1. Chapter 4: Exercise Set A, pg 109, # 2 and 8.
   Exercise Set B, pg 117, # 8 and 11.
   Exercise Set C, pgs 124 – 125, # 2 and 3.
   Exercise Set D, pgs 127 – 128, # 1, 2 and 3.

2. A test kitchen is interested in evaluating the effect of different types of fat on the appeal of chocolate chip cookies. Trained tasters will evaluate cookies on five different characteristics such as moistness, texture, flavor, greasiness and appearance. The evaluation of each characteristic will be recorded on a scale from a 0 to 20 (0 being least appealing and 20 representing most appealing for that characteristic) by having a tasters mark on the scale and measuring the distance from 0 to the mark. An overall appeal score will be the sum of the evaluation scores for the five characteristics. They decide to look at four different types of fat: vegetable margarine, vegetable oil, butter, and vegetable shortening (Crisco). The other ingredients in the cookie dough will be the same and in the same amounts for all cookies. All cookies from one batch of dough will be baked in the same oven set at 350 degrees Fahrenheit for the same amount of time using similar cookie sheets. The order in which the batches of cookies will be baked is determined at random. The trained tasters will be presented cookies to taste in a random order and they will not know what type of fat was used to make the cookies. There are two different ways to conduct the experiment. Experiment 1 – Make one batch of cookie dough with each of the types of fat: one batch with vegetable margarine, one batch with vegetable oil, one batch with butter and one batch with vegetable shortening (Crisco). Twenty cookies will be baked from each batch of dough. Experiment 2 – Make five batches of cookie dough with each of the types of fat: five batches with vegetable margarine, five batches with vegetable oil, five batches with butter and five batches with vegetable shortening (Crisco). Four cookies are baked from each batch of dough.

   a) What is the response?
   b) What are the conditions (treatments)?
   c) What is the experimental material?
   d) Describe in some detail the source of chance variation for each experiment.
   e) Suppose the cookies made with butter are found to have higher mean appeal and the differences in mean appeal compared to cookies made with the other fats are statistically significant. What conclusions and what generalizations can be made for each experiment?

3. A study will be performed to evaluate the effectiveness of different hand cleaning methods on reducing bacteria on hands. There are three hand cleaning methods: washing with soap, washing with antibacterial soap, and spraying with an antibacterial spray (65% Ethanol). The study will use volunteers with each volunteer being assigned one of the hand cleaning methods. After hands are cleaned the right hand of each volunteer is placed on a sterile media plate. Bacteria still on the hand
will be transferred to the media that is designed to facilitate bacterial growth. The plates are incubated for 2 days at 36° C. After incubation the number of bacterial colonies is counted for each plate.

a) Explain briefly why this study is an experiment and not an observational study?

b) What is the response variable?

c) What are the conditions of the experiment?

d) What are the experimental units?

e) Give an example of an outside variable that is controlled in the study. How is the variable controlled?

f) Give an example of an outside variable that is not controlled in the study? Explain briefly. In your explanation you should indicate why this variable should be controlled.

g) Is there a control group in this study?

h) Is random selection used in this study? Explain briefly.

i) Suppose the experimenter wanted to be able to detect a 1 standard deviation difference in group means with Alpha = 0.05 and Beta = 0.05, how many volunteers would be needed for the experiment?

j) Thirty six people volunteer for the experiment. Give two combinations of Alpha, Beta and the size of the detectable difference in treatment means that correspond to this number of volunteers.

k) Describe in detail how you would randomly assign the hand cleaning methods to the volunteers so that there are an equal number (12) of volunteers using each method. Once you have described what you will do, actually do the randomization. Include your randomized assignment of the 3 methods to the 36 volunteers.

l) Is there replication within this experiment? Explain briefly.

4. A one factor, completely randomized experiment, as described in problem 3, is run. The results appear on the next page.

a) Plot the data and compute summary statistics. If you use a computer program, “cut and paste” the output on your answer sheet. Based on the plot what can you say about the effectiveness of the various methods? What can you say about the variability within each method?

b) Estimate the effect of each of the methods.

c) Construct an analysis of variance table giving sources of variation, degrees of freedom, sums of squares, mean squares, appropriate F statistic and associated P-value. If you use a computer package, you can copy the results from the output onto your answer sheet. I will not look at output simply attached at the end of what you turn in.

d) Give the value of R² and an interpretation of this value.

e) Are there statistically significant differences amongst the three methods in terms of sample mean number of bacterial colonies? Support your answer by referring to the appropriate test of the null hypothesis: H₀ :  τ₁ = τ₂ = τ₃ = 0.
f) Construct 95% confidence intervals for the differences in true mean numbers of bacterial colonies.
- Antibacterial Spray compared to Antibacterial Soap
- Antibacterial Spray compared to Regular Soap
- Antibacterial Soap compared to Regular Soap

g) Based on the confidence intervals in f), what pairs of treatments have differences in sample means that are statistically significant?

h) Write a brief summary (one or two sentences is enough) of the findings of the experiment. In this summary make a recommendation based on your analysis as to what method of hand cleaning should be used.

**Data for Hand Cleaning Experiment**

**Number of Bacterial Colonies**

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<th>Regular Soap</th>
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