Experimental Design Free Response

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Question 1

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Blocking, Double Blind , Completely Randomized Design, Randomized Block Design

Paper: Part-A / Series: 2000 / Difficulty: Medium / Question Number: 5

5. High cholesterol level in people can be reduced by exercise or by drug treatment. A pharmaceutical company has developed a new cholesterol-reducing drug. Researchers would like to compare its effects to the effects of the cholesterol-reducing drug that is currently available on the market. Volunteers who have a history of high cholesterol and who are currently not on medication will be recruited to participate in a study.

(a) Explain how you would carry out a completely randomized experiment for the study.

(b) Describe an experimental design that would improve the design in (a) by incorporating blocking.

(c) Can the experimental design in (b) be carried out in a double blind manner? Explain.

Question 2

Qualification: AP Statistics

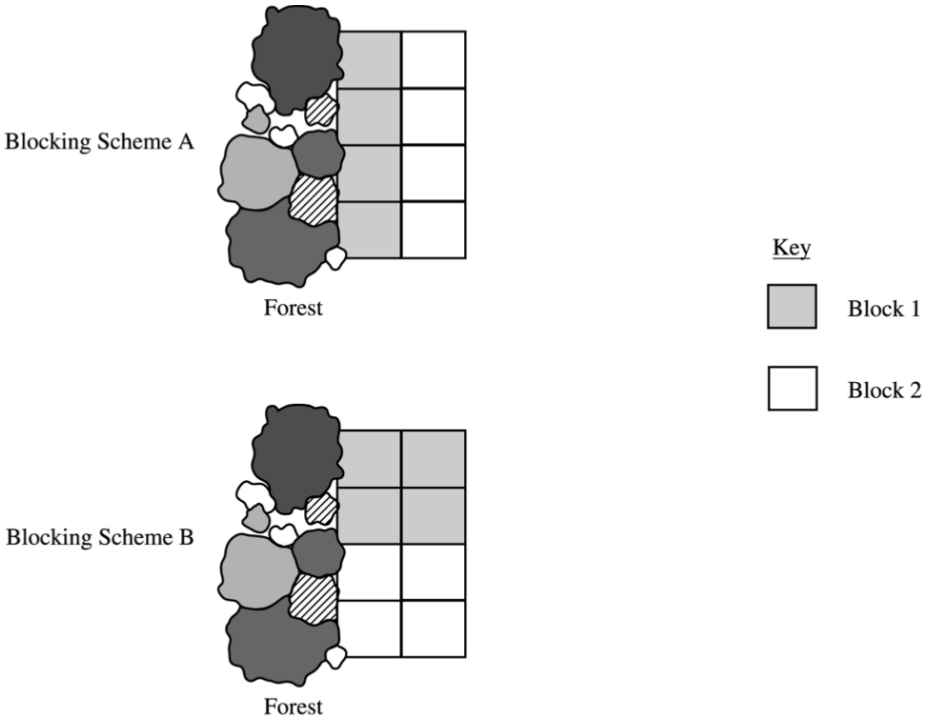
Areas: Experimental Design

Subtopics: Blocking, Randomization, Randomized Block Design

Paper: Part-A / Series: 2001 / Difficulty: Medium / Question Number: 4

4. Students are designing an experiment to compare the productivity of two varieties of dwarf fruit trees. The site for the experiment is a field that is bordered by a densely forested area on the west (left) side. The field has been divided into eight plots of approximately the same area. The students have decided that the test plots should be blocked. Four trees, two of each of the two varieties, will be assigned at random to the four plots within each block, with one tree planted in each plot.

   The two blocking schemes shown below are under consideration. For each scheme, one block is indicated by the white region and the other block is indicated by the gray region in the figures.



   (a) Which of the blocking schemes, A or B, is better for this experiment? Explain your answer.

   (b) Even though the students have decided to block, they must randomly assign the varieties of trees to the plots within each block. What is the purpose of this randomization in the context of this experiment?

Question 3

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Double Blind , Paired Design, Crossover Design

Paper: Part-A / Series: 2002 / Difficulty: Medium / Question Number: 2

2. A manufacturer of boots plans to conduct an experiment to compare a new method of waterproofing to the current method. The appearance of the boots is not changed by either method. The company recruits 100 volunteers in Seattle, where it rains frequently, to wear the boots as they normally would for 6 months. At the end of the 6 months, the boots will be returned to the company to be evaluated for water damage.

