Solutions to Computer Exercise 6 (R)

1. In this case it seems best to rely on the Fisher exact test, which gives a (two-tailed) *p*-value of 0.1026 (although the ordinary chi-squared test, with Yates' correction, gives an almost identical *p*-value of 0.1052). There is not sufficient evidence for assortative mating (either negative or positive). Note however that samples sizes are quite small and that, unless assortative mating would have been very strong, this is an example of a low power observation of rather little value. More choices need to be observed before it is meaningful to form an opinion about the matter.

2. There is a significant Sex x Foodpl interaction ($F_{3,139} = 5.801$, p = 0.000915), which means that the effect of food plant on adult dry weight was different for males and females. Looking at the interaction plot, one sees that females were more sensitive to food plant variation than males.

3. The contrasts corresponding to the two main effects, Diet and Stress, and the Diet x Stress interaction are as follows

Regular/Low	Regular/High	Junk/Low	Junk/High
1	1	-1	-1
1	-1	1	-1
1	-1	-1	1

The way to think about the interaction contrast is that it represents the difference in effect of food (Regular or Junk) between Low and High stress. Or conversely, the difference in effect of stress (Low or High) between Regular and Junk food. In either case, one gets p = 0.0168 for the test of the interaction.

4. For the inverse transformed butterfat variable, there is no significant Breed × AgeCls interaction ($F_{4,90}$ = 0.526, p = 0.72), nor is there an effect of age class ($F_{1,90}$ = 0.977, p = 0.33), but there is a highly significant effect of breed on the butterfat percentage ($F_{4,90}$ = 60.60, p < 0.000001).

All the breeds differ significantly from each other, except Jersey and Guernsey cows, which are not significantly different.

5. With Pot as fixed effect, the influence of Jimsonweed type on leaf length/width ratio is tested with an *F*-ratio that has the error mean square in the denominator. Thus, the 'noise' is the within type and pot variability estimated from the three replicate seedlings from each type and pot combination. From this analysis, the effect of type on leaf shape is highly significant: p = 0.000005. For the analysis with Pot as a random effect (using the function `lmer` and maximum likelihood estimation), we also find a significant effect of type on leaf shape: X^2_1 = 59.54 and p < 0.0001.

The analysis of Pot as a fixed effect is a bit contentious as its *F*-ratio has the error mean square in the denominator (and if you would regard Pot as random, you would – at least in the old-fashioned ANOVA with random effect as you can calculate in R using the function `aov` – use the interaction mean square in the denominator when testing the fixed effect). Estimating the interaction between Pot and Type in the `lmer` function is not overly nice either: it will fit a very low variance for the interaction term just based on two values! However, one could argue that the grouping of seedlings into pots is artificially constructed by the experimenter and that there is no *a priori* reason to expect a possible difference in leaf shape between the two types to depend on the pot they were grown in. From an analysis of the entire dataset (16 pots), with pot as fixed effect, one notes that there is a significant effect of pot but no significant interaction. The apparent absence of an interaction lends support to the two analyses above (For the fixed effect model, if the interaction really is absent, the interaction mean square estimates the same variance σ^2 as the error mean square, but the error mean square is a better estimate, being based on more degrees of freedom).

On the other hand, there is an effect of pot. A likely reason is that the seedlings in some pots have grown more than the seedlings in other pots and that leaf shape changes with the size of the seedling. In general it is always important to think about what the level of independent observation of the main effect is. With only two pots, was it really even possible to tell whether the Type:Pot interaction was of potential importance?