5.30 SYSTEMATIC RANDOM SAMPLE  Sample surveys often use a *systematic random sample* to choose a sample of apartments in a large building or dwelling units in a block at the last stage of a multistage sample. An example will illustrate the idea of a systematic sample.

Suppose that we must choose 4 addresses out of 100. Because $100/4 = 25$, we can think of the list as four lists of 25 addresses. Choose 1 of the first 25 addresses at random using Table B. The sample contains this address and the addresses 25, 50, and 75 places down the list from it. If the table gives 13, for example, then the systematic random sample consists of the addresses numbered 13, 38, 63, and 88.

(a) Use Table B to choose a systematic random sample of 5 addresses from a list of 200. Enter the table at line 120. Split the 200 addresses into 5 groups of 40 each. Looking for 2-digit numbers from 01 to 40, we find 35, and so take 35, 75, 115, 155, and 195.

(b) Like an SRS, a systematic random sample gives all individuals the same chance to be chosen. Explain why this is true. Then explain carefully why a systematic sample is nonetheless *not* an SRS.

Every address has a 1-in-40 chance of being selected, but not every subset has an equal chance of being picked—for example, 01, 02, 03, 04, and 05 cannot be selected by this method.

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**HW #32 31, 33 - 36**

*For each of the experimental situations described in Exercises 5.31 to 5.34, identify the experimental units or subjects, the factors, the treatments, and the response variables.*

5.31 RESISTING DROUGHT  The ability to grow in shade may help pines found in the dry forests of Arizona to resist drought. How well do these pines grow in shade? Investigators planted pine seedlings in a greenhouse in either full light or light reduced to 5% of normal by shade cloth. At the end of the study, they dried the young trees and weighed them.

Units are the individual trees. Factor is the amount of light. Treatments are full light and reduced light. Response variable is the weight of the trees.

5.33 IMPROVING RESPONSE RATE  How can we reduce the rate of refusals in telephone surveys? Most people who answer at all listen to the interviewer’s introductory remarks and then decide whether to continue. One study made telephone calls to randomly selected households to ask opinions about the next election. In some calls, the interviewer gave her name, in others she identified the university she was representing, and in still others she identified both herself and the university. For each type of call, the interviewer either did or did not offer to send a copy of the final survey results to the person interviewed. Do these differences in the introduction affect whether the interview is completed?

The units are the individuals who were called.
One factor is what information is offered. Second factor is offering to send a copy of the results.
Treatments are (1) giving name, (2) identifying university, (3) both of these.
The treatments are either offering or not offering.
The response is whether the interview was completed.
5.34 **SICKLE-CELL DISEASE** Sickle-cell disease is an inherited disorder of the red blood cells that in the United States affects mostly blacks. It can cause severe pain and many complications. Can the drug hydroxyurea reduce the severe pain caused by sickle-cell disease? A study by the National Institutes of Health gave the drug to 150 sickle-cell sufferers and a placebo (a dummy medication) to another 150. The researchers then counted the episodes of pain reported by each subject.


5.35 **COMPARING LEARNING METHODS** An educator wants to compare the effectiveness of computer software that teaches reading with that of a standard reading curriculum. She tests the reading ability of each student in a class of fourth graders, then divides them into two groups. One group uses the computer regularly, while the other studies a standard curriculum. At the end of the year, she retests all the students and compares the increase in reading ability in the two groups.

(a) Is this an experiment? Why or why not? This is an experiment, since the teacher imposes treatments (instruction methods).

(b) What are the explanatory and response variables? The explanatory variable is the method used (computer software or standard curriculum), and the response is the change in reading ability.

5.36 **OPTIMIZING A PRODUCTION PROCESS** A chemical engineer is designing the production process for a new product. The chemical reaction that produces the product may have higher or lower yield, depending on the temperature and the stirring rate in the vessel in which the reaction takes place. The engineer decides to investigate the effects of combinations of two temperatures (50º C and 60ºC) and three stirring rates (60 rpm, 90 rpm, and 120 rpm) on the yield of the process. She will process two batches of the product at each combination of temperature and stirring rate.