   (a) Describe a design for this experiment that uses the 100 volunteers. Include a few sentences on how it would be implemented.

   (b) Could your design be double blind? Explain.

Question 4

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Treatments, Method of Assigning Treatments, Blocking, Completely Randomized Design, Randomized Block Design

Paper: Part-A / Series: 2002-Form-B / Difficulty: Medium / Question Number: 3

3. A preliminary study conducted at a medical center in St. Louis has shown that treatment with small, low-intensity magnets reduces the self-reported level of pain in polio patients. During each session, a patient rested on an examining table in the doctor's office while the magnets, embedded in soft pads, were strapped to the body at the site of pain. Sessions continued for several weeks, after which pain reduction was measured.

   A new study is being designed to investigate whether magnets also reduce pain in patients suffering from herniated disks in the lower back. One hundred male patients are available for the new study.

   (a) Describe an appropriate design for the new study. Your discussion should briefly address treatments used, methods of treatment assignment, and what variables would be measured. Do not describe how the data would be analyzed.

   (b) Would you modify the design above if, instead of 100 male patients, there were 50 male and 50 female patients available for the study? If so, how would you modify your design? If not, why not?

Question 5

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Random Assignment, Control Group, Generalize Conclusion to Population

Paper: Part-A / Series: 2003 / Difficulty: Medium / Question Number: 4

4. Because of concerns about employee stress, a large company is conducting a study to compare two programs (tai chi or yoga) that may help employees reduce their stress levels. Tai chi is a 1,200-year-old practice, originating in China, that consists of slow, fluid movements. Yoga is a practice, originating in India, that consists of breathing exercises and movements designed to stretch and relax muscles. The company has assembled a group of volunteer employees to participate in the study during the first half of their lunch hour each day for a 10-week period. Each volunteer will be assigned at random to one of the two programs. Volunteers will have their stress levels measured just before beginning the program and 10 weeks later at the completion of it.

   (a) A group of volunteers who work together ask to be assigned to the same program so that they can participate in that program together. Give an example of a problem that might arise if this is permitted. Explain to this volunteer group why random assignment to the two programs will address this problem.

   (b) Someone proposes that a control group be included in the design as well. The stress level would be measured for each volunteer assigned to the control group at the start of the study and again 10 weeks later. What additional information, if any, would this provide about the effectiveness of the two programs?

   (c) Is it reasonable to generalize the findings of this study to all employees of this company? Explain.

Question 6

Qualification: AP Statistics

Areas: Hypothesis Testing, Experimental Design

Subtopics: Control Group, Random Assignment, Variability, Two Sample T Test for Difference Of Means

Paper: Part-A / Series: 2003-Form-B / Difficulty: Somewhat Challenging / Question Number: 4

4. There have been many studies recently concerning coffee drinking and cholesterol level. While it is known that several coffee-bean components can elevate blood cholesterol level, it is thought that a new type of paper coffee filter may reduce the presence of some of these components in coffee.

   The effect of the new filter on cholesterol level will be studied over a 10-week period using 300 nonsmokers who each drink 4 cups of caffeinated coffee per day. Each of these 300 participants will be assigned to one of two groups: the experimental group, who will only drink coffee that has been made with the new filter, or the control group, who will only drink coffee that has been made with the standard filter. Each participant's cholesterol level will be measured at the beginning and at the end of the study.

   (a) Describe an appropriate method for assigning the subjects to the two groups so that each group will have an equal number of subjects.

   (b) In this study, the researchers chose to include a group who only drank coffee that was made with the standard filter. Why is it important to include a control group in this study even though cholesterol levels will be measured at the beginning and at the end of the study?

   (c) Which test would you conduct to determine whether the change in cholesterol level would be greater if people used the new filter rather than using the standard filter?

   (d) Why would the researchers choose to use only nonsmokers in the study?

Question 7

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Blocking, Treatments, Method of Assigning Treatments

Paper: Part-A / Series: 2004 / Difficulty: Medium / Question Number: 2

2. Researchers who are studying a new shampoo formula plan to compare the condition of hair for people who use the new formula with the condition of hair for people who use the current formula. Twelve volunteers are available to participate in this study. Information on these volunteers (numbered 1 through 12) is shown in the table below.

