**AP Stats**
**Review for the AP Exam - Chapter 5**

**Name:** Key
**Hour:** _____

1. Know the following terms:
   - Observational Study
   - Experiment
   - Population
   - Sample
   - Census
   - Voluntary Response Sample
   - Convenience Sample
   - Bias
   - Simple Random Sample (SRS)
   - Systematic Random Sample
   - Stratified Random Sample
   - Cluster Sample
   - Undercoverage
   - Nonresponse Bias
   - Response Bias
   - Completely Randomized Design
   - Randomized Block Design
   - Matched Pairs Design
   - Blind/Double-Blind Studies

2. What are the three key elements of good experimental design:

C Control R randomization R replication

3. A compact disc (CD) manufacturer wanted to determine which of two different cover designs for a newly released CD will generate more sales. The manufacturer chose 70 stores to sell the CD. Thirty-five of these stores were randomly assigned to sell CDs with one of the cover designs and the other 35 were assigned to sell the CDs with the other cover design. The manufacturer recorded the number of CDs sold at each of the stores and found a significant difference between the mean number of CDs sold for the two cover designs. Which of the following gives the conclusion that should be made based on the results and provides the best explanation for the conclusion?

(A) It is not reasonable to conclude that the difference in sales was caused by the different cover designs because this was not an experiment.
(B) It is not reasonable to conclude that the difference in sales was caused by the different cover designs because there was no control group for comparison.
(C) It is not reasonable to conclude that the difference in sales was caused by the different cover designs because the 70 stores were not randomly chosen.
(D) It is reasonable to conclude that the difference in sales was caused by the different cover designs because the cover designs were randomly assigned to stores.
(E) It is reasonable to conclude that the difference in sales was caused by the different cover designs because the sample size was large.

4. The manager of a public swimming pool wants to compare the effectiveness of two laundry detergents, Detergent A and Detergent B, in cleaning the towels that are used daily. As each dirty towel is turned it, it is placed into the only washing machine on the premises. When the washing machine contains 20 towels, the manager flips a coin to determine whether Detergent A or Detergent B will be used for that load. The cleanliness of the load of towels is rated on a scale of 1 to 10 by a person who does not know which detergent was used. The manager continues this experiment for many days. Which of the following best describes the manager's study?

(A) A completely randomized design
(B) A randomized block design with Detergent A and Detergent B as blocks
(C) A randomized block design with the washing machine as the block
(D) A matched-pairs design with Detergent A and Detergent B as the pair
(E) An observational study

5. In the design of a survey, which of the following best explains how to minimize bias?

(A) Increase the sample size.
(B) Decrease the sample size.
(C) Randomly select the sample.
(D) Increase the number of questions in the survey.
(E) Carefully word and field-test survey questions.

6. There is no question #6! ☺

(2009B #4)

7. 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.

Number and tag all of the blackbirds 00-99. Then use a random number generator to select 50 unique numbers between 00-99. The 50 selected will be assigned to treatment 1 and all others assigned to treatment 2. Repeat the same process for starlings and geese.

(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.

The researcher could increase the sample size. This reduces the standard error and therefore creates a larger rejection region. This would make the test more likely to detect a difference in the treatments, if one exists.

(2008B #4)

8. 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.

Option 1: Each patient will be their own twin and receive both treatments in a randomly selected order. After numbering the 100 patients 00-99 then use a random number generator to assign the first 50 unique numbers between 00 and 99. These 50 patients would have their blood pressure measured then listen to soothing music for 20 minutes and retest their blood pressure. After a reasonable amount of time, the process would be repeated in a noise-free environment. The difference, after-before, in blood pressure would be recorded. The same process would be used for the other 50 patients, only using noise-free environment first, then 20 minutes of soothing music. The differences in the change in BP can then be calculated (music - noise free) and we can perform a one-sample t-test to see if the mean difference is significant.

Option 2 - Matched pairs design by matching individuals with similar initial BP.

Option 3 - random 2-sample t-test

(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.

Type I We reject $H_0$ of no difference when there really is no difference. We may recommend music therapy when it really does not make a difference.

Type II We fail to reject $H_0$ of no difference when there is a difference. The clinic will not offer music therapy as a free service to patients.

