Code words for equations, scheme, and plots in multiple equilibrium problems

During the course of the linkage section, you are exposed to a large number of “names” associated with various chemical schemes, equations that emerge from them, and ways to plot these equations. These can be very confusing the first time around. So here is a list of the various names used in the course, and what, exactly, they refer to.

**Langmuir**

This is a code-word for two things – an equation and a binding-scheme. A “Langmuir binding scheme” is the simplest kind of binding of a ligand (X) to a receptor (R) to form a complex (RX):

\[
X + R \rightarrow RX \quad \text{Langmuir binding scheme}
\]

If you solve this scheme for the fraction of the receptor in the ligand-bound form as a function of free X, you get:

\[
f(x) = \frac{Kx}{1+Kx} \quad \text{Langmuir equation}
\]

**Adair**

This is a code-word for a general multiple-site binding scheme and for the equation that emerges from it. The scheme envisions a macromolecule with N sites at which a single ligand, X, can bind. Each binding step (for the first ligand, the second ligand, etc) has its own equilibrium constant:

\[
K_1, K_2, \ldots, K_N
\]

\[
P_0 - PX_1 - PX_2 - \cdots - PX_{(N-1)} - PX_N \quad \text{Adair binding scheme}
\]

This scheme leads to an equation for the average number of sites bound as a function of ligand concentration:

\[
\nu(x) = \frac{K_1 x + 2K_1K_2x^2 + 3K_1K_2K_3x^3 + \ldots}{K_1 x + K_1K_2x^2 + K_1K_2K_3x^3 + \ldots} \quad \text{Adair equation}
\]
**Hill**

This code-word refers to four things – a “perfectly cooperative” binding model, an equation emerging from that model, a way to plot various kinds of data as a function of ligand concentration, and a quantitative feature of this plot.

\[
P_o - P_N \quad \textbf{Hill binding model} \quad \nu(x) = \frac{Kx^N}{1 + Kx^N} \quad \textbf{Hill equation}
\]

A plot of \(\log[\nu/(\nu_{max} - \nu)]\) vs log(x) is called a **Hill plot**.

Here are a linear and a Hill plot of the Hill equation, with \(n=1\) or \(n=4\):

The slope on a Hill plot, \(n_H\), is called the **Hill coefficient**.

**Monod-Wyman-Changeux (MWC)**

This code-word refers to a particular scheme for cooperativity:

\[
L_o \quad K_1 \quad K_2 \quad ... \\
T_o \rightarrow R_o - RX_1 - RX_2 - RX_3 - ... RX_N , \quad \text{where the following assumptions hold:}
\]

1. The protein contains \(N\) identical subunits
2. The T-- R conformational transition involves all N subunits, with mixed subunits forbidden.
3. Ligand binds independently to the N identical sites on R
4. Ligand cannot bind to the T conformation
   (This assumption can be relaxed in an extended MWC formulation)