Volunteer	Gender	Age
1	Male	21
2	Female	20
3	Male	47
4	Female	60
5	Female	62
6	Male	61
7	Male	58
8	Female	44
9	Male	44
10	Female	24
11	Male	23
12	Female	46

(a) These researchers want to conduct an experiment involving the two formulas (new and current) of shampoo. They believe that the condition of hair changes with age but not gender. Because researchers want the size of the blocks in an experiment to be equal to the number of treatments, they will use blocks of size 2 in their experiment. Identify the volunteers (by number) that would be included in each of the six blocks and give the criteria you used to form the blocks.

(b) Other researchers believe that hair condition differs with both age and gender. These researchers will also use blocks of size 2 in their experiment. Identify the volunteers (by number) that would be included in each of the six blocks and give the criteria you used to form the blocks.

(c) The researchers in part (b) decide to select three of the six blocks to receive the new formula and to give the other three blocks the current formula. Is this an appropriate way to assign treatments? If so, describe a method for selecting the three blocks to receive the new formula. If not, describe an appropriate method for assigning treatments.

Question 8

Qualification: AP Statistics

Areas: Experimental Design, Hypothesis Testing

Subtopics: Matched Pairs Design , Randomization, Completely Randomized Design

Paper: Part-A / Series: 2005-Form-B / Difficulty: Medium / Question Number: 3

3. In search of a mosquito repellent that is safer than the ones that are currently on the market, scientists have developed a new compound that is rated as less toxic than the current compound, thus making a repellent that contains this new compound safer for human use. Scientists also believe that a repellent containing the new compound will be more effective than the ones that contain the current compound. To test the effectiveness of the new compound versus that of the current compound, scientists have randomly selected 100 people from a state.

   Up to 100 bins, with an equal number of mosquitoes in each bin, are available for use in the study. After a compound is applied to a participant's forearm, the participant will insert his or her forearm into a bin for 1 minute, and the number of mosquito bites on the arm at the end of that time will be determined.

   (a) Suppose this study is to be conducted using a completely randomized design. Describe a randomization process and identify an inference procedure for the study.

   (b) Suppose this study is to be conducted using a matched-pairs design. Describe a randomization process and identify an inference procedure for the study.

   (c) Which of the designs, the one in part (a) or the one in part (b), is better for testing the effectiveness of the new compound versus that of the current compound? Justify your answer.

Question 9

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Treatments, Randomization, LImiting Variability, Statistical Advantage, Completely Randomized Design

Paper: Part-A / Series: 2006 / Difficulty: Medium / Question Number: 5

5. A biologist is interested in studying the effect of growth-enhancing nutrients and different salinity (salt) levels in water on the growth of shrimps. The biologist has ordered a large shipment of young tiger shrimps from a supply house for use in the study. The experiment is to be conducted in a laboratory where 10 tiger shrimps are placed randomly into each of 12 similar tanks in a controlled environment. The biologist is planning to use 3 different growth-enhancing nutrients (A, B, and C) and two different salinity levels (low and high).

   (a) List the treatments that the biologist plans to use in this experiment.

   (b) Using the treatments listed in part (a), describe a completely randomized design that will allow the biologist to compare the shrimps' growth after 3 weeks.

   (c) Give one statistical advantage to having only tiger shrimps in the experiment. Explain why this is an advantage.

   (d) Give one statistical disadvantage to having only tiger shrimps in the experiment. Explain why this is a disadvantage.

Question 10

Qualification: AP Statistics

Areas: Experimental Design, Hypothesis Testing

Subtopics: Experimental Units, Treatments, Randomization, Replication, Confounding Variables, Response Variable , Two Sample Z Interval For Difference in Proportions

Paper: Part-A / Series: 2006-Form-B / Difficulty: Medium / Question Number: 5

5. When a tractor pulls a plow through an agricultural field, the energy needed to pull that plow is called the draft. The draft is affected by environmental conditions such as soil type, terrain, and moisture.

   A study was conducted to determine whether a newly developed hitch would be able to reduce draft compared to the standard hitch. (A hitch is used to connect the plow to the tractor.) Two large plots of land were used in this study. It was randomly determined which plot was to be plowed using the standard hitch. As the tractor plowed that plot, a measurement device on the tractor automatically recorded the draft at 25 randomly selected points in the plot.

   After the plot was plowed, the hitch was changed from the standard one to the new one, a process that takes a substantial amount of time. Then the second plot was plowed using the new hitch. Twenty-five measurements of draft were also recorded at randomly selected points in this plot.