Depending on which side you are on may determine severity. A Type I error will cost the clinic money providing the free music therapy when it doesn't actually make a difference. A Type II error means the patient will not have access to the free service that could make a difference. I believe the potential for better health is more serious than cost, so I would say a Type II error is more serious.

(2003B #3)

9. A study was conducted to determine if taking vitamin C reduces the occurrence of the flu. The study was conducted using 808 student volunteers who did not take a flu shot. The subjects were randomly assigned to one of two groups: a treatment group who received 1,000 milligrams of vitamin C daily or a control group who received a placebo flavored to taste like the vitamin C treatment. All participants were monitored to ensure that they adhered to their assigned treatment on a daily basis throughout the period of the study. At the end of the flu season, each subject's medical record was reviewed by a physician to determine whether he or she had contracted the flu during the period of the study. The physician did not know which treatment each subject received. The results of the study are shown in the table below.

| | Flu | No Flu | Total |
|---|---|---|---|
| Placebo | 331 | 74 | 405 |
| Vitamin C | 302 | 101 | 403 |
| Total | 633 | 175 | 808 |

(a) Is this study an experiment of an observational study? Explain your answer.

Experiment since a treatment of Vitamin C or placebo was imposed.

(b) Based on this study, a health expert claims that there is evidence to suggest that vitamin C reduces the occurrence of the flu in the population of students who would volunteer for such a study. State the name of a test and the null and alternative hypotheses that the health expert could have used to support this claim. Do not carry out the test.

Two sample z-test for Proportions

$H_0: p_c - p_p = 0$ $H_a: p_c - p_p < 0$

$p_c$ = proportion of all students who volunteer, receive Vitamin C, and contract the flu

$p_p$ = proportion of volunteers, receiving the placebo, and contracting the flu

(2005 #5)

10. A survey will be conducted to examine the educational level of adult heads of households in the United States. Each respondent in the survey will be placed into one of the following to categories:

- Does not have a high school diploma
- Has a high school diploma

The survey will be conducted using a telephone interview. Random-digit dialing will be used to select the sample.

(a) For this survey, state one potential source of bias and describe how it might affect the estimate of the proportion of adult heads of households in the United States who do not have a high school diploma.

The US. adult head of households without HS. diplomas may struggle to find a job. Or if they do have a job it may not pay sufficiently to have a phone. This may result in those U.S. Heads of Households without a job being under represented in the study.

(b) A pilot survey indicated that about 22 percent of the population of adult heads of households do not have a high school diploma. Using this information, how many respondents should be obtained if the goal of the survey is to estimate the proportion of the population who do not have a high school diploma to within 0.03 with 95 percent confidence? Justify your answer.

$.03 = 1.96\sqrt{\frac{.22(1-.22)}{n}}$ → $n/\left(\frac{.03}{1.96}\right)^2 = (.22)(.78)$

$\left(\frac{.03}{1.96}\right)^2 = \sqrt{\frac{.22(1-.22)}{n}}^2$ → $n = 732.465$

They need 733 respondents

(c) Since education is largely the responsibility of each state, the agency wants to be sure that estimates are available for each state as well as for the nation. Identify a sampling method that will achieve this additional goal and briefly describe a way to select the survey sample using this method.

Use stratified random sampling with each state as a stratum. The agency could randomly select respondents from each state. Estimates are then obtained from each state proportional to their respective sizes, then combined to obtain a national estimate.

(2005B #3)

11. 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.

Assign every individual a number between 00 and 99. Use the random digit table 2 #'s at a time not allowing for repeats. The first 50 unique values will be assigned to the current compound, the remaining 50 will be assigned the new compound. Spray all right (continue on the next page) arms with the assigned compound. With one person

per bin, individuals will keep their arms in the bins for 1 minute the count the number of mosquito bites. Follow up with a 2-sample t-test for the difference in the mean number of bites for the new − current compounds.

(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.

Number everyone from 00 to 99 then use a random number table, two digits at a time, to select 50 unique values. Those selected 50 will apply the new compound to their left arm and the current compound to the right arm. Both arms will be placed in the bins for 1 minute. Bites are then calculated and the difference in bites, new - current, is taken for each individual. A one-sample t-test for the mean difference in number of mosquito bites can then be completed.

(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.

The matched-pairs design of part b would be more effective since mosquitos tend to be more attracted to certain individuals regardless of the type of repellent used.