# APPENDIX

## PROBLEM SOLVING WITH RECIPES AND EQUATIONS

**Overview:** Although we can capture biological changes with many different data types, biology seems to operate with largely two modes of change - one based on local rules (in response to local conditions) and the other on global rules (hard-coded principles). The first is meant to be flexible (less precision), whereas the second is more constrained (more precision). Both sets are always in play.

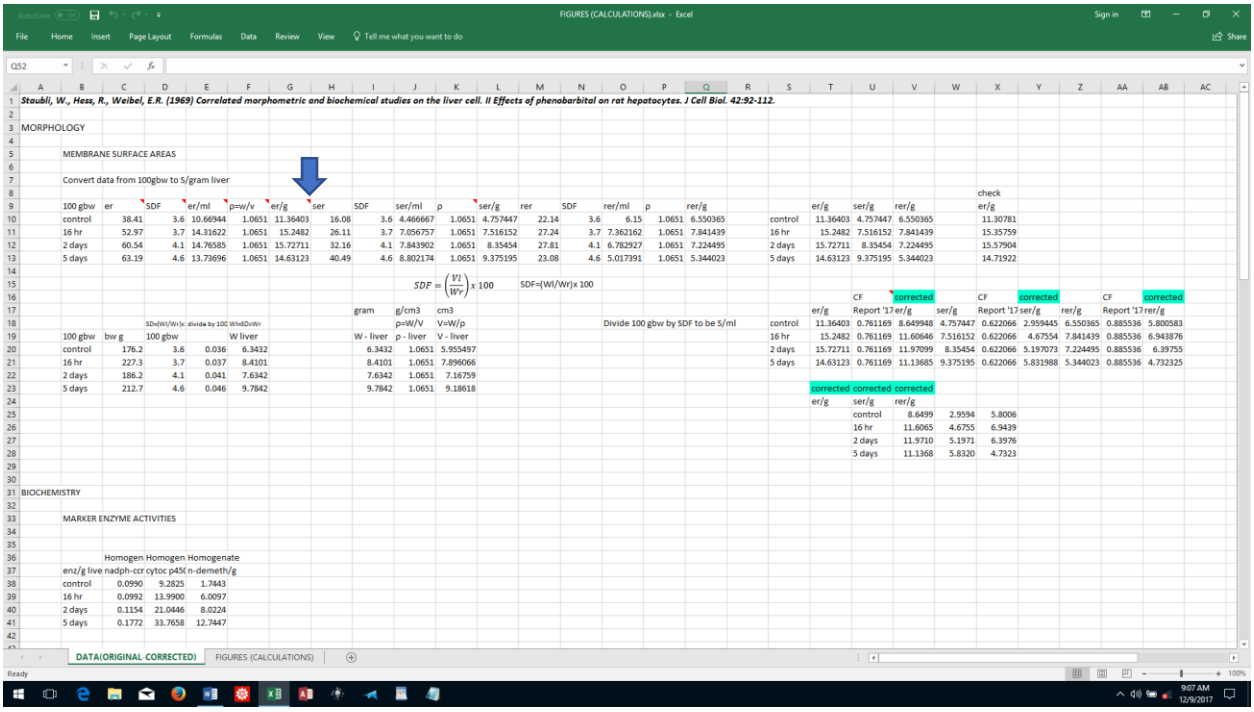
The Appendix includes the calculations used to generate the figures given in the report. As usual, the files are available on line (playingcomplexitygames.com).

