# cells/L

Xp = Bp / Qp

Xh = Bh / Qh

# ratio

limINp = (DIN / (DIN + KINp))

limONp = (DON / (DON + KONp))

limICp = (DIC / (DIC + KICp))

limOCp = (DOC / (DOC + KOCp))

limINh = (DIN / (DIN + KINh))

limONh = (DON / (DON + KONh))

limICh = (DIC / (DIC + KICh))

limOCh = (DOC / (DOC + KOCh))

limSh = (Sh / (Sh + KSh))

limSp = (Sp / (Sp + KSp))

# vmax = muinfp\* VmaxIp / Qp

# umol N /L

gross\_uptakeINp = VmaxINp \* limINp \* exp(-omegaP\*ROS) \* Bp

gross\_uptakeONp = VmaxONp \* limONp \* exp(-omegaP\*ROS) \* Bp

gross\_uptakeINh = VmaxINh \* limINh \* exp(-omegaH\*ROS) \* Bh

gross\_uptakeONh = VmaxONh \* limONh \* exp(-omegaH\*ROS) \* Bh

# umol C /L

gross\_uptakeICp = VmaxICp \* limICp \* exp(-omegaP\*ROS) \* Bp

gross\_uptakeOCp = VmaxOCp \* limOCp \* exp(-omegaP\*ROS) \* Bp

gross\_uptakeICh = VmaxICh \* limICh \* exp(-omegaH\*ROS) \* Bh

gross\_uptakeOCh = VmaxOCh \* limOCh \* exp(-omegaH\*ROS) \* Bh

# umol N / L

actual\_uptakeNp = Min(gross\_uptakeINp + gross\_uptakeONp,

(gross\_uptakeICp + gross\_uptakeOCp) / Rp)

actual\_uptakeNh = Min(gross\_uptakeINh + gross\_uptakeONh,

(gross\_uptakeICh + gross\_uptakeOCh) / Rh)

# ratio

IOuptakeRateNp = gross\_uptakeINp / (gross\_uptakeINp + gross\_uptakeONp)

IOuptakeRateCp = gross\_uptakeICp / (gross\_uptakeICp + gross\_uptakeOCp)

IOuptakeRateNh = gross\_uptakeINh / (gross\_uptakeINh + gross\_uptakeONh)

IOuptakeRateCh = gross\_uptakeICh / (gross\_uptakeICh + gross\_uptakeOCh)

# umol N / L

overflowNp = gross\_uptakeINp + gross\_uptakeONp - actual\_uptakeNp

overflowNh = gross\_uptakeINh + gross\_uptakeONh - actual\_uptakeNh

# umol C /L

overflowCp = gross\_uptakeICp + gross\_uptakeOCp - actual\_uptakeNp \* Rp

overflowCh = gross\_uptakeICh + gross\_uptakeOCh - actual\_uptakeNh \* Rh

# umol N / L

overflowINp = (1 - Op) \* overflowNp \* IOuptakeRateNp

overflowONp = Op \* overflowNp + (1 - Op) \* overflowNp \* (1 - IOuptakeRateNp)

overflowICp = (1 - Op) \* overflowCp \* IOuptakeRateCp

overflowOCp = Op \* overflowCp + (1 - Op) \* overflowCp \* (1 - IOuptakeRateCp)

overflowINh = Oh \* overflowNh + (1 - Oh) \* overflowNh \* IOuptakeRateNh

overflowONh = (1 - Oh) \* overflowNh \* (1 - IOuptakeRateNh)

overflowICh = Oh \* overflowCh + (1 - Oh) \* overflowCh \* IOuptakeRateCh

overflowOCh = (1 - Oh) \* overflowCh \* (1 - IOuptakeRateCh)

respirationp = bp\* actual\_uptakeNp + Bp \* r0p

respirationh = bh\* actual\_uptakeNh + Bh \* r0h

dic\_uptake = - (DIC - c\_sat) / tau

# M = M / Q

# death = M \* X = M \* B /Q = M / Q \* B

death\_ratep = Min(Max(Mp - Msp\*limSh, 0), 1 / seconds\_in\_day)

