

- A **matched pairs design** is a common form of blocking for comparing just two treatments. In some matched pairs designs, each subject receives both treatments in a random order. In others, two very similar subjects are paired, and the two treatments are randomly assigned within each pair.

Section 4.2 Exercises

45. **Learning biology with computers** An educator wants to compare the effectiveness of computer software for teaching biology with that of a textbook presentation. She gives a biology pretest to each of a group of high school juniors, then randomly divides them into two groups. One group uses the computer, and the other studies the text. At the end of the year, she tests all the students again and compares the increase in biology test scores in the two groups. Is this an observational study or an experiment? Justify your answer.

46. **Cell phones and brain cancer** One study of cell phones and the risk of brain cancer looked at a group of 469 people who have brain cancer. The investigators matched each cancer patient with a person of the same age, gender, and race who did not have brain cancer, then asked about the use of cell phones. Result: "Our data suggest that the use of handheld cellular phones is not associated with risk of brain cancer."³¹ Is this an observational study or an experiment? Justify your answer.

47. **Chocolate and happy babies** A University of Helsinki (Finland) study wanted to determine if chocolate consumption during pregnancy had an effect on infant temperament at age 6 months. Researchers began by asking 305 healthy pregnant women to report their chocolate consumption. Six months after birth, the researchers asked mothers to rate their infants' temperament, including smiling, laughter, and fear. The babies born to women who had been eating chocolate daily during pregnancy were found to be more active and "positively reactive"—a measure that the investigators said encompasses traits like smiling and laughter.³²

- Was this an observational study or an experiment? Justify your answer.
- What are the explanatory and response variables?
- Does this study show that eating chocolate regularly during pregnancy helps produce infants with good temperament? Explain.

48. **Child care and aggression** A study of child care enrolled 1364 infants and followed them through their sixth year in school. Later, the researchers published an article in which they stated that "the more


time children spent in child care from birth to age four-and-a-half, the more adults tended to rate them, both at age four-and-a-half and at kindergarten, as less likely to get along with others, as more assertive, as disobedient, and as aggressive."³³

- Is this an observational study or an experiment? Justify your answer.
- What are the explanatory and response variables?
- Does this study show that child care causes children to be more aggressive? Explain.

49. **Effects of class size** Do smaller classes in elementary school really benefit students in areas such as scores on standardized tests, staying in school, and going on to college? We might do an observational study that compares students who happened to be in smaller and larger classes in their early school years. Identify a variable that may lead to confounding with the effects of small classes. Explain how confounding might occur.

50. **Effects of binge drinking** A common definition of "binge drinking" is 5 or more drinks at one sitting for men and 4 or more for women. An observational study finds that students who binge drink have lower average GPA than those who don't. Identify a variable that may be confounded with the effects of binge drinking. Explain how confounding might occur.

For the experiments described in Exercises 51 to 56, identify the experimental units, the explanatory and response variables, and the treatments.

pg 237  51. **Growing in the shade** 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, light reduced to 25% of normal by shade cloth, or light reduced to 5% of normal. At the end of the study, they dried the young trees and weighed them.

52. **Internet telephone calls** You can use Voice over Internet Protocol (VoIP) to make long-distance calls over the Internet. One of the most popular VoIP services is Skype. How will the appearance of ads during calls affect the use of this service? Researchers design an experiment to find out. They recruit 300 people who

have not used Skype before to participate. Some people get the current version of Skype with no ads. Others see ads whenever they make calls. The researchers are interested in frequency and length of phone calls.