(a) What are the experimental units and the response variable in this experiment? The experimental units are the batches of the product; the yield of each batch is the response variable.

(b) How many factors are there? How many treatments? Create a table to lay out the treatments. There are two factors: temperature (with 2 levels) and stirring rates (with 3 levels), for a total of 6 treatments.

<table>
<thead>
<tr>
<th>Factor A: Temperature</th>
<th>Factor B: Stirring rates</th>
</tr>
</thead>
<tbody>
<tr>
<td>50ºC</td>
<td>60 rpm</td>
</tr>
<tr>
<td>60ºC</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>4</td>
</tr>
</tbody>
</table>

(c) How many experimental units are required for the experiment? Since two experimental units will be used for each treatment, we need 12.
HW #33  39 – 41, 46, 49, 53, 56

5.39  **RECRUITING FEMALE EMPLOYEES**  Will providing child care for employees make a company more attractive to women, even those who are unmarried? You are designing an experiment to answer this question. You prepare recruiting material for two fictitious companies, both in similar businesses in the same location. Company A’s brochure does not mention child care. There are two versions of Company B’s brochure, identical except that one describes the company’s on-site child-care facility. Your subjects are 40 unmarried women who are college seniors seeking employment. Each subject will read recruiting material for both companies and choose the one she would prefer to work for. You will give each version of Company B’s brochure to half the women. You expect that a higher percentage of those who read the description that includes child care will choose Company B.

(a) Outline an appropriate design for the experiment.

Randomly select 20 women for Group 1, which will see the “childcare” version of Company B’s brochure, and assign the other 20 women to Group 2 (the “no childcare” group). Allow all women to examine the appropriate brochures, and observe which company they choose. Compare the number from Group 1 who choose Company B with the corresponding number from Group 2.

(b) The names of the subjects appear below. Use Table B, beginning at line 131, to do the randomization required by your design. List the subjects who will read the version that mentions child care.

<table>
<thead>
<tr>
<th>Abrams</th>
<th>Danielson</th>
<th>Gutierrez</th>
<th>Lippman</th>
<th>Rosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Adamson</td>
<td>Durr</td>
<td>Howard</td>
<td>Martinez</td>
<td>Sugiwara</td>
</tr>
<tr>
<td>Afifi</td>
<td>Edwards</td>
<td>Hwang</td>
<td>McNeill</td>
<td>Thompson</td>
</tr>
<tr>
<td>Brown</td>
<td>Fluharty</td>
<td>Iselin</td>
<td>Morse</td>
<td>Travers</td>
</tr>
<tr>
<td>Cansico</td>
<td>Garcia</td>
<td>Janle</td>
<td>Ng</td>
<td>Turing</td>
</tr>
<tr>
<td>Chen</td>
<td>Gerson</td>
<td>Kaplan</td>
<td>Quinones</td>
<td>Ullmann</td>
</tr>
<tr>
<td>Cortez</td>
<td>Green</td>
<td>Kim</td>
<td>Rivera</td>
<td>Williams</td>
</tr>
<tr>
<td>Curzakis</td>
<td>Gupta</td>
<td>Lattimore</td>
<td>Roberts</td>
<td>Wong</td>
</tr>
</tbody>
</table>

5.40 ENCOURAGING ENERGY CONSERVATION  Example 5.13 (text page 297) describes an experiment to learn whether providing households with electronic indicators or charts will reduce their electricity consumption. An executive of the electric company objects to including a control group. He says, “It would be simpler to just compare electricity use last year (before the indicator or chart was provided) with consumption in the same period this year. If households use less electricity this year, the indicator or chart must be working.” Explain clearly why this design is inferior to that in Example 5.13.

