**Chemical oxygen demand**

Oxygen required to convert organic compounds to $CO_2$

ex) COD for a bacterial cell:

$C_5H_7O_2N + 5O_2 \rightarrow 5CO_2 + NH_3 + 2H_2O$

MW for $C_5H_7O_2N$ = 113 g/mol

(5 mol x 32 g COD/mol) / (113 g cells/mol) = 1.42 g COD/g cells (shown in Table 2.1)

**Equation for true yield:**

$$Y = f_s^0 \frac{(M_c \text{ g cells/mol cells})}{(n_e \text{ e}^- \text{ eq/mol cells})(8 \text{ g COD/e}^- \text{ eq donor})}$$

Generally concentration of substrates are expressed as COD because of complex nature of wastewater

$f_s^0$ = (e-eq cells) / (e- eq donor)

$$Y = \frac{(e^- \text{ eq cells})}{(e^- \text{ eq donor})} \frac{(M_c \text{ g cells/mol cells})}{(n_e \text{ e}^- \text{ eq/mol cells})(8 \text{ g COD/e}^- \text{ eq donor})} = \frac{\text{g cells}}{\text{g COD}}$$

- Why 8 g COD/e$^-$ eq donor?

  For a COD reaction

  e.g., $C_6H_{12}O_6 + 6O_2 \rightarrow 6CO_2 + 6H_2O$

  or $(1/6)C_6H_{12}O_6 + O_2 \rightarrow CO_2 + H_2O$

  e$^-$ donated by $C_6H_{12}O_6$ = e$^-$ accepted to $O_2$

  $O_2$ [0] $\rightarrow$ $CO_2$ [-2]

  32 g COD/4 e$^-$ eq donor (=acceptor) = 8 g COD/e$^-$ eq donor

- Other parameters for the equation

  $M_c = C_5H_7O_2N \rightarrow$ 113 g/mol

$n_e$ → $C_5H_7O_2N$, see p. 137 O-20: $n_e = 20$

Then, plug in the numbers for the case of $C_5H_7O_2N$ with $NH_4$ as nitrogen source (ammonia acid dissociation constant ($pK_a$) = 9.25 → mostly in $NH^+$ under normal pH conditions)

➔ $Y = 0.706\ f_s^0$