53. **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?
54. **Eat well and exercise** Most American adolescents don't eat well and don't exercise enough. Can middle schools increase physical activity among their students? Can they persuade students to eat better? Investigators designed a "physical activity intervention" to increase activity in physical education classes and during leisure periods throughout the school day. They also designed a "nutrition intervention" that improved school lunches and offered ideas for healthy home-packed lunches. Each participating school was randomly assigned to one of the interventions, both interventions, or no intervention. The investigators observed physical activity and lunchtime consumption of fat.
55. **Fabric science** A maker of fabric for clothing is setting up a new line to "finish" the raw fabric. The line will use either metal rollers or natural-bristle rollers to raise the surface of the fabric; a dyeing-cycle time of either 30 or 40 minutes; and a temperature of either 150° or 175°C. An experiment will compare all combinations of these choices. Three specimens of fabric will be subjected to each treatment and scored for quality.
56. **Exercise and heart rate** A student project measured the increase in the heart rates of fellow students when they stepped up and down for 3 minutes to the beat of a metronome. The step was either 5.75 or 11.5 inches high and the metronome beat was 14, 21, or 28 steps per minute. Thirty students took part in the experiment. Five of them stepped at each combination of height and speed.
57. **Cocoa and blood flow** A study conducted by Norman Hollenberg, professor of medicine at Brigham and Women's Hospital and Harvard Medical School, involved 27 healthy people aged 18 to 72. Each subject consumed a cocoa beverage containing 900 milligrams of flavonols (a class of flavonoids) daily for 5 days. Using a finger cuff, blood flow was measured on the first and fifth days of the study. After 5 days, researchers measured what they called "significant improvement" in blood flow and the function of the cells that line the blood vessels.³⁴ What flaw in the design of this experiment makes it impossible to say whether the cocoa really caused the improved blood flow? Explain.
58. **Reducing unemployment** Will cash bonuses speed the return to work of unemployed people? A state department of labor notes that last year 68% of people who filed claims for unemployment insurance found a new job within 15 weeks. As an experiment, this year the state offers \$500 to people filing unemployment claims if they find a job within 15 weeks. The percent who do so increases to 77%. What flaw in the design of this experiment makes it impossible to say whether the bonus really caused the increase? Explain.
59. **Layoffs and "survivor guilt"** Workers who survive a layoff of other employees at their location may suffer from "survivor guilt." A study of survivor guilt and its effects used as subjects 120 students who were offered an opportunity to earn extra course credit by doing proofreading. Each subject worked in the same cubicle as another student, who was an accomplice of the experimenters. At a break midway through the work, one of three things happened:
Treatment 1: The accomplice was told to leave; it was explained that this was because she performed poorly.
Treatment 2: It was explained that unforeseen circumstances meant there was only enough work for one person. By "chance," the accomplice was chosen to be laid off.
Treatment 3: Both students continued to work after the break.
 The subjects' work performance after the break was compared with performance before the break.³⁵ Describe how you would randomly assign the subjects to the treatments
 - (a) using slips of paper.
 - (b) using technology.
 - (c) using Table D.
60. **Effects of TV advertising** Figure 4.2 (page 239) displays the 6 treatments for a two-factor experiment on TV advertising. Suppose we have 150 students who are willing to serve as subjects. Describe how you would randomly assign the subjects to the treatments
 - (a) using slips of paper.
 - (b) using technology.
 - (c) using Table D.
61. **Stronger players** A football coach hears that a new exercise program will increase upper-body strength better than lifting weights. He is eager to test this new program in the off-season with the players on his high school team. The coach decides to let his players choose which of the two treatments they will undergo for 3 weeks—exercise or weight lifting. He will use the



number of push-ups a player can do at the end of the experiment as the response variable. Which principle of experimental design does the coach's plan violate? Explain how this violation could lead to confounding.

62. **Killing weeds** A biologist would like to determine which of two brands of weed killer, X or Y, is less likely to harm the plants in a garden at the university. Before spraying near the plants, the biologist decides to conduct an experiment using 24 individual plants. Which of the following two plans for randomly assigning the treatments should the biologist use? Why?

Plan A: Choose the 12 healthiest-looking plants. Then flip a coin. If it lands heads, apply Brand X weed killer to these plants and Brand Y weed killer to the remaining 12 plants. If it lands tails, do the opposite.

Plan B: Choose 12 of the 24 plants at random. Apply Brand X weed killer to those 12 plants and Brand Y weed killer to the remaining 12 plants.