   (a) What was the response variable in this study?

   Identify the treatments.

   What were the experimental units?

   (b) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was randomization used properly in this study? Justify your answer.

   (c) Given that the goal of the study is to determine whether a newly developed hitch reduces draft compared to the standard hitch, was replication used properly in this study? Justify your answer.

   (d) Plot of land is a confounding variable in this experiment. Explain why.

Question 11

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Random Assignment, Control Group, Blocking, Randomized Block Design

Paper: Part-A / Series: 2007 / Difficulty: Medium / Question Number: 2

2. As dogs age, diminished joint and hip health may lead to joint pain and thus reduce a dog's activity level. Such a reduction in activity can lead to other health concerns such as weight gain and lethargy due to lack of exercise. A study is to be conducted to see which of two dietary supplements, glucosamine or chondroitin, is more effective in promoting joint and hip health and reducing the onset of canine osteoarthritis. Researchers will randomly select a total of 300 dogs from ten different large veterinary practices around the country. All of the dogs are more than 6 years old, and their owners have given consent to participate in the study. Changes in joint and hip health will be evaluated after 6 months of treatment.

   (a) What would be an advantage to adding a control group in the design of this study?

   (b) Assuming a control group is added to the other two groups in the study, explain how you would assign the 300 dogs to these three groups for a completely randomized design.

   (c) Rather than using a completely randomized design, one group of researchers proposes blocking on clinics, and another group of researchers proposes blocking on breed of dog. How would you decide which one of these two variables to use as a blocking variable?

Question 12

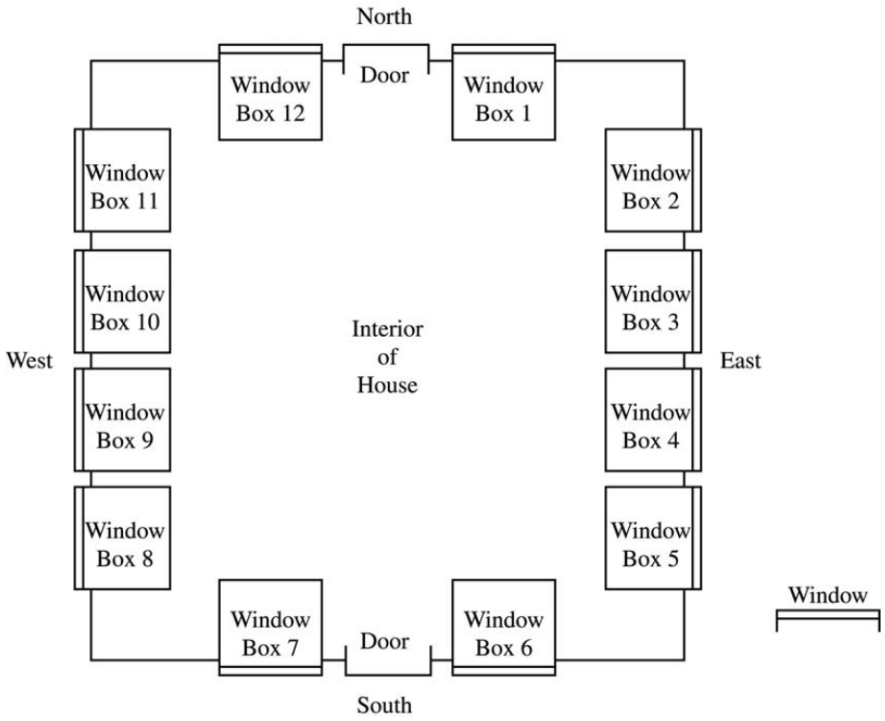
Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Randomization, Randomized Block Design, Blocking

Paper: Part-A / Series: 2007-Form-B / Difficulty: Somewhat Challenging / Question Number: 3

3. The United States Department of Energy is conducting an experiment to compare the heat gain in houses using two different types of windows, A and B. Six windows of each type are available for the experiment. The Department has constructed a house with twelve windows as shown on the floor plan below.



In the interior of the house, each window is surrounded by a window box to capture and measure the amount of heat coming in through that window and to isolate the heat gain for each window.

(a) A randomized block experiment will be used to compare the heat gain for the two types (A and B) of windows. How would you group the window boxes into blocks? (Clearly indicate your blocks using the window box numbers.) Justify your choice of blocks.

