

# Lecture-00-Hemoglobin

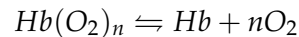
## Quantitative Biochemistry

- My name is Dr Philip Fowler and my undergraduate was in Physics, my PhD in Chemistry and I spent ten years in the Department of Biochemistry before moving up to the John Radcliffe to establish my own research group investigating antibiotic resistance.
- I took this course over in 2020 from Professor Elspeth Garman who gave this course and developed it over 25 years. About ten years ago I was a class tutor on this course.
- Please feel free to email me with any suggestions (or any other thoughts). My email is philip.fowler@ndm.ox.ac.uk.
- This term we have 12 lectures to introduce you to the mathematics you need for biochemistry. Next term someone else will introduce the statistics you need.

## Hemoglobin



Hemoglobin (Hb) has four oxygen binding sites so we can write

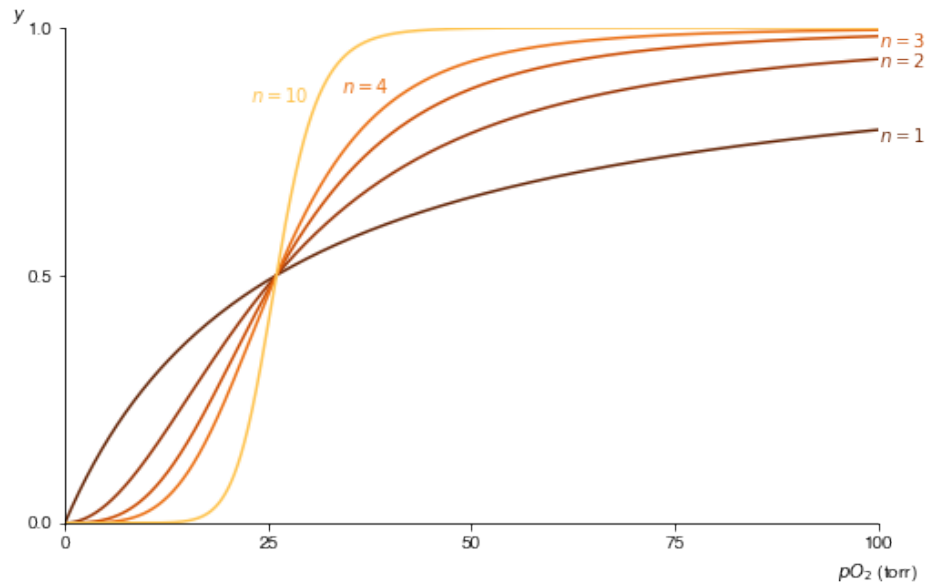


where  $n \leq 4$

The binding of oxygen to hemoglobin is described by the *Hill equation*

$$Y = \frac{(p\text{O}_2)^n}{(p\text{O}_2)^n + (P_{50})^n}$$

where  $Y$  is the fraction of binding sites occupied by oxygen molecules,  $p\text{O}_2$  is the partial pressure of oxygen (analogous to concentration) and  $P_{50}$  is a measure of affinity.



### How we measure $n$ ?

I can't draw curves like those above – we **always** have to convert the function into the form of a straight line and then measure the gradient and y-intercept.

$$Y = \frac{(pO_2)^n}{(pO_2)^n + (P_{50})^n}$$

$$Y = \frac{\left(\frac{pO_2}{P_{50}}\right)^n}{\left(\frac{pO_2}{P_{50}}\right)^n + 1}$$

$$Y \left( \left(\frac{pO_2}{P_{50}}\right)^n + 1 \right) = \left(\frac{pO_2}{P_{50}}\right)^n$$

$$Y = \left(\frac{pO_2}{P_{50}}\right)^n (1 - Y)$$

$$\frac{Y}{1 - Y} = \left(\frac{pO_2}{P_{50}}\right)^n$$

Hmm, is that simpler?? Well if we take the logarithms of both the LHS and RHS and apply the log laws (more later!) we can simplify it...

$$\begin{aligned}\ln\left(\frac{Y}{1-Y}\right) &= \ln\left(\frac{pO_2}{P_{50}}\right)^n \\ &= n \ln\left(\frac{pO_2}{P_{50}}\right) \\ \ln\left(\frac{Y}{1-Y}\right) &= n \ln(pO_2) - n \ln(P_{50})\end{aligned}$$

this looks like

$$y = m.x + c$$

i.e. if we plot  $\left(\frac{Y}{1-Y}\right)$  against  $\ln(pO_2)$  the gradient is  $n$  and the y-intercept is  $-n \ln(P_{50})$ .

We are now in position where we can take measurements in an experiment and, by plotting a graph in the form above, can estimate  $n$  and  $P_{50}$ !