63. **Do diets work?** Dr. Linda Stern and her colleagues recruited 132 obese adults at the Philadelphia Veterans Affairs Medical Center in Pennsylvania. Half the participants were randomly assigned to a low-carbohydrate diet and the other half to a low-fat diet. Researchers measured each participant's change in weight and cholesterol level after six months and again after one year. Explain how each of the four principles of experimental design was used in this study.

64. **The effects of day care** Does day care help low-income children stay in school and hold good jobs later in life? The Carolina Abecedarian Project (the name suggests the ABCs) has followed a group of 111 children since 1972. Back then, these individuals were all healthy but low-income black infants in Chapel Hill, North Carolina. All the infants received nutritional supplements and help from social workers. Half were also assigned at random to an intensive preschool program.³⁶ Explain how each of the four principles of experimental design was used in this study.

65. **Headache relief** Doctors identify "chronic tension-type headaches" as headaches that occur almost daily for at least six months. Can antidepressant medications or stress management training reduce the number and severity of these headaches? Are both together more effective than either alone? Researchers want to compare four treatments: antidepressant alone, placebo alone, antidepressant plus stress management, and placebo plus stress management. Describe a completely randomized design involving 36 headache sufferers who are willing to participate in this experiment. Write a few sentences describing how you would implement your design.

66. **More rain for California?** The changing climate will probably bring more rain to California, but we don't know whether the additional rain will come during

the winter wet season or extend into the long dry season in spring and summer. Kenwyn Suttle of the University of California at Berkeley and his coworkers wanted to compare the effects of three treatments: added water equal to 20% of annual rainfall either during January to March (winter) or during April to June (spring), and no added water (control). Eighteen plots of open grassland, each with area 70 square meters, were available for this study. One response variable was total plant biomass, in grams per square meter, produced in a plot over a year.³⁷

Describe a completely randomized design for this experiment. Write a few sentences describing how you would implement your design.

67. **Treating prostate disease** A large study used records from Canada's national health care system to compare the effectiveness of two ways to treat prostate disease. The two treatments are traditional surgery and a new method that does not require surgery. The records described many patients whose doctors had chosen each method. The study found that patients treated by the new method were significantly more likely to die within 8 years.³⁸
- (a) Further study of the data showed that this conclusion was wrong. The extra deaths among patients who got the new method could be explained by other variables. What other variables might be confounded with a doctor's choice of surgical or nonsurgical treatment?
- (b) You have 300 prostate patients who are willing to serve as subjects in an experiment to compare the two methods. Describe a completely randomized design for this experiment. Write a few sentences describing how you would implement your design.
68. **Getting teachers to come to school** Elementary schools in rural India are usually small, with a single teacher. The teachers often fail to show up for work. Here is an idea for improving attendance: give the teacher a digital camera with a tamperproof time and date stamp and ask a student to take a photo of the teacher and class at the beginning and end of the day. Offer the teacher better pay for good attendance, verified by the photos. Will this work? Researchers obtained permission to use 120 rural schools in Rajasthan for an experiment to find out.³⁹
- (a) Explain why it would not be a good idea to offer better pay for good attendance to the teachers in all 120 schools and then to compare this year's attendance with last year's.
- (b) Describe a completely randomized design for an experiment involving these 120 schools. Write a few sentences describing how you would implement your design.
69. **Do placebos really work?** Researchers in Japan conducted an experiment on 13 individuals who were extremely allergic to poison ivy. On one arm,

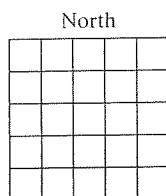
each subject was rubbed with a poison ivy leaf and told the leaf was harmless. On the other arm, each subject was rubbed with a harmless leaf and told it was poison ivy. All the subjects developed a rash on the arm where the harmless leaf was rubbed. Of the 13 subjects, 11 did not have any reaction to the real poison ivy leaf.⁴⁰ Explain how the results of this study support the idea of a placebo effect.

