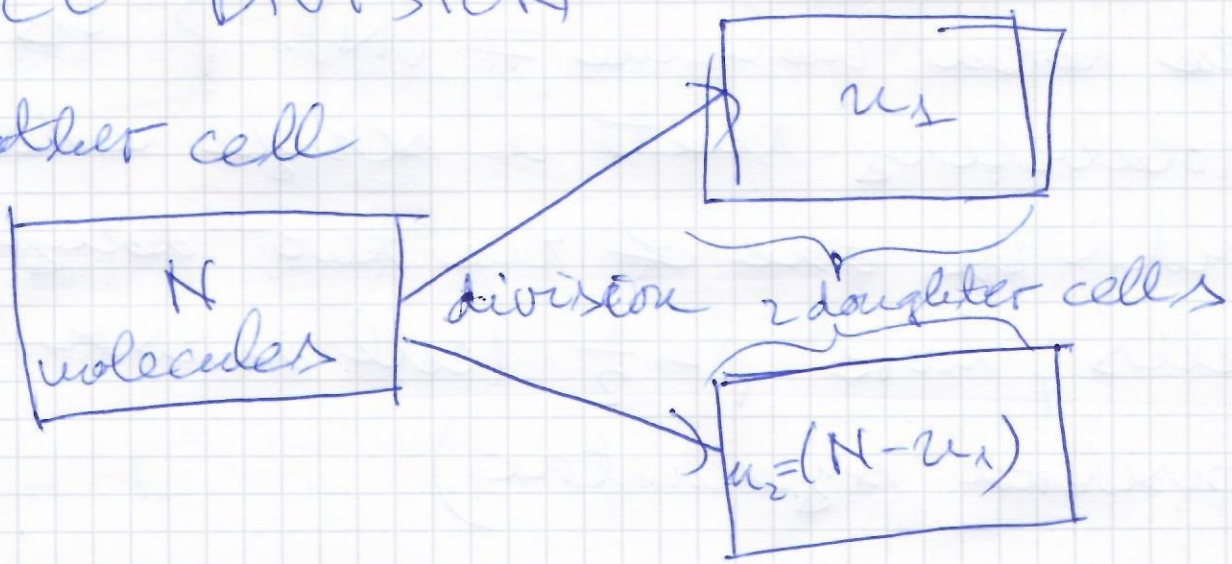
MOLECULES IN CELL, THROUGH STOCHASTIC ~~EFFECTS~~ EFFECTS IN MOLECULE PARTITIONING DURING CELL DIVISION



"Error" in molecule partitioning:

$$\frac{\Delta n}{2} = \frac{n_1 - n_2}{2} = \frac{n_1 - (N-n_1)}{2} = n_1 - \frac{N}{2}$$

↳ divide by 2 to be consistent with the Science Elowitz paper.

RMS (root the mean square) of $\frac{\Delta n}{2}$

$$\sqrt{\left\langle \left(\frac{\Delta n}{2}\right)^2 \right\rangle} = \sqrt{\left\langle \left(n_1 - \frac{N}{2}\right)^2 \right\rangle} = \sqrt{\langle n_1^2 \rangle - N\langle n_1 \rangle + \frac{N^2}{4}}$$

Distribution (probability) to get n_1 molecules follows Binomial distribution:

Use properties of Binomial distribution:

Mean:

$\langle n_1 \rangle = (N)\, p \cdot$ [illegible]

↳ Total # of trials, here equal ~~to~~ the ~~total~~ molecule # (N). p is probability that a single molecule ends in one of the two daughter cells, here $p = \frac{1}{2}$ (cell division is considered symmetric)

Variance:

$$\mathrm{Var}(n_1) = \langle n_1^2 \rangle - \langle n_1 \rangle^2 = N \cdot p(1-p)$$

$$\langle n_1^2 \rangle = N \cdot p(1-p) + \langle n_1 \rangle^2 = N \cdot \frac{1}{2} \cdot \frac{1}{2} + \left(\frac{N}{2}\right)^2$$

$$\langle n_1^2 \rangle = \frac{N}{4} + \frac{N^2}{4} = \frac{N}{4}(N+1)$$

$$\sqrt{\left\langle \left(\frac{\Delta n}{2}\right)^2 \right\rangle} = \sqrt{\frac{N^2}{4} + \frac{N}{4} - \frac{N^2}{2} + \frac{N^2}{4}}$$

$$\sqrt{\left\langle \left(\frac{\Delta n}{2}\right)^2 \right\rangle} = \frac{\sqrt{N}}{2} \quad \left\{ \text{Q.E.D. relation from the science} \right) \quad (1)$$

to the signal intensity I:

$N = \alpha \boxed{I}$; $n_1 = \alpha \cdot \boxed{I_1}$; $n_2 = \alpha \cdot \boxed{I_2}$

I: total fluorescence signal

I_1: signal in one daughter cell

I_2: signal in the other daughter cell

$$\sqrt{\left\langle \left(\frac{\Delta n}{2}\right)^2 \right\rangle} = \alpha \cdot \sqrt{\left\langle \frac{(I_1 - I_2)^2}{2} \right\rangle} \quad (2)$$

$$\sqrt{\frac{N}{2}} = \sqrt{\alpha \cdot I} \quad (3)$$

From (1), (2) and (3):

$$\alpha \sqrt{\left\langle \frac{(I_1 - I_2)^2}{2} \right\rangle} = \frac{\sqrt{\alpha}}{2} \sqrt{I}$$

$$\sqrt{\left\langle \frac{(I_1 - I_2)^2}{2} \right\rangle} = \frac{1}{2\sqrt{\alpha}} \sqrt{I}$$

$\sqrt{\left\langle \frac{(I_1 - I_2)^2}{2} \right\rangle}$: LHS signal difference

I: total signal intensity

If LHS signal diff. vs fitted to $\sqrt{\text{total sig}}$ α can be extracted from fit and used to determine total # molecules from fluorescence signal!