# Files Used in the Appendix

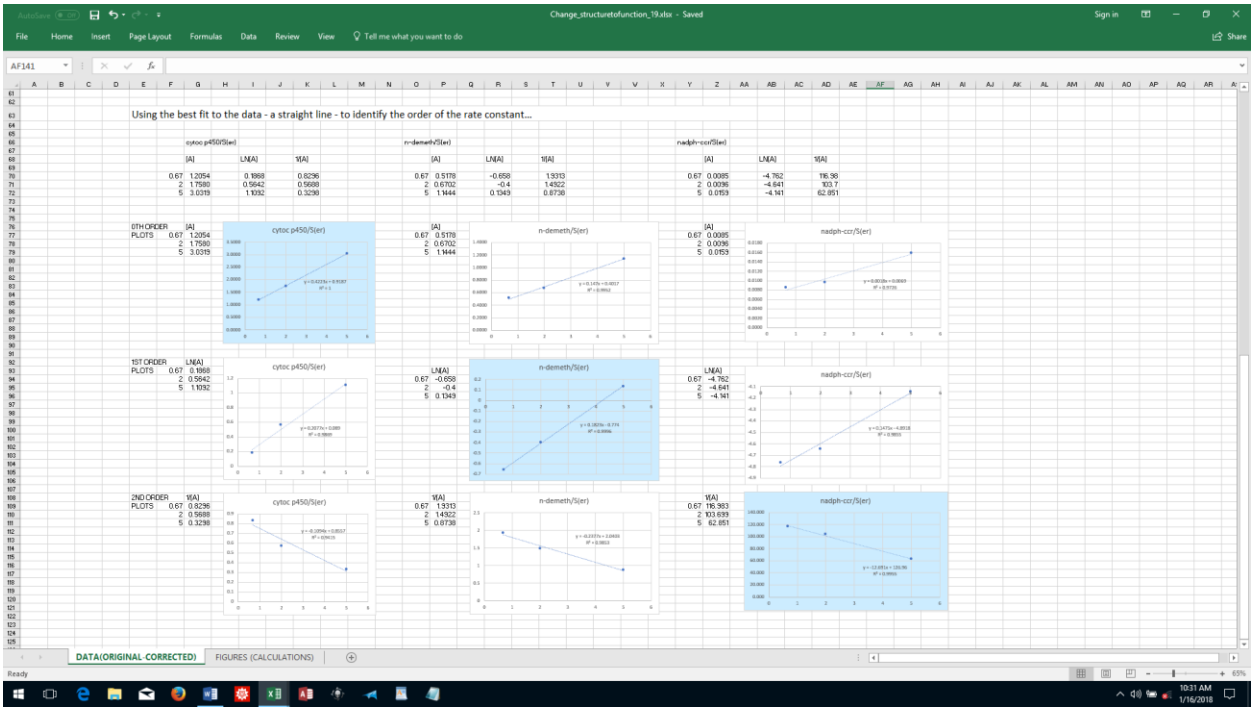
| File | Program | Source |
|---|---|---|
| Change_structuretofunction_19.xlsx | Excel | Microsoft |
| Tab 1: Data (original-corrected) | | |
| Tab 2: Figures (with calculations) | | |

## Tab 1: Data (original – corrected)

DATA – morphology, biochemistry, enzyme densities, rate constants, average cell. Data collected from published research papers were related to a gram of liver and corrected for section related artifacts. Notice that some of the data entry fields carry comments (black triangles), which can be read by opening them with the cursor.