70. **Pain relief study** Fizz Laboratories, a pharmaceutical company, has developed a new drug for relieving chronic pain. Sixty patients suffering from arthritis and needing pain relief are available. Each patient will be treated and asked an hour later, "About what percent of pain relief did you experience?"
 - (a) Why should Fizz not simply give the new drug to 30 patients and no treatment to the other 30 patients, and then record the patients' responses?
 - (b) Should the patients be told whether they are getting the new drug or a placebo? How would this knowledge probably affect their reactions?
71. **Meditation for anxiety** An experiment that claimed to show that meditation lowers anxiety proceeded as follows. The experimenter interviewed the subjects and rated their level of anxiety. Then the subjects were randomly assigned to two groups. The experimenter taught one group how to meditate and they meditated daily for a month. The other group was simply told to relax more. At the end of the month, the experimenter interviewed all the subjects again and rated their anxiety level. The meditation group now had less anxiety. Psychologists said that the results were suspect because the ratings were not blind. Explain what this means and how lack of blindness could bias the reported results.
72. **Testosterone for older men** As men age, their testosterone levels gradually decrease. This may cause a reduction in lean body mass, an increase in fat, and other undesirable changes. Do testosterone supplements reverse some of these effects? A study in the Netherlands assigned 237 men aged 60 to 80 with low or low-normal testosterone levels to either a testosterone supplement or a placebo. The report in the *Journal of the American Medical Association* described the study as a "double-blind, randomized, placebo-controlled trial."⁴¹ Explain each of these terms to someone who knows nothing about statistics.
73. **Do diets work?** Refer to Exercise 63. Subjects in the low-carb diet group lost significantly more weight than subjects in the low-fat diet group during the first six months. At the end of a year, however, the average weight loss for subjects in the two groups was not significantly different.⁴²
 - (a) Why did researchers randomly assign the subjects to the diet treatments?
 - (b) Explain to someone who knows little statistics what "lost significantly more weight" means.
 - (c) The subjects in the low-carb diet group lost an average of 5.1 kg in a year. The subjects in the low-fat diet group lost an average of 3.1 kg. Explain how this information could be consistent with the fact that weight loss in the two groups was not significantly different.
74. **Acupuncture and pregnancy** A study sought to determine whether the ancient Chinese art of acupuncture could help infertile women become pregnant.⁴³ One hundred sixty healthy women undergoing assisted reproductive therapy were recruited for the study. Half of the subjects were randomly assigned to receive acupuncture treatment 25 minutes before embryo transfer and again 25 minutes after the transfer. The remaining 80 subjects were instructed to lie still for 25 minutes after the embryo transfer. *Results:* In the acupuncture group, 34 women became pregnant. In the control group, 21 women became pregnant.
 - (a) Why did researchers randomly assign the subjects to the two treatments?
 - (b) The difference in the percent of women who became pregnant in the two groups is statistically significant. Explain what this means to someone who knows little statistics.
 - (c) Explain why the design of the study prevents us from concluding that acupuncture caused the difference in pregnancy rates.
75. **Doctors and nurses** Nurse-practitioners are nurses with advanced qualifications who often act much like primary-care physicians. Are they as effective as doctors at treating patients with chronic conditions? An experiment was conducted with 1316 patients who had been diagnosed with asthma, diabetes, or high blood pressure. Within each condition, patients were randomly assigned to either a doctor or a nurse-practitioner. The response variables included measures of the patients' health and of their satisfaction with their medical care after 6 months.⁴⁴
 - (a) Which are the blocks in this experiment: the different diagnoses (asthma, and so on) or the type of care (nurse or doctor)? Why?
 - (b) Explain why a randomized block design is preferable to a completely randomized design here.
76. **Comparing cancer treatments** The progress of a type of cancer differs in women and men. Researchers want to design an experiment to compare three therapies for this cancer. They recruit 500 male and 300 female patients who are willing to serve as subjects.
 - (a) Which are the blocks in this experiment: the cancer therapies or the two sexes? Why?
 - (b) What are the advantages of a randomized block design over a completely randomized design using these 800 subjects?



- (c) Suppose the researchers had 800 male and no female subjects available for the study. What advantage would this offer? What disadvantage?