(b) For the design in part (a), describe how you would assign window types (A and B) to the numbered window boxes.

Question 13

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Type I and Type II Error, Type I Consequences, Type II Consequences, Matched Pairs Design , Paired Design

Paper: Part-A / Series: 2008-Form-B / Difficulty: Somewhat Challenging / Question Number: 4

4. A researcher wants to conduct a study to test whether listening to soothing music for 20 minutes helps to reduce diastolic blood pressure in patients with high blood pressure, compared to simply sitting quietly in a noise-free environment for 20 minutes. One hundred patients with high blood pressure at a large medical clinic are available to participate in this study.

   (a) Propose a design for this study to compare these two treatments.

   (b) The null hypothesis for this study is that there is no difference in the mean reduction of diastolic blood pressure for the two treatments and the alternative hypothesis is that the mean reduction in diastolic blood pressure is greater for the music treatment. If the null hypothesis is rejected, the clinic will offer this music therapy as a free service to their patients with high blood pressure. Describe Type I and Type II errors and the consequences of each in the context of this study, and discuss which one you think is more serious.

Question 14

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Method of Assigning Treatments, Random Assignment, Increasing Power, Completely Randomized Design, Blocking

Paper: Part-A / Series: 2009-Form-B / Difficulty: Medium / Question Number: 4

4. A manufacturer of toxic pesticide granules plans to use a dye to color the pesticide so that birds will avoid eating it. A series of experiments will be designed to find colors or patterns that three bird species (blackbirds, starlings, and geese) will avoid eating. Representative samples of birds will be captured to use in the experiments, and the response variable will be the amount of time a hungry bird will avoid eating food of a particular color or pattern.

   (a) Previous research has shown that male birds do not avoid solid colors. However, it is possible that males might avoid colors displayed in a pattern, such as stripes. In an effort to prevent males from eating the pesticide, the following two treatments are applied to the pesticide granules.

   Treatment 1: A red background with narrow blue stripes

   Treatment 2: A blue background with narrow red stripes

   To increase the power of detecting a difference in the two treatments in the analysis of the experiment, the researcher decided to block on the three species of birds (blackbirds, starlings, and geese). Assuming there are 100 birds of each of the three species, explain how you would assign birds to treatments in such a block design.

   (b) Other than blocking, what could the researcher do to increase the power of detecting a difference in the two treatments in the analysis of the experiment? Explain how your approach would increase the power.

Question 15

Qualification: AP Statistics

Areas: Experimental Design, Confidence Intervals

Subtopics: Double Blind , Relative Risk, Constructing a Confidence Interval , Interpreting a Confidence Interval, Two Sample Z Interval For Difference in Proportions

Paper: Part-B / Series: 2009-Form-B / Difficulty: Hard / Question Number: 6

6. Two treatments, A and B, showed promise for treating a potentially fatal disease. A randomized experiment was conducted to determine whether there is a significant difference in the survival rate between patients who receive treatment A and those who receive treatment B. Of 154 patients who received treatment A, 38 survived for at least 15 years, whereas 16 of the 164 patients who received treatment B survived at least 15 years.

(a) Treatment A can be administered only as a pill, and treatment B can be administered only as an injection. Can this randomized experiment be performed as a double-blind experiment? Why or why not?

(b) The conditions for inference have been met. Construct and interpret a 95 percent confidence interval for the difference between the proportion of the population who would survive at least 15 years if given treatment A and the proportion of the population who would survive at least 15 years if given treatment B.

In many of these types of studies, physicians are interested in the ratio of survival probabilities, $\frac{p_A}{p_B}$, where p_A represents the true 15-year survival rate for all patients who receive treatment A and p_B represents the true 15-year survival rate for all patients who receive treatment B. This ratio is usually referred to as the relative risk of the two treatments.

For example, a relative risk of 1 indicates the survival rates for patients receiving the two treatments are equal, whereas a relative risk of 1.5 indicates that the survival rate for patients receiving treatment A is 50 percent higher than the survival rate for patients receiving treatment B. An estimator of the relative risk is the ratio of estimated probabilities, $\frac{\hat{p}_A}{\hat{p}_B}$.

(c) Using the data from the randomized experiment described above, compute the estimate of the relative risk.

