Homework #1

You were asked to fill in the following table. The point is to see that as the animal cools, the gradient gets progressively less, and so the drop in temperature per unit time get less as well. Most everyone got this right, so I will fill in only part of the table. Note, however, some of you gave temperatures to 5 decimal points. One is sufficient, and much easier to read!

time	animal	water	gradient	change (-0.2*gradient)
0	40.0	10.0	30.0	-6.0
1	34.0	10.0	24.0	-4.8
2	29.2	10.0	19.2	-3.8
3		10.0	15.4	-3.1
4		10.0	12.3	-2.5
5		10.0	9.8	-2.0
6		10.0	7.8	
7		10.0		
8		10.0		
9		10.0		
10	13.2	10.0	3.2	-0.6

Homework # 2

Researchers had found that a daily dose of 500 mg acrylamide (for life!) induces cancer in rats. The California Attorney General was alarmed by this finding and wanted to force warning labels on French fries and potato chips, because cooking of these starches produces acrylamide. However, a newspaper article discounted this as a problem because the author felt that (based on the rat data) a human would need to eat 35,000 mg of acrylamide per day to induce cancer. That's about 180 pounds of French fries per day!

The newspaper reporter's estimate of 35,000 mg/day was obviously based on scaling by weight. If a rat weighs 1 kg, and a human weighs 70 kg, then 70 * 500 = 35,000 mg.

You were asked to compute the daily safe dose if risk scales not with mass but with metabolic rate.

Recalling that for mammals

$$E \sim 3.8\ M^{.75}$$

Substitute 70 for M and estimate E for human as = 91.96
Subtitute 1 for M and estimate E for rat = 3.8

Therefore the human's metabolic rate is 91.96/3.8 = 24.2 X higher than the rat

So 24.2 X 500 = only 12,100 mg per day, substantially less than the 35,000 based on scaling by mass.

Then you were asked to to talk briefly about how the safe dose would scale if the dose depended on clearance time from the body, where clearance time might (hypothetically) scale with mass specific metabolic rate.

Here E/M scales with M -.25, which would imply that the safe dose for a human is actually substantially LESS than 500 mg/day.

Of course, we don't know how the safe dose scales; but that is all the more reason to be very careful when adjusting doses for animals (and humans!) of different sizes.

Homework # 3

You were presented with a "strong inference" experiment in which the workers tested two competing hypotheses as to the impact of developmental temperatures on adult performance. They raised the flies at either 18°C or at 25°C, and then tested dominance at those two temperatures. Thus, they compared dominance of 18°C versus 25°C males at 18°C and at 25°C.

The first hypothesis was the "beneficial acclimation hypothesis," which states that animals reared in a given environment adjust their physiology to work well in that environment. If this hypothesis holds, then flies reared at 18°C will be dominant at 18°C, but 25°C flies will be dominant at 25°C.

The alternative was a "bigger is better hypothesis." Body size is often advantageous in dominance interactions, and flies reared at low temperatures are larger than flies reared at high temperatures. If this hypothesis holds, then flies reared at 18°C will be dominant at BOTH 18°C and 25°C.

So the authors set up a 2 X 2 design (2 dev temperatures X 2 adult test temperatures) and tested dominance.

Results: Which hypothesis was correct? None of the above! The authors found that flies reared at 25°C (thus small) were dominant at both temperatures.

So we then discussed two new hypotheses. One is a "smaller is better" – perhaps small flies are more maneuverable and hence win in fights. The other is an "intermediate optimum developmental temperature" – perhaps 25°C, which is an intermediate temperature for rearing flies, is optimal for producing vigorous flies.

You were then asked to derive an experimental design that simultaneously tests all four hypotheses.

There are several ways to do this, but the simplest is set up a 3 X 3 design (development at 18, 25, and say 28°C; and testing at those same three temperatures.

	Developmental temperature of the winning fly under a given hypothesis			
Test temperature	Benefical Acclimation	Bigger is Better	Smaller is Better	Optimal dev temperature
18	18	18	28	25
25	25	18	28	25
28	28	18	28	25

This design neatly tests all four hypotheses, as the predictions for each hypothesis differs.

If you want more details, consult:

Zamudio, K., R. B. Huey, and W. D. Crill. 1995. Bigger isn't always better: developmental and parental temperature and male territoriality in *Drosophila melanogaster*. Anim. Behav. 49:671-677.

Huey, R. B., D. Berrigan, G. W. Gilchrist, and J. C. Herron. 1999. Testing the adaptive significance of acclimation: a strong inference approach. American Zoologist 39:323-336.