77. **In the cornfield** An agriculture researcher wants to compare the yield of 5 corn varieties: A, B, C, D, and E. The field in which the experiment will be carried out increases in fertility from north to south. The researcher therefore divides the field into 25 plots of equal size, arranged in 5 east–west rows of 5 plots each, as shown in the diagram.



- (a) Explain why a randomized block design would be better than a completely randomized design in this setting.
- (b) Should the researcher use the rows or the columns of the field as blocks? Justify your answer.
- (c) Use technology or Table D to carry out the random assignment required by your design. Explain your method clearly.

78. **Comparing weight-loss treatments** Twenty overweight females have agreed to participate in a study of the effectiveness of four weight-loss treatments: A, B, C, and D. The researcher first calculates how overweight each subject is by comparing the subject's actual weight with her "ideal" weight. The subjects and their excess weights in pounds are as follows:

Birnbaum	35	Hernandez	25	Moses	25	Smith	29
Brown	34	Jackson	33	Nevesky	39	Stall	33
Brunk	30	Kendall	28	Obrach	30	Tran	35
Cruz	34	Loren	32	Rodriguez	30	Wilansky	42
Deng	24	Mann	28	Santiago	27	Williams	22

The response variable is the weight lost after 8 weeks of treatment. Previous studies have shown that the effects of a diet may vary based on a subject's initial weight.

- (a) Explain why a randomized block design would be better than a completely randomized design in this setting.
- (b) Should researchers form blocks of size 4 based on subjects' last names in alphabetical order or by how overweight the subjects are? Explain.
- (c) Use technology or Table D to carry out the random assignment required by your design. Explain your method clearly.

79. **Aw, rats!** A nutrition experimenter intends to compare the weight gain of newly weaned male rats fed Diet A with that of rats fed Diet B. To do this, she will feed each diet to 10 rats. She has available 10 rats from one litter and 10 rats from a second litter. Rats in the first litter appear to be slightly healthier.

- (a) If the 10 rats from Litter 1 were fed Diet A, the effects of genetics and diet would be confounded, and the experiment would be biased. Explain this statement carefully.
- (b) Describe a better design for this experiment.

80. **Technology for teaching statistics** The Brigham Young University (BYU) statistics department is performing experiments to compare teaching methods. Response variables include students' final-exam scores and a measure of their attitude toward statistics. One study compares two levels of technology for large lectures: standard (overhead projectors and chalk) and multimedia. There are eight lecture sections of a basic statistics course at BYU, each with about 200 students. There are four instructors, each of whom teaches two sections.⁴⁵ Suppose the sections and lecturers are as follows:

Section	Lecturer	Section	Lecturer
1	Hilton	5	Tolley
2	Christensen	6	Hilton
3	Hadfield	7	Tolley
4	Hadfield	8	Christensen

- (a) Suppose we randomly assign two lecturers to use standard technology in their sections and the other two lecturers to use multimedia technology. Explain how this could lead to confounding.
- (b) Describe a better design for this experiment.
81. **Look, Ma, no hands!** Does talking on a hands-free cell phone distract drivers? Researchers recruit 40 student subjects for an experiment to investigate this question. They have a driving simulator equipped with a hands-free phone for use in the study. Each subject will complete two sessions in the simulator: one while talking on the hands-free phone and the other while just driving. The order of the two sessions for each subject will be determined at random. The route, driving conditions, and traffic flow will be the same in both sessions.
- (a) What type of design did the researchers use in their study?
- (b) Explain why the researchers chose this design instead of a completely randomized design.
- (c) Why is it important to randomly assign the order of the treatments?
- (d) Explain how and why researchers controlled for other variables in this experiment.
82. **Chocolate gets my heart pumping** Cardiologists at Athens Medical School in Greece wanted to test whether chocolate affected blood flow in the blood vessels. The researchers recruited 17 healthy young volunteers, who were each given a 3.5-ounce bar of dark chocolate, either bittersweet or fake chocolate. On another day, the volunteers received the other treatment. The order in which subjects received the bittersweet and fake chocolate was determined at random. The subjects had no chocolate outside the study, and investigators didn't know whether a subject had eaten the real or the fake chocolate. An ultrasound was taken of each

volunteer's upper arm to see the functioning of the cells in the walls of the main artery. The researchers found that blood vessel function was improved when the subjects ate bittersweet chocolate, and that there were no such changes when they ate the placebo (fake chocolate).⁴⁶

