For this exam, please do all of your work on the bottom of the page or on the back side. To pass, you must exhibit mastery of the concepts examined. You may use a calculator, the provided tables, and the equation sheet from the web.

In an experiment on rhesus monkeys, nerve cells emanating from the left side of the spinal cord were cut while those from the right side were left intact. During the time in which the cut cells had the opportunity to regenerate, the content of creatine phosphate (CP) was measured in the left and right portions of the spinal cord. The following table shows CP measurements in mg CP per 100 gm tissue. We wish to test if there is a difference in population mean CP between the control and experimental conditions in rhesus monkeys.

Animal	Right side (control)	Left side (regenerating)	Difference
1	16.3	11.5	4.8
2	4.8	3.6	1.2
3	10.9	12.5	−1.6
4	14.2	6.3	7.9
5	16.3	15.2	1.1
6	9.9	8.1	1.8
7	29.2	16.6	12.6
8	22.4	13.1	9.3
Mean	15.50	10.86	4.64
SD	7.61	4.49	4.89

(a) State whether this data should be analyzed using paired sample techniques or two independent sample techniques. Provide a brief justification of your response.

Solution: A paired analysis is more appropriate because there are two observations taken on each individual. There is a paired design. Comparisons between measurements on the same individual better control for extraneous factors.

(b) Use a nondirectional (two-sided) t-test to compare the control and experimental means. State hypotheses, calculate a test statistic, determine a range for the p-value, and interpret the test in the context of the problem. *(If you decide to use two independent sample techniques, the appropriate number of degrees of freedom is 11.)*

Solution:

$H_0 : \mu_d = 0$
$H_A : \mu_d \neq 0$

$t = \frac{4.64}{4.89/\sqrt{8}} = 2.68$.

There are 7 degrees of freedom. The two sided p-value is between 0.02 and 0.04.

There is evidence that the CP level differs between the control and experimental conditions in rhesus monkeys.

(c) Would side-by-side boxplots of the CP measurements in each group or a boxplot of the differences be a more appropriate plot for assessing if lack of normality in the population might invalidate the test?

Solution: A boxplot of the differences is more appropriate because in a paired test, the lack of normality of the paired differences in the population is what affects the validity of the test.

(d) State two assumptions for the t-test you carried out in part (b) to be valid for inference to a population of rhesus monkeys.

Solution: We assume that the eight animals in the sample were randomly selected from the population, and that the population of differences is sufficiently normal in the populaiton that the test statistic has an approximate t distribution. Other assumptions may be valid as well.