The sampling distribution of $\frac{\hat{p}_A}{\hat{p}_B}$ is skewed. However, when both sample sizes n_A and n_B are relatively large, the distribution of $\ln\left(\frac{\hat{p}_A}{\hat{p}_B}\right)$ — the natural logarithm of relative risk — is approximately normal with a mean of $\ln\left(\frac{p_A}{p_B}\right)$ and a standard deviation of $\sqrt{\frac{1-p_A}{n_A p_A}+\frac{1-p_B}{n_B p_B}}$, where p_A and p_B can be estimated by using $\hat{p}_A$ and $\hat{p}_B$.

When a 95 percent confidence interval for $\ln\left(\frac{p_A}{p_B}\right)$ is known, an approximate 95 percent confidence interval for $\frac{p_A}{p_B}$ — the relative risk of the two treatments — can be constructed by applying the inverse of the natural logarithm to the endpoints of the confidence interval for $\ln\left(\frac{p_A}{p_B}\right)$.

(d) The conditions for inference are met for the data in the experiment above, and a 95 percent confidence interval for $\ln\left(\frac{p_A}{p_B}\right)$ is (0.3868, 1.4690). Construct and interpret a 95 percent confidence interval for the relative risk, $\frac{p_A}{p_B}$, of the two treatments.

(e) What is an advantage of using the interval in part (d) over using the interval in part (b) ?

Question 16

Qualification: AP Statistics

Areas: Experimental Design, Data - Two Variable

Subtopics: Response Variable , Experimental Units, Treatments, Scatterplot, Scatterplot Construction, Is Linear Model Appropriate?, Linear Regression

Paper: Part-A / Series: 2010 / Difficulty: Medium / Question Number: 1

1. Agricultural experts are trying to develop a bird deterrent to reduce costly damage to crops in the United States. An experiment is to be conducted using garlic oil to study its effectiveness as a nontoxic, environmentally safe bird repellant. The experiment will use European starlings, a bird species that causes considerable damage annually to the corn crop in the United States. Food granules made from corn are to be infused with garlic oil in each of five concentrations of garlic —0 percent, 2 percent, 10 percent, 25 percent, and 50 percent. The researchers will determine the adverse reaction of the birds to the repellant by measuring the number of food granules consumed during a two-hour period following overnight food deprivation. There are forty birds available for the experiment, and the researchers will use eight birds for each concentration of garlic. Each bird will be kept in a separate cage and provided with the same number of food granules.

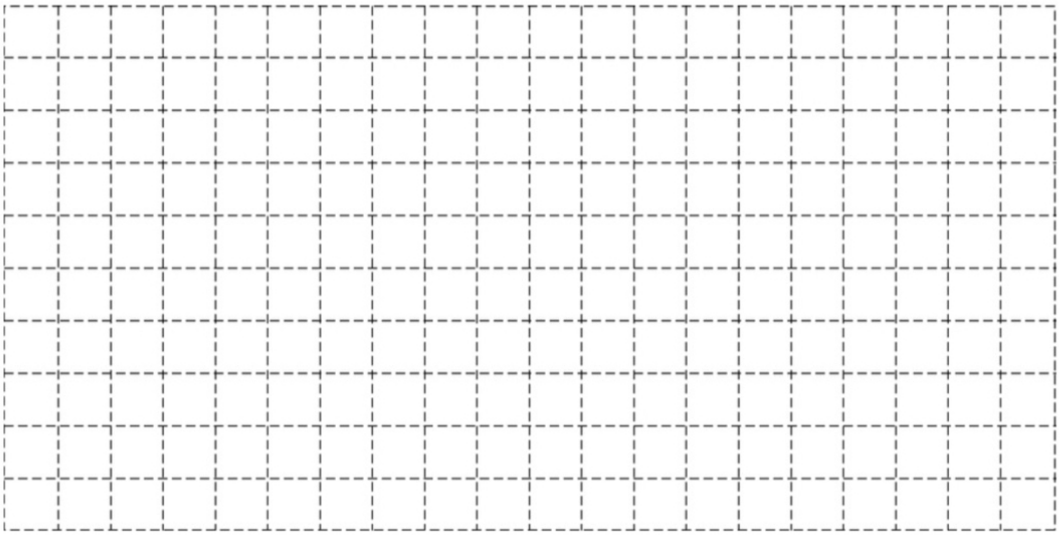
   (a) For the experiment, identify

      i. the treatments
      ii. the experimental units
      iii. the response that will be measured

   (b) After performing the experiment, the researchers recorded the data shown in the table below.