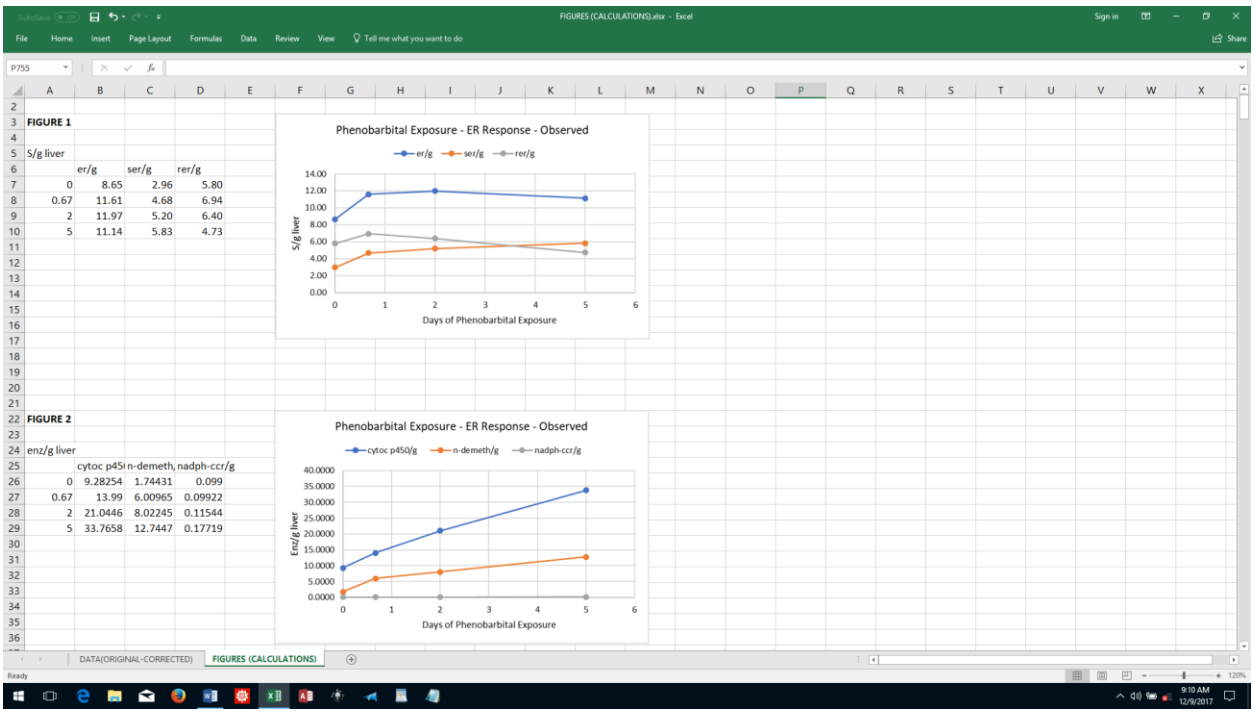


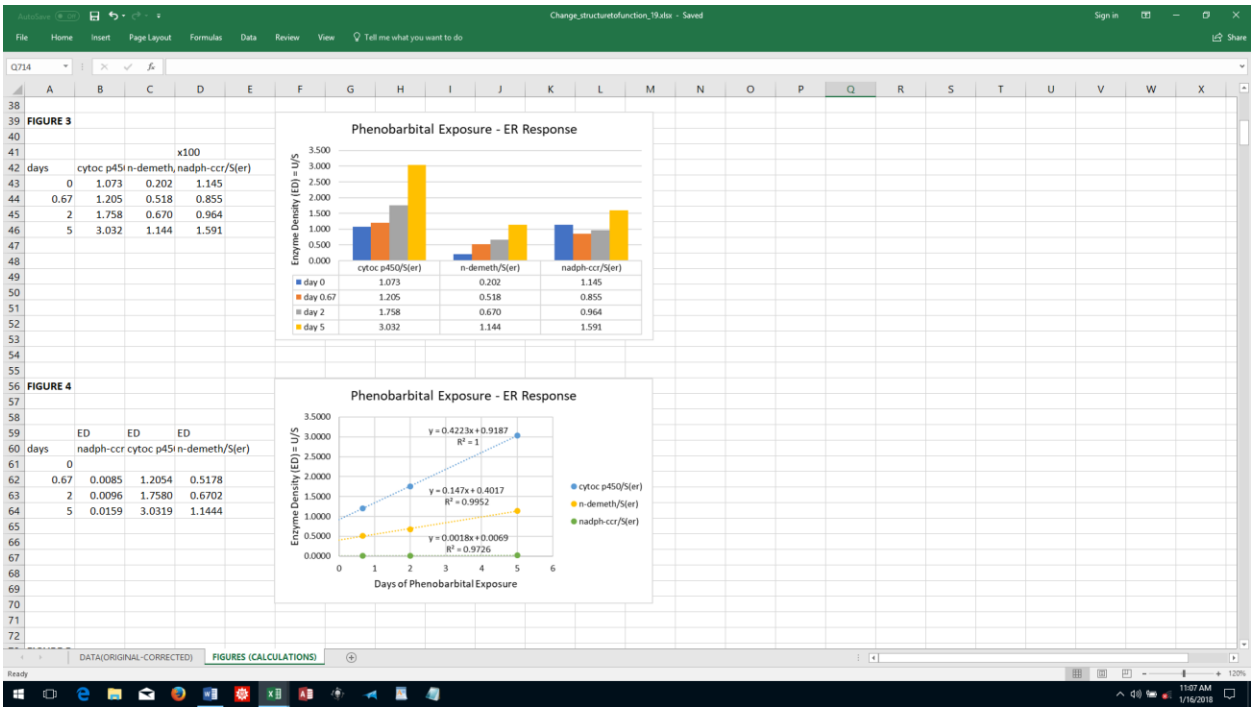
RATE CONSTANTS – Identifying the order of the reaction (blue highlight) for different enzymes.