If this year is considerably different in some way from last year, we cannot compare electricity consumption over the two years. For example, if this summer is warmer, the customers may run their air conditioners more often. The possible differences between the two years would confound the effects of the treatments.

5.41 EXERCISE AND HEART ATTACKS  Does regular exercise reduce the risk of a heart attack? Here are two ways to study this question. Explain clearly why the second design will produce more trustworthy data.

1. A researcher finds 2000 men over 40 who exercise regularly and have not had heart attacks. She matches each with a similar man who does not exercise regularly, and she follows both groups for 5 years.
2. Another researcher finds 4000 men over 40 who have not had heart attacks and are willing to participate in a study. She assigns 2000 of the men to a regular program of supervised exercise. The other 2000 continue their usual habits. The researcher follows both groups for 5 years.

The second design is an experiment—a treatment is imposed on the subjects. The first is a study; it may be confounded by the types of men in each group. In spite of the researcher’s attempt to match “similar” men from each group, those in the first group (who exercise) could be somehow different from men in the non-exercising group.

5.46 CARBON DIOXIDE AND TREE GROWTH  The concentration of carbon dioxide (CO₂) in the atmosphere is increasing rapidly due to our use of fossil fuels. Because plants use CO₂ to fuel photosynthesis, more CO₂ may cause trees and other plants to grow faster. An elaborate apparatus allows researchers to pipe extra CO₂ to a 30-meter circle of forest. We want to compare the growth in base area of trees in treated and untreated areas to see if extra CO₂ does in fact increase growth. We can afford to treat three circular areas.

(a) Describe the design of a completely randomized experiment using 6 well-separated 30-meter circular areas in a pine forest. Sketch the circles and carry out the randomization your design calls for. Assume that the 6 circular areas are given in advance. Number them in any order. Use Table B to select 3 for the treatment. We used line 104. The first 4 digits are: 5 2 7 1. We cannot use the 7 because it is more than 6. Therefore, we would treat areas 5, 2 and 1.
(b) Areas within the forest may differ in soil fertility. Describe a matched pairs design using three pairs of circles that will reduce the extra variation due to different fertility. Sketch the circles and carry out the randomization your design calls for.

If the pairs are not given in advance, divide the 6 areas into 3 pairs so that the elements of each pair are close to each other and therefore of similar fertility. For each pair, we randomly pick one of the two to receive the treatment. Label the two areas in each pair A and B. If the random number from Table B is even, then apply the treatment to area A. Otherwise, apply the treatment to area B. Alternatively, we could go along the table looking for either a 0 or a 1, ignoring the other digits. If we find a 0 before a 1, then treat area A. Otherwise, treat B.

5.49 **DOES SAINT-JOHN’S WORT RELIEVE MAJOR DEPRESSION?** Here are some excerpts from the report of a study of this issue. The study concluded that the herb is no more effective than a placebo.

(a) “Design: Randomized, double-blind, placebo-controlled clinical trial. . . .” Explain the meaning of each of the terms in this description. “Randomized” means that patients were randomly assigned either St. John’s Wort or the placebo. “Double-blind” means that both the subjects and those who work with the subjects do not know who is getting what treatment. “Placebo controlled” means that we will compare the results for the group using St. John’s Wort to the group that received the placebo.

(b) “Participants . . . were randomly assigned to receive either Saint-John’s-Wort extract (n = 98) or placebo (n = 102). . . . The primary outcome measure was the rate of change in the Hamilton Rating Scale for Depression over the treatment period.” Based on this information, use a diagram to outline the design of this clinical trial.
5.53 DOES CALCIUM REDUCE BLOOD PRESSURE? You are participating in the design of a medical experiment to investigate whether a calcium supplement in the diet will reduce the blood pressure of middle-aged men. You have available 40 men with high blood pressure who are willing to serve as subjects.

(a) Outline an appropriate design for the experiment.