- (a) What type of design did the researchers use in their study?
 - (b) Explain why the researchers chose this design instead of a completely randomized design.
 - (c) Why is it important to randomly assign the order of the treatments for the subjects?
 - (d) Explain how and why researchers controlled for other variables in this experiment.
83. **Room temperature and dexterity** An expert on worker performance is interested in the effect of room temperature on the performance of tasks requiring manual dexterity. She chooses temperatures of 70°F and 90°F as treatments. The response variable is the number of correct insertions, during a 30-minute period, in a peg-and-hole apparatus that requires the use of both hands simultaneously. Each subject is trained on the apparatus and then asked to make as many insertions as possible in 30 minutes of continuous effort.
- (a) Describe a completely randomized design to compare dexterity at 70° and 90° using 20 volunteer subjects.
 - (b) Because individuals differ greatly in dexterity, the wide variation in individual scores may hide the systematic effect of temperature unless there are many subjects in each group. Describe in detail the design of a matched pairs experiment in which each subject serves as his or her own control.
84. **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.⁴⁷
- (a) Describe the design of a completely randomized experiment using six well-separated 30-meter circular areas in a pine forest. Sketch the circles and carry out the randomization your design calls for.
 - (b) Areas within the forest may differ in soil fertility. Describe a matched pairs design using three pairs of circles that will account for the extra variation due to different fertility. Sketch the circles and carry out the randomization your design calls for.
85. **Got deodorant?** A group of students wants to perform an experiment to determine whether Brand A or Brand B deodorant lasts longer. One group member suggests the following design: Recruit

40 student volunteers—20 male and 20 female. Separate by gender, because male and female bodies might respond differently to deodorant. Give all the males Brand A deodorant and all the females Brand B. Have each student rate how well the deodorant is still working at the end of the school day on a 0 to 10 scale. Then compare ratings for the two treatments.

- (a) Identify any flaws you see in the proposed design for this experiment.
 - (b) Describe how you would design the experiment. Explain how your design addresses each of the problems you identified in part (a).
86. **Close shave** Which of two brands (X or Y) of electric razor shaves closer? Researchers want to design and carry out an experiment to answer this question using 50 adult male volunteers. Here's one idea: Have all 50 subjects shave the left sides of their faces with the Brand X razor and shave the right sides of their faces with the Brand Y razor. Then have each man decide which razor gave the closer shave and compile the results.
- (a) Identify any flaws you see in the proposed design for this experiment.
 - (b) Describe how you would design the experiment. Explain how your design addresses each of the problems you identified in part (a).

Multiple choice: Select the best answer for Exercises 87 to 94.

87. Can changing diet reduce high blood pressure? Vegetarian diets and low-salt diets are both promising. Men with high blood pressure are assigned at random to four diets: (1) normal diet with unrestricted salt; (2) vegetarian with unrestricted salt; (3) normal with restricted salt; and (4) vegetarian with restricted salt. This experiment has
- (a) one factor, the type of diet.
 - (b) two factors, high blood pressure and type of diet.
 - (c) two factors, normal/vegetarian diet and unrestricted/restricted salt.
 - (d) three factors, men, high blood pressure, and type of diet.
 - (e) four factors, the four diets being compared.
88. In the experiment of the previous exercise, the subjects were randomly assigned to the different treatments. What is the most important reason for this random assignment?
- (a) Random assignment eliminates the effects of other variables such as stress and body weight.
 - (b) Random assignment is a good way to create groups of subjects that are roughly equivalent at the beginning of the experiment.
 - (c) Random assignment makes it possible to make a conclusion about all men.
 - (d) Random assignment reduces the amount of variation in blood pressure.