Garlic oil concentration	0%	2%	10%	25%	50%
Mean number of food granules consumed	58	48	29	24	20
Number of birds	8	8	8	8	8

   i. Construct a graph of the data that could be used to investigate the appropriateness of a linear regression model for analyzing the results of the experiment.



   ii. Based on your graph, do you think a linear regression model is appropriate? Explain.

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Question 17

Qualification: AP Statistics

Areas: Experimental Design, Probability

Subtopics: Random Assignment, Method of Assigning Treatments

Paper: Part-B / Series: 2017 / Difficulty: Hard / Question Number: 6

6. Consider an experiment in which two men and two women will be randomly assigned to either a treatment group or a control group in such a way that each group has two people. The people are identified as Man 1, Man 2, Woman 1, and Woman 2. The six possible arrangements are shown below.

Arrangement A	
Treatment	Control
Man 1 Man 2	Woman 1 Woman 2

Arrangement B	
Treatment	Control
Man 1 Woman 1	Man 2 Woman 2

Arrangement C	
Treatment	Control
Man 1 Woman 2	Man 2 Woman 1

Arrangement D	
Treatment	Control
Woman 1 Woman 2	Man 1 Man 2

Arrangement E	
Treatment	Control
Man 2 Woman 2	Man 1 Woman 1

Arrangement F	
Treatment	Control
Man 2 Woman 1	Man 1 Woman 2

Two possible methods of assignment are being considered: the sequential coin flip method, as described in part (a), and the chip method, as described in part (b). For each method, the order of the assignment will be Man 1, Man 2, Woman 1, Woman 2.

(a) For the sequential coin flip method, a fair coin is flipped until one group has two people. An outcome of tails assigns the person to the treatment group, and an outcome of heads assigns the person to the control group. As soon as one group has two people, the remaining people are automatically assigned to the other group.

(i) Complete the table below by calculating the probability of each arrangement occurring if the sequential coin flip method is used.

Arrangement	A	B	C	D	E	F
Probability						

(ii) For the sequential coin flip method, what is the probability that Man 1 and Man 2 are assigned to the same group?

The six arrangements are repeated below.

Arrangement A	
Treatment	Control
Man 1 Man 2	Woman 1 Woman 2

Arrangement B	
Treatment	Control
Man 1 Woman 1	Man 2 Woman 2

Arrangement C	
Treatment	Control
Man 1 Woman 2	Man 2 Woman 1

Arrangement D	
Treatment	Control
Woman 1 Woman 2	Man 1 Man 2

Arrangement E	
Treatment	Control
Man 2 Woman 2	Man 1 Woman 1

Arrangement F	
Treatment	Control
Man 2 Woman 1	Man 1 Woman 2

(b) For the chip method, two chips are marked "treatment" and two chips are marked "control." Each person selects one chip at random without replacement.

(i) Complete the table below by calculating the probability of each arrangement occurring if the chip method is used.

Arrangement	A	B	C	D	E	F
Probability						

(ii) For the chip method, what is the probability that Man 1 and Man 2 are assigned to the same group?

(c) Sixteen participants consisting of 10 students and 6 teachers at an elementary school will be used for an experiment to determine lunch preference for the school population of students and teachers. As the participants enter the school cafeteria for lunch, they will be randomly assigned to receive one of two lunches so that 8 will receive a salad, and 8 will receive a grilled cheese sandwich. The students will enter the cafeteria first, and the teachers will enter next. Which method, the sequential coin flip method or the c method, should be used to assign the treatments? Justify your choice.

Question 18

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Control Group, Random Assignment, Experimental Units, Treatments, Response Variable , Randomized Block Design

Paper: Part-A / Series: 2019 / Difficulty: Medium / Question Number: 2

2. Researchers are investigating the effectiveness of using a fungus to control the spread of an insect that destroys trees. The researchers will create four different concentrations of fungus mixtures: 0 milliliters per liter (ml/L), 1.25 ml/L, 2.5 ml/L, and 3.75 ml/L. An equal number of the insects will be placed into 20 individual containers. The group of insects in each container will be sprayed with one of the four mixtures, and the researchers will record the number of insects that are still alive in each container one week after spraying.

   (a) Identify the treatments, experimental units, and response variable of the experiment.

   Treatments:

   Experimental units:

   Response variable:

   (b) Does the experiment have a control group? Explain your answer.

