1. In a study 20 adults with mild periodontal disease are assessed before and 6 months after the implementation of a dental education program intended to promote better oral hygiene. After 6 months periodontal status improved in 13 persons, declined in 3 persons, and remained the same in 4 persons.

   a) What statistical procedure would be appropriate to assess whether the program improved oral hygiene? **Sign test.**

   b) State your null and alternative hypotheses.

   H_o: median difference = 0
   H_a: median difference > 0

   c) What is the p-value of your test? Would you reject the null hypothesis? Assume a 5% significance level.

   Using the sign test, the p-value of the test is p-value = $P[X \geq 13 | n=16, p=1/2] = 0.0106$. Since the p-value is less than the significance level of 0.05, we reject the null hypothesis.

   d) Perform your test as a two-tailed test. Use a 5% significance level.

   If the test were a two-tailed (sided) test, the p-value would be

   p-value = $2 * P[X \geq 13 | n=16, p=1/2] = 2(0.0106) = 0.0212$. The p-value is less than 5% so we reject the null hypothesis.

2. Whenever the sign test is used, the null hypothesis indicates the sample data will contain an equal number of observations in each of the two response categories (i.e., as many "pluses" as "minuses").

   True False

3. In non-parametric test, interest focuses on the median, not the mean.

   True False

4. Because non-parametric tests use ranks instead of the actual data, they will **always** have lower power than their parametric counterparts.

   True **False**

5. The APGAR score was developed in 1952 as a measure of the physical condition of an infant a 1 and 5 minutes after birth. The score is obtained by summing five components, each of which is rated as 0, 1 or 2 and represents different aspects of the condition of an infant at birth. The score is routinely calculated for most newborn infants in U.S. hospitals. Suppose we wish to relate the APGAR scores at 1 and 5 minutes and assess the significance of this relationship. What statistical procedure would be appropriate to use?

   Scores are individually matched, so one could take the difference between each subject's score at 1 and 5 minutes and perform either a sign test or a signed rank test.

6. Twenty sets of identical twins participated in a study to assess the performance of an experimental drug on memory retention. One of the two siblings was randomly assigned the drug and the other a placebo. Both were given a test to assess their memory retention. The following table shows the results from their tests.

Twin Pair	Placebo	Drug	Diff.
1	66	73	-7
2	55	77	-22
3	89	94	-5
4	66	77	-11
5	93	97	-4
6	74	77	-3
7	82	87	-5
8	83	82	1
9	54	62	-8
10	35	98	-53
11	85	84	1
12	98	92	6
13	56	60	-4
14	51	66	-15
15	68	69	-1
16	72	78	-6
17	52	72	-20
18	84	82	2
19	73	66	7
20	76	95	-19

a) Sketch a stem-and-leaf display for the differences. Do they appear to be normal?

-5 | 3
-4 |
-3 |
-2 | 20
-1 | 951
-0 | 876554431
0 | 11267

No. The data do not appear to be normal.

b) Test for a difference in memory retention. Set up the hypothesis test and compute the p-value of the test. Assume a significance level of 5 percent.

Sign test

Let m = median difference

Ho: m = 0 versus Ha: m $\neq$ 0 (two-tailed test)

Under the Ho, we expect half of the sample to have differences less than zero and the other half to have positive differences. We observe 5 positive values of 20. The p-value of 5 positive values (or something more extreme) is

p-value = 2*P[X≤5|n=20,p=0.50) = 2*(0.0207) = 0.0414.

Since the p-value = 0.0414 < 0.05, we reject the null hypothesis.

Signed rank test

Ho: m = 0 versus Ha: m $\neq$ 0 (two-tailed test)

R+ = 31.0
E(R+) = 105.0
Var(R+) = 717.5

T = (|31-105| - 1/2)/sqrt(717.5-1) = 2.75

p-value = 2* P[Z>2.75] = 2*(0.0030)=0.0060.

Since the p-value = 0.0060 < 0.05, we reject the null hypothesis.