Process	Biochemical reaction	Formulation	Description
Gross primary production (GPP)	$106CO_2 + 16HNO_3 + H_3PO_4 + 122H_2O$+(sunlight) $\rightarrow (CH_2O)_{106}(NH_3)_{16}H_3PO_4 + 138O_2$ Nutrient limitation for phytoplankton growth $\text{nlim} = \frac{NO_3 + NH_4}{NO_3 + NH_4 + K_N} \times \frac{PO_4}{PO_4 + K_{PO_4}} \times \frac{DSi}{DSi + K_{Si}}$	$\text{GPP} = P^B_{max}(T) \times \text{nlim} \times \text{phytoplankton} \times \int_H^0 1 - \exp\left(-\frac{\alpha}{P^B_{\max}(T)} \times I(0) \times \exp(-K_D \cdot H)\right) \text{dz}$ P^B_{max}: photosynthesis rate nlim: Nutrient limitation for phytoplankton growth	GPP refers to the total rate of organic carbon production by phytoplankton based on the rate of photosynthesis $I(0)$: solar radiation K_D: Light extinction coefficient H: water depth
Net primary production (NPP)	NPP is the rate of phytoplankton produces biomass which already subtract the respiration of primary producers, including: k_{excr} phytoplankton excretion k_{growth} growth constants of phytoplankton k_{maint} phytoplanktonic maintenance	$\text{NPP} = \frac{\text{GPP}}{H} \times (1 - k_{\text{excr}}) \times (1 - k_{\text{growth}}) - k_{\text{maint}}(T) \times \text{p}hytoplankton$	NPP is GPP minus the autotrophs' respiration rate (i.e., only by the primary producers).
Nitrification	$NH_4^+ + 2O_2 \rightarrow NO_3^- + H_2O + 2H^+$	$N = k_{\text{nit}}(T) \times \frac{NH_4}{NH_4 + K_{NH_4}} \times \frac{O_2}{O_2 + K_{O_2,\text{nit}}}$ $k_{\text{nit}}(T)$ maximum rate constant K_{NH_4} half-saturation constants	Under aerobic conditions, ammonia is oxidized to nitrite and nitrate via nitrification
Denitrification	$94.4HNO_3 + (CH_2O)_{106}(NH_3)_{16}(H_3PO_4)$ $\rightarrow 106CO_2 + 55.2N_2 + H_3PO_4 + 177.2H_2O$	$D = k_{\text{denit}}(T) \times \frac{\text{TOC}}{\text{TOC} + K_{\text{TOC}}} \times \frac{NO_3}{NO_3 + K_{NO_3}} \times \frac{K_{\text{in},O_2}}{O_2 + K_{\text{in},O_2}}$	Under anaerobic conditions, nitrate is reduced to gas forms as N_2, N_2O while organic P is degraded to inorganic PO_4^{3-}
Aerobic degradation (respiration)	$138O_2 + (CH_2O)_{106}(NH_3)_{16}(H_3PO_4)$ $\rightarrow 106CO_2 + 16HNO_3 + H_3PO_4 + 122H_2O$	$R = k_{\text{OX}}(T) \cdot \frac{\text{TOC}}{\text{TOC} + K_{\text{TOC}}} \cdot \frac{O_2}{O_2 + K_{O_2,\text{ox}}}$	Degradation of organic carbon in the aerobic condition that converts into inorganic matters

Phytoplankton = NPP - Phytoplankton mortality
DSi = NPP of Diatom = NPP x Redfield ratio for silica (15/106)
NH_4^+ = Aerobic degradation – Nitrification – NPP_{NH4}
NO_3^- = Nitrification - Denitrification – NPP_{NO3}
TOC = Phytoplankton mortality – Aerobic degradation – Denitrification
O_2 = Oxygen air exchange + NPP – Aerobic degradation – Nitrification
PO_4^{3-} = Aerobic degradation + Denitrification – NPP_{PO4} – PO4 adsorption