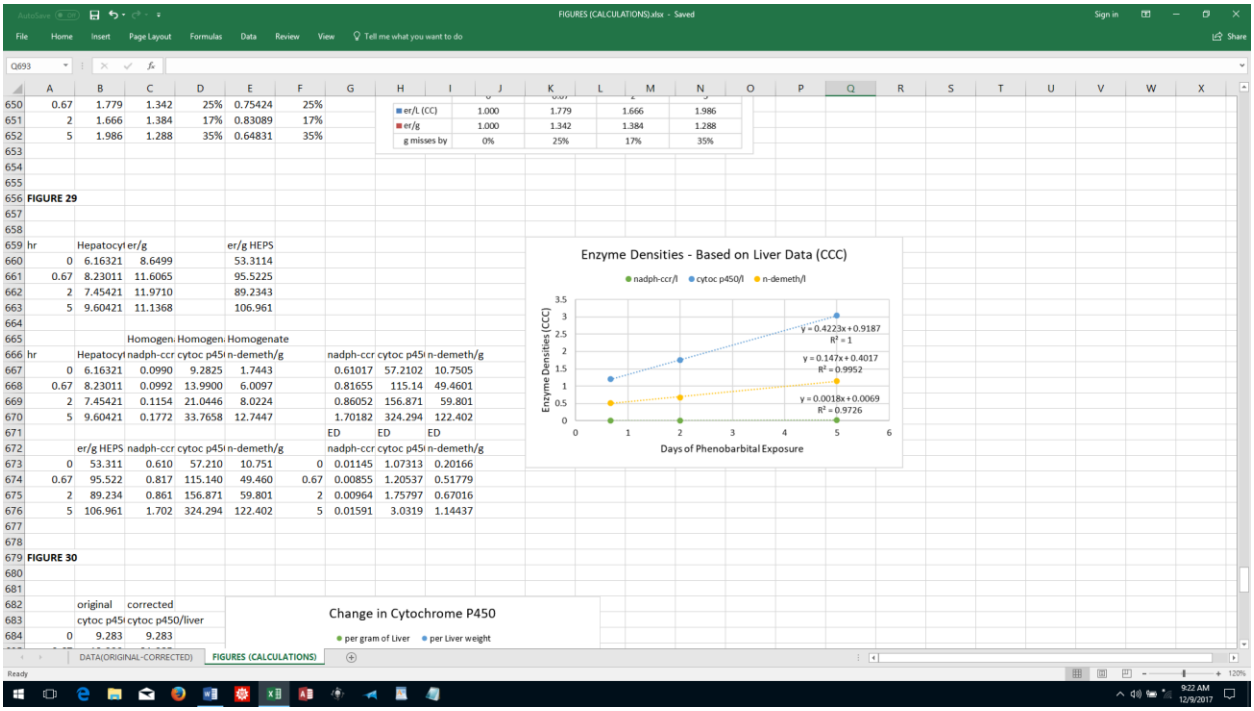



## Tab 2: Figures (calculations)

The data sets derived from the literature (Papers 1-4) appear next to the plots.