death\_rateh = Min(Max(Mh - Msh\*limSp, 0), 1 / seconds\_in\_day)

deathp = death\_ratep \* Bp #\* Xp

deathh = death\_rateh \* Bh #\* Xh

exudationOp = EOp \* Bp

exudationIp = EIp \* Bp

exudationOh = EOh \* Bh

exudationIh = EIh \* Bh

# epsilon = epsilon / Q

# VTMax = VTmax / Q

Treleasep = ETp \* Bp

Treleaseh = ETh \* Bh

Tbreakdownh = VTmax \* ROS / (ROS + KTh) \* Bh

# signal

Sreleasep = Esp \* Bp - Sp\*decaySp

Sreleaseh = Esh \* Bh - Sh\*decaySh

# final equation - coculture

dBpdt = actual\_uptakeNp - deathp - exudationOp - exudationIp - respirationp - Sreleasep

dBhdt = actual\_uptakeNh - deathh - exudationOh - exudationIh - respirationh - Sreleaseh

dDONdt = deathp \* gammaDp + deathh \* gammaDh + exudationOp + exudationOh - gross\_uptakeONp - gross\_uptakeONh + overflowONp + overflowONh

dDOCdt = deathp \* gammaDp \* Rp + deathh \* gammaDh \* Rh + exudationOp \*Rp + exudationOh \* Rh - gross\_uptakeOCp - gross\_uptakeOCh + overflowOCp + overflowOCh

dRDONdt = deathp \* (1 - gammaDp) + deathh \* (1 - gammaDh)

dRDOCdt = deathp \* (1 - gammaDp) \* Rp + deathh \* (1 - gammaDh) \* Rh

dDINdt = exudationIp + exudationIh - gross\_uptakeINp - gross\_uptakeINh + overflowINp + overflowINh + respirationh + respirationp

dDICdt = exudationIp \*Rp + exudationIh\* Rh - gross\_uptakeICp - gross\_uptakeICh + overflowICp + overflowICh + respirationh\* Rh + respirationp \* Rp + dic\_uptake

dROSdt = Max( -ROS\*ROS\_decay + Treleasep + Treleaseh - Tbreakdownh, -ROS)

dSpdt = Sreleasep

dShdt = Sreleaseh

# PRO only model

dDONdt\_ponly = deathp \* gammaDp + exudationOp - gross\_uptakeONp + overflowONp

dDOCdt\_ponly = deathp \* gammaDp \* Rp + exudationOp \*Rp - gross\_uptakeOCp + overflowOCp

dRDONdt\_ponly = deathp \* (1 - gammaDp)

dRDOCdt\_ponly = deathp \* (1 - gammaDp) \* Rp

dDINdt\_ponly = exudationIp - gross\_uptakeINp + overflowINp+ respirationp

dDICdt\_ponly = exudationIp \*Rp - gross\_uptakeICp + overflowICp + respirationp\* Rp + dic\_uptake

dROSdt\_ponly = Treleasep

dROSdt\_ponly = Max( -ROS\*ROS\_decay + Treleasep, -ROS)

dShdt\_ponly = Integer(0)

# HET only model

dDONdt\_honly = deathh \* gammaDh + exudationOh - gross\_uptakeONh + overflowONh

dDOCdt\_honly = deathh \* gammaDh \* Rh + exudationOh \* Rh - gross\_uptakeOCh + overflowOCh

dRDONdt\_honly = deathh \* (1 - gammaDh)

dRDOCdt\_honly = deathh \* (1 - gammaDh) \* Rh

dDINdt\_honly = exudationIh - gross\_uptakeINh + overflowINh + respirationh

dDICdt\_honly = exudationIh\* Rh - gross\_uptakeICh + overflowICh + respirationh\* Rh + dic\_uptake

dROSdt\_honly = Max( -ROS\*ROS\_decay + Treleaseh - Tbreakdownh, -ROS)

dSpdt\_honly = Integer(0)