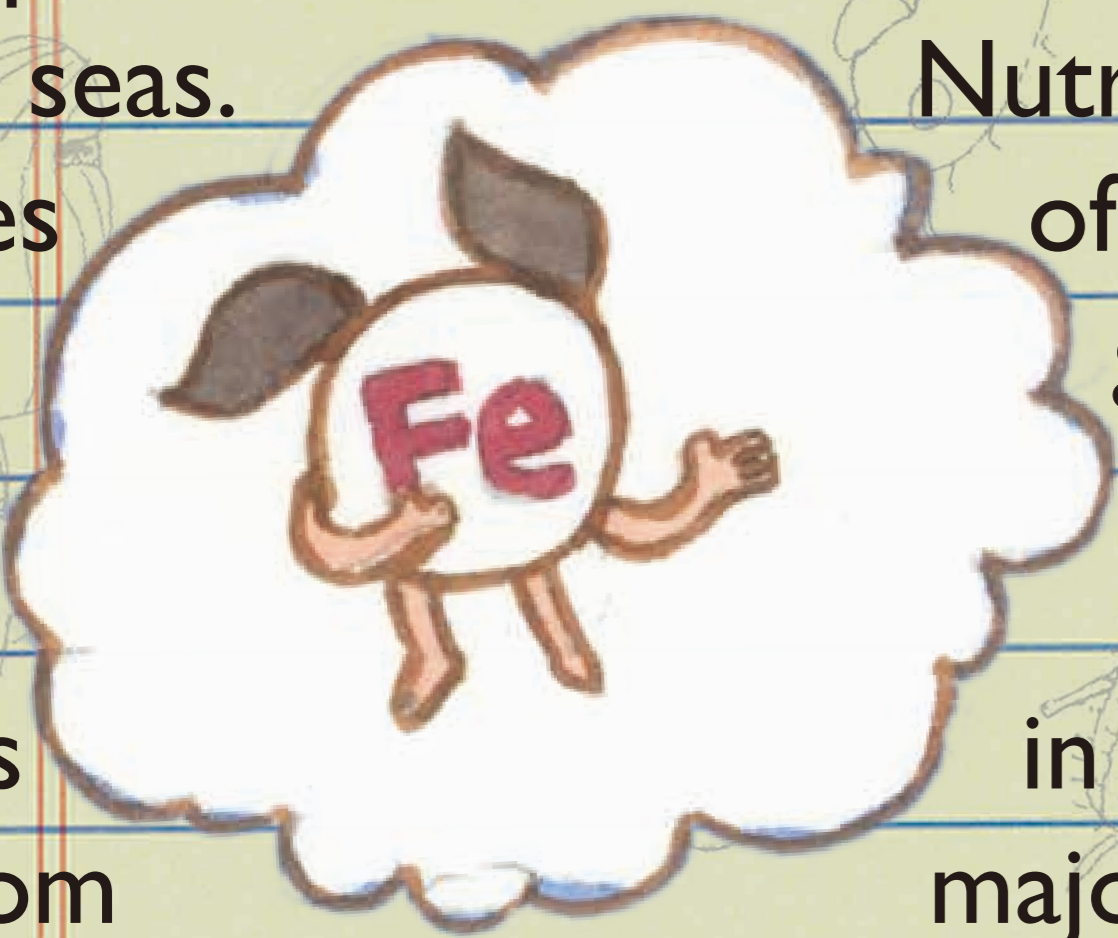


### What Are the Limiting Factors?

The biologically essential nutrient with the lowest relative amount in the environment becomes the limiting factor. If you put too much fish food in your aquarium at home or in the pond in the park, the water will turn green very soon. This means the algae is growing fast and multiplying quickly. It is the same with large reservoirs. If fruit trees are planted nearby and fertilizer is often added, after a heavy rain or typhoon, then the necessary but utterly lacking nutrients suddenly become available for the algae in the reservoir to grow. The vital but usually absent essential nutrient is the limiting factor for microalgal growth.

It is not good news for the ecosystem when nutrient supply is so high that biomass becomes so large that it is no longer sustainable for that ecosystem. Large amounts of biomass eventually become decomposing organic matter, which at the same time greatly enhance both heterotrophic bacteria growth and oxygen consumption. The high oxygen consumption rates cause the aquatic environment to become anoxic.

The open ocean is big and deep. The nutrient concentrations and supply rates in the surface layer of the open ocean are generally low. Thus, phytoplankton biomass is quite low. In contrast, nutrient supply rates are relatively high in the marginal seas. Nutrients can enter the ocean through the transport processes of river run off, atmospheric deposition, and submarine groundwater discharge. The relatively high supply rates of limiting nutrients in the marginal seas thus elevate primary production in the waters. The major nutrients in the ocean are nitrogen (N) and phosphorus (P). Aside from major nutrients, trace metals can also limit algal growth. For example, in the Southern Ocean and equatorial Pacific Ocean, nitrate and phosphate concentrations are high but the relative supply of iron is extremely low. Thus in the Southern Ocean iron becomes the main factor limiting algal growth.



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