Randomly assign 20 men to each of two groups. Record each subject’s blood pressure, then apply the treatments: a calcium supplement for Group 1, and a placebo for Group 2. After sufficient time has passed, measure blood pressure again and observe any change.

(b) The names of the subjects appear below. Use Table B, beginning at line 119, to do the randomization required by your design, and list the subjects to whom you will give the drug.

<table>
<thead>
<tr>
<th>Alomar</th>
<th>Denman</th>
<th>Han</th>
<th>Liang</th>
<th>Rosen</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asihiro</td>
<td>Durr</td>
<td>Howard</td>
<td>Maldonado</td>
<td>Solomon</td>
</tr>
<tr>
<td>Bennett</td>
<td>Edwards</td>
<td>Hruska</td>
<td>Marsden</td>
<td>Tompkins</td>
</tr>
<tr>
<td>Bikalis</td>
<td>Farouk</td>
<td>Imrani</td>
<td>Moore</td>
<td>Townsend</td>
</tr>
<tr>
<td>Chen</td>
<td>Fratianna</td>
<td>James</td>
<td>O’Brien</td>
<td>Tullock</td>
</tr>
<tr>
<td>Clement</td>
<td>George</td>
<td>Kaplan</td>
<td>Ogle</td>
<td>Underwood</td>
</tr>
<tr>
<td>Cranston</td>
<td>Green</td>
<td>Kruschev</td>
<td>Plochman</td>
<td>Willis</td>
</tr>
<tr>
<td>Curtis</td>
<td>Guillen</td>
<td>Lawless</td>
<td>Rodriguez</td>
<td>Zhang</td>
</tr>
</tbody>
</table>


(c) Preliminary work suggests that calcium may be effective, and that the effect may be greater for black men than for white men. How could your design in (a) be modified to account for differences between black men and white men?

We could block according to race. First divide the men into two groups by race. Then randomly select 10 black men to receive a calcium supplement and 10 black men to receive a placebo. Repeat for the group of white men. After sufficient time has passed, measure blood pressure again and observe any change. Compare the difference in change between the two groups blocked by race.
5.56 WILL TAKING ANTIOXIDANTS HELP PREVENT COLON CANCER? People who eat lots of fruits and vegetables have lower rates of colon cancer than those who eat little of these foods. Fruits and vegetables are rich in “antioxidants” such as vitamins A, C, and E. Will taking antioxidants help prevent colon cancer? The subjects were divided into four groups: daily beta carotene, daily vitamins C and E, all three vitamins every day, and daily placebo. After four years, the researchers were surprised to find no significant difference in colon cancer among the groups.

(a) What are the explanatory and response variables in this experiment?
   The explanatory variable is the vitamin(s) taken each day; the response variable is whether colon cancer develops.

(b) Outline the design of the experiment. Use your judgment in choosing the group sizes.

Equal group sizes are convenient but not necessary.

(c) Assign labels to the 864 subjects and use Table B, starting at line 118, to choose the first 5 subjects for the beta carotene group.
   Using labels 001 through 864 (or 000 through 863), we choose 731, 253, 304, 470, and 296.

(d) The study was double-blind. What does this mean?
   “Double-blind” means that both the subjects and those who work with the subjects do not know who is getting what treatment. This prevents the expectations of those involved from affecting the way in which the subjects’ conditions are diagnosed.

(e) What does “no significant difference” mean in describing the outcome of the study?
   The observed differences were no more than what might reasonably occur by chance even if there is no effect due to the treatments.

(f) Suggest some lurking variables that could explain why people who eat lots of fruits and vegetables have lower rates of colon cancer. The experiment suggests that these variables, rather than the antioxidants, may be responsible for the observed benefits of fruits and vegetables.
   Fruits and vegetables contain fiber; this could account for the benefits of those foods. Also, people who eat lots of fruit and vegetables may have healthier diets overall (e.g., less red meat).