- (e) Random assignment prevents the placebo effect from ruining the results of the study.
89. To investigate whether standing up while studying affects performance in an algebra class, a teacher assigns half of the 30 students in his class to stand up while studying and assigns the other half to not stand up while studying. To determine who receives which treatment, the teacher identifies the two students who did best on the last exam and randomly assigns one to stand and one to not stand. The teacher does the same for the next two highest-scoring students and continues in this manner until each student is assigned a treatment. Which of the following best describes this plan?
- This is an observational study.
 - This is an experiment with blocking.
 - This is a completely randomized experiment.
 - This is a stratified random sample.
 - This is a cluster sample.
90. A gardener wants to try different combinations of fertilizer (none, 1 cup, 2 cups) and mulch (none, wood chips, pine needles, plastic) to determine which combination produces the highest yield for a variety of green beans. He has 60 green-bean plants to use in the experiment. If he wants an equal number of plants to be assigned to each treatment, how many plants will be assigned to each treatment?
- 1
 - 3
 - 4
 - 5
 - 12
91. Corn variety 1 yielded 140 bushels per acre last year at a research farm. This year, corn variety 2, planted in the same location, yielded only 110 bushels per acre. Based on these results, is it reasonable to conclude that corn variety 1 is more productive than corn variety 2?
- Yes, because 140 bushels per acre is greater than 110 bushels per acre.
 - Yes, because the study was done at a research farm.
 - No, because there may be other differences between the two years besides the corn variety.
 - No, because there was no use of a placebo in the experiment.
 - No, because the experiment wasn't double-blind.
92. A report in a medical journal notes that the risk of developing Alzheimer's disease among subjects who regularly opted to take the drug ibuprofen was about half the risk among those who did not. Is this good evidence that ibuprofen is effective in preventing Alzheimer's disease?
- Yes, because the study was a randomized, comparative experiment.
 - No, because the effect of ibuprofen is confounded with the placebo effect.
 - Yes, because the results were published in a reputable professional journal.
 - No, because this is an observational study. An experiment would be needed to confirm (or not confirm) the observed effect.
 - Yes, because a 50% reduction can't happen just by chance.
93. A farmer is conducting an experiment to determine which variety of apple tree, Fuji or Gala, will produce more fruit in his orchard. The orchard is divided into 20 equally sized square plots. He has 10 trees of each variety and randomly assigns each tree to a separate plot in the orchard. What are the experimental unit(s) in this study?
- The trees
 - The plots
 - The apples
 - The farmer
 - The orchard
94. Two essential features of all statistically designed experiments are
- compare several treatments; use the double-blind method.
 - compare several treatments; use chance to assign subjects to treatments.
 - always have a placebo group; use the double-blind method.
 - use a block design; use chance to assign subjects to treatments.
 - use enough subjects; always have a control group.
95. **Seed weights (2.2)** Biological measurements on the same species often follow a Normal distribution quite closely. The weights of seeds of a variety of winged bean are approximately Normal with mean 525 milligrams (mg) and standard deviation 110 mg.
- What percent of seeds weigh more than 500 mg? Show your method.
 - If we discard the lightest 10% of these seeds, what is the smallest weight among the remaining seeds? Show your method.
96. **Twins (1.3, 3.1)** A researcher studied a group of identical twins who had been separated and adopted at birth. In each case, one twin (Twin A) was adopted by a low-income family and the other (Twin B) by a high-income family. Both twins were given an IQ test as adults. Here are their scores:⁴⁸
- | | | | | | | | | | | | | |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Twin A: | 120 | 99 | 99 | 94 | 111 | 97 | 99 | 94 | 104 | 114 | 113 | 100 |
| Twin B: | 128 | 104 | 108 | 100 | 116 | 105 | 100 | 100 | 103 | 124 | 114 | 112 |
- How well does one twin's IQ predict the other's? Give appropriate evidence to support your answer.
 - Do identical twins living in low-income homes tend to have lower IQs later in life than their twins who live in high-income homes? Give appropriate evidence to support your answer.