Solutions for 9.9 Exercises

1. **Vitamin C in tomato juice:**

   (a) Observational study.

   (b) Continuous.

   (c) Examples: mean vitamin C concentration in all cans of that brand of tomato juice stocked at the supermarket over a period of time; proportion of cans of that brand with vitamin C > 20.

   Rainfall and cloud seeding

   (a) Designed experiment.

   (b) Continuous.

   (c) Examples: mean rainfall from seeded clouds; difference between mean rainfall from seeded clouds and mean rainfall from control clouds; standard deviation of rainfall from seeded clouds.

2. No, the conclusion cannot be justified from this study alone, as it is an observational study. Possible confounding variables include socioeconomic status, parental stress from working, educational achievement of parents, and diet.

3. (a) OK, but not ideal. Pieces may not have identical chances of selection. Must be well mixed.

   (b) Fine.

   (c) Hopeless. People tend to avoid the extremes.

   (d) Not good—the order may reflect health, etc.

   (e) Fine.

   (f) Not good—too subjective. People tend to avoid edge plants.

   (g) The first digit of a phone number is no good; the remaining digits are probably OK.

   (h) Not very good, because of possible association with ethnicity.

   (i) Not good—location of chicks in the box may be associated with proximity to light, etc.

4. (a) **Bacteria in hen houses**

   False replication; 6 experimental units.

   (b) **Drought-affected lemon trees**

   False replication (if 180 experimental units assumed); 18 experimental units.

5. For both women and men (separately), randomly allocate equal numbers of subjects to the three therapies to ensure comparison within each gender. Which variables are important depends on the outcome(s) to be measured. But in a cancer study, age is likely to be an important explanatory variables, and possibly ethnicity.

6. (a) expt unit = row; block = none; number of reps = 1.

   (b) expt unit = plot of 8 plants; block = row; number of reps = 3.

   (c) expt unit = plant; block = none; number of reps = 24.

   (d) expt unit = 6 plants within a row; block = quarter; number of reps = 4.

   (e) Design (d) is the best, because the blocking ensures that the three sprays are represented at both ends of the trial area.

   (f)
```
> spray <- c(rep("S1",24),rep("S2",24),rep("S3",24))
> plant <- sample(72,72)
> data.frame(spray,plant)
```

7. (a) Randomise the three treatments to the three runs, separately on each day. Day is a blocking factor.

   (b)
```
> day <- rep(c("Mon", "Tue", "Wed", "Thu", "Fri"), each = 3)
> run <- rep(1:3, 5)
> additive <- c(sample(3, 3), sample(3, 3), sample(3, 3), sample(3,
+     3), sample(3, 3))
> data.frame(day, run, additive)
```

```
   day run additive
1  Mon   1        3
2  Mon   2        2
3  Mon   3        1
4  Tue   1        3
5  Tue   2        1
6  Tue   3        2
7  Wed   1        3
8  Wed   2        2
9  Wed   3        1
10 Thu   1        3
11 Thu   2        2
12 Thu   3        1
13 Fri   1        2
14 Fri   2        3
15 Fri   3        1
```

   (c) A single employee should supervise all three runs on a particular day, to prevent confounding employee effects with treatments. It doesn't matter which employee does which day. It's a bit better using only two employees across the experiment rather than three, for uniformity.

8. A.

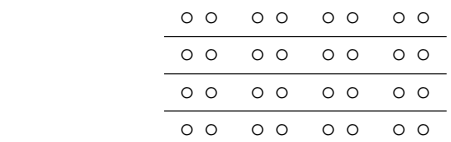
9. C.

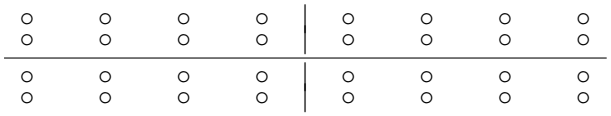
10. No—the effect of the hormone injection is confounded with the effect of the three day period. Control mice were needed.

11. (a) Example of an appropriate randomised block design (| is the division between blocks):

○ 3 ○	○ 2 ○	○ 2 ○	○ 4 ○
○ 2 ○	○ 4 ○	○ 1 ○	○ 1 ○
○ 4 ○	○ 1 ○	○ 3 ○	○ 2 ○
○ 1 ○	○ 3 ○	○ 4 ○	○ 3 ○

(b) Either of the following randomised block designs:





(c) Example of an appropriate Latin square design:

○ 2 ○	○ 1 ○	○ 4 ○	○ 3 ○
○ 4 ○	○ 2 ○	○ 3 ○	○ 1 ○
○ 3 ○	○ 4 ○	○ 1 ○	○ 2 ○
○ 1 ○	○ 3 ○	○ 2 ○	○ 4 ○