Change_structuretofunction_19.xlsx - Saved
FIGURE 3
x100
days | cytoc p45i | n-demeth | nadph-ccr/S(er)
0 | 1.073 | 0.202 | 1.145
0.67 | 1.205 | 0.518 | 0.855
2 | 1.758 | 0.670 | 0.964
5 | 3.032 | 1.144 | 1.591
Phenobarbital Exposure - ER Response
Enzyme Density (ED) = U/S
cytoc p450/S(er)
n-demeth/S(er)
nadph-ccr/S(er)
day 0 | 1.073 | 0.202 | 1.145
day 0.67 | 1.205 | 0.518 | 0.855
day 2 | 1.758 | 0.670 | 0.964
day 5 | 3.032 | 1.144 | 1.591
FIGURE 4
ED | ED | ED
days | nadph-ccr | cytoc p45i | n-demeth/S(er)
0
0.67 | 0.0085 | 1.2054 | 0.5178
2 | 0.0096 | 1.7580 | 0.6702
5 | 0.0159 | 3.0319 | 1.1444
Phenobarbital Exposure - ER Response
y = 0.4223x + 0.9187
R² = 1
y = 0.147x + 0.4017
R² = 0.9952
y = 0.0018x + 0.0069
R² = 0.9726
Enzyme Density (ED) = U/S
Days of Phenobarbital Exposure
cytoc p450/S(er)
n-demeth/S(er)
nadph-ccr/S(er)
DATA(ORIGINAL-CORRECTED)
FIGURES (CALCULATIONS)
Ready


FIGURES (CALCULATIONS).xlsx - Saved
er/L (CC) | 1.000 | 1.779 | 1.666 | 1.986
er/g | 1.000 | 1.342 | 1.384 | 1.288
g misses by | 0% | 25% | 17% | 35%
0.67 | 1.779 | 1.342 | 25% | 0.75424 | 25%
2 | 1.666 | 1.384 | 17% | 0.83089 | 17%
5 | 1.986 | 1.288 | 35% | 0.64831 | 35%
FIGURE 29
hr | Hepatocyt | er/g | er/g HEPS
0 | 6.16321 | 8.6499 | 53.3114
0.67 | 8.23011 | 11.6065 | 95.5225
2 | 7.45421 | 11.9710 | 89.2343
5 | 9.60421 | 11.1368 | 106.961
Homogen | Homogen | Homogenate
hr | Hepatocyt | nadph-ccr | cytoc p45i | n-demeth/g | nadph-ccr | cytoc p45i | n-demeth/g
0 | 6.16321 | 0.0990 | 9.2825 | 1.7443 | 0.61017 | 57.2102 | 10.7505
0.67 | 8.23011 | 0.0992 | 13.9900 | 6.0097 | 0.81655 | 115.14 | 49.4601
2 | 7.45421 | 0.1154 | 21.0446 | 8.0224 | 0.86052 | 156.871 | 59.801
5 | 9.60421 | 0.1772 | 33.7658 | 12.7447 | 1.70182 | 324.294 | 122.402
ED | ED | ED
er/g HEPS | nadph-ccr | cytoc p45i | n-demeth/g | nadph-ccr | cytoc p45i | n-demeth/g
0 | 53.311 | 0.610 | 57.210 | 10.751 | 0 | 0.01145 | 1.07313 | 0.20166
0.67 | 95.522 | 0.817 | 115.140 | 49.460 | 0.67 | 0.00855 | 1.20537 | 0.51779
2 | 89.234 | 0.861 | 156.871 | 59.801 | 2 | 0.00964 | 1.75797 | 0.67016
5 | 106.961 | 1.702 | 324.294 | 122.402 | 5 | 0.01591 | 3.0319 | 1.14437
Enzyme Densities - Based on Liver Data (CCC)
nadph-ccr/l
cytoc p450/l
n-demeth/l
y = 0.4223x + 0.9187
R² = 1
y = 0.147x + 0.4017
R² = 0.9952
y = 0.0018x + 0.0069
R² = 0.9726
Enzyme Densities (CCC)
Days of Phenobarbital Exposure
FIGURE 30
original | corrected
cytoc p45i | cytoc p450/liver
0 | 9.283 | 9.283
Change in Cytochrome P450
per gram of Liver
per Liver weight
DATA(ORIGINAL-CORRECTED)
FIGURES (CALCULATIONS)
Ready