   (c) Describe how the treatments can be randomly assigned to the experimental units so that each treatment has the same number of units.

Question 19

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Random Assignment, Experimental Units, Treatments, Response Variable , Method of Assigning Treatments, Matched Pairs Design , Completely Randomized Design

Paper: Part-A / Series: 2022 / Difficulty: Easy / Question Number: 2

2. A dermatologist will conduct an experiment to investigate the effectiveness of a new drug to treat acne. The dermatologist has recruited 36 pairs of identical twins. Each person in the experiment has acne and each person in the experiment will receive either the new drug or a placebo. After each person in the experiment uses either the new drug or the placebo for 2 weeks, the dermatologist will evaluate the improvement in acne severity for each person on a scale from 0 (no improvement) to 100 (complete cure).

(a) Identify the treatments, experimental units, and response variable of the experiment.

- Treatments:
- Experimental units:
- Response variable:

Each twin in the experiment has a severity of acne similar to that of the other twin. However, the severity of acne differs from one twin pair to another.

(b) For the dermatologist's experiment, describe a statistical advantage of using a matched-pairs design where twins are paired rather than using a completely randomized design.

(c) For the dermatologist's experiment, describe how the treatments can be randomly assigned to people using a matched-pairs design in which twins are paired.

Question 20

Qualification: AP Statistics

Areas: Experimental Design

Subtopics: Response Variable , Random Assignment, Treatments, Experimental Units, Method of Assigning Treatments

Paper: Part-A / Series: 2023 / Difficulty: Easy / Question Number: 2

2. A developer wants to know whether adding fibers to concrete used in paving driveways will reduce the severity of cracking, because any driveway with severe cracks will have to be repaired by the developer. The developer conducts a completely randomized experiment with 60 new homes that need driveways. Thirty of the driveways will be randomly assigned to receive concrete that contains fibers, and the other 30 driveways will receive concrete that does not contain fibers. After one year, the developer will record the severity of cracks in each driveway on a scale of 0 to 10, with 0 representing not cracked at all and 10 representing severely cracked.

(a) Based on the information provided about the developer's experiment, identify each of the following.

- Experimental units

- Treatments

- Response variable

(b) Describe an appropriate method the developer could use to randomly assign concrete that contains fibers and concrete that does not contain fibers to the 60 driveways.

Suppose the developer finds that there is a statistically significant reduction in the mean severity of cracks in driveways using the concrete that contains fibers compared to the driveways using concrete that does not contain fibers.

(c) In terms of the developer's conclusion, what is the benefit of randomly assigning the driveways to either the concrete that contains fibers or the concrete that does not contain fibers?

Question 21

Qualification: AP Statistics

Areas: Experiments and Observations (Types Of Study), Experimental Design

Subtopics: Observational vs Experiment , Random Assignment, Generalize Conclusion to Population , Method of Assigning Treatments, Completely Randomized Design

Paper: Part-A / Series: 2024 / Difficulty: Medium / Question Number: 3

3. A car maker produces four different models of cars: A, B, C, and D. A group of researchers is investigating which model of car has the longest distance traveled per gallon of gas (mileage). Higher mileage is considered better than lower mileage. The researchers will conduct a study in which they contact several owners of each model of car and ask them to estimate their mileage.

   (a) Is this an observational study or an experiment? Justify your answer in context.

   Model D has an autopilot feature, in which the car controls its own motion with human supervision. James owns a Model D car and will investigate whether using the autopilot feature results in higher mileage than not using the autopilot. James will drive his car on 70 different days to and from work, using the same route at the same time each day. James will record the mileage each day.

   (b) James will use a completely randomized design to conduct his investigation. Describe an appropriate method James could use to randomly assign the two treatments, driving using the autopilot feature and driving without using the autopilot feature, to 35 days each.

   (c) After the investigation was completed, James verified that the conditions for inference were met and conducted a hypothesis test. He discovered the mean mileage when using the autopilot feature was significantly higher than the mean mileage when not using the autopilot feature.

   James is a member of a Model D club with thousands of members who all drive Model D cars. He will give a presentation at a Model D club members' meeting later this year and would like to state that the results of his hypothesis test apply to all Model D cars in his club. Another member of the club who is a statistician tells James his findings do not apply to all Model D cars in the club. What change would James need to make to his original study to be able to generalize to all Model D cars in the club?