

1. A nutrition scientist wants to determine whether limiting daily eating to a 10-hour window (intermittent fasting) affects blood sugar levels as compared to eating without restrictions.
 - a. Explain how a matched-pairs design could be used to investigate this question.
 - b. Explain the benefit of performing a matched pairs t -test versus a two-sample t -test to investigate this question.

2. For each scenario, determine whether a two-sample t -test for a difference of means or a paired t -test for a mean difference is more appropriate. Explain your choice.
 - a. Researchers select two separate random samples: 100 adults aged 60 and older and 100 adults aged 40-59. Each person reports their daily water consumption. The researchers want to investigate whether older adults drink less water than middle-aged adults.
 - b. From a large law firm, 30 associates are randomly selected. Half are randomly assigned to work remotely for one week and half to work in-person. The company wants to compare the number of legal briefs written by remote workers versus in-person workers.
 - c. From a large law firm, 30 associates are randomly selected. Half are randomly assigned to work remotely the first week and in-person the second week. The other half work in-person first, then remotely. The company wants to compare the number of legal briefs written under remote versus in-person conditions.

3. A chocolate company is considering a new recipe for their popular dark chocolate bars. To assess the impact of the new recipe, they conducted a taste test involving 5 chocolate enthusiasts. Each participant tasted both the current recipe and the new recipe (in a random order) and rated each on a scale from 1 to 10, with 10 being the highest. The ratings were recorded as follows:

Participant number	Current recipe rating	New recipe rating	Difference (New – Current)
1	7	8	
2	6	6	
3	8	9	
4	5	7	
5	9	8	

- Calculate the mean rating for the current recipe and the mean rating for the new recipe.
- Calculate the difference in mean ratings (new recipe – current recipe).
- Find the differences in each participant's ratings (new recipe – current recipe) and complete the final column in the table.
- Calculate the mean difference in ratings.
- What do you notice about the difference of the means calculated in part (b) and the mean difference calculated in part (d)?
- If the company wanted to perform a hypothesis test using these data, would they use the difference of means or the mean difference? Explain.

4. A researcher compares two fertilizers by dividing each of 10 fields into halves. One half of each field is randomly assigned to receive Fertilizer A and the other half receives Fertilizer B. After a growing season, the mean plant height (in cm) is measured in each half of each field. For each field, the difference in mean heights ($B - A$) is calculated. Data and summary statistics are shown in the tables.

Field number	1	2	3	4	5	6	7	8	9	10
Height with Fertilizer A (cm)	35.2	40.3	38.7	42.1	37.6	39.8	41.2	36.0	40.7	38.3
Height with Fertilizer B (cm)	34.9	41.0	39.2	41.7	38.5	40.3	40.8	36.8	41.5	38.0
Difference ($B - A$)	-0.3	0.7	0.5	-0.4	0.9	0.5	-0.4	0.8	0.8	-0.3

	Mean	Standard deviation (cm)
Fertilizer A	38.99	2.252
Fertilizer B	39.27	2.228
Difference ($B - A$)	0.28	0.557

At a significance level of $\alpha = 0.05$, is there convincing statistical evidence that the true mean difference in plant height between Fertilizer B and Fertilizer A differs from 0? Provide an appropriate hypothesis test to support your answer.

5. The mayor of a town is interested in comparing the popularity of library services for two libraries in his town. Library A is located in a bustling urban area, while Library B serves a suburban community. Each library randomly selects eight calendar weeks from the previous year and records the number of books borrowed that week. The results are given below.

Library A	150	160	145	155	158	162	148	159
Library B	140	132	138	135	142	130	136	133

Assuming that the conditions for inference are met, which of the following hypothesis tests should be performed to determine if there is a true difference in the average number of books borrowed at Library A and Library B?

- A) A one-sided, paired t -test
- B) A two-sided, paired t -test
- C) A one-sided, two-sample t -test
- D) A two-sided, two-sample t -test
6. A fitness trainer wants to assess whether a new workout program improves the endurance of participants. To evaluate the program, the trainer measures the endurance levels for a random sample of 10 participants before and after completing the 8-week workout program. Endurance is measured as the time (in minutes) the participants can run continuously on a treadmill at a set speed. The summary statistics are given below.

	Before program	After program	Difference (After – Before)
Mean (minutes)	27.91	32.71	4.80
Standard deviation (minutes)	3.81	4.11	1.85

What is the test statistic, t , associated with the appropriate hypothesis test?

- A) $t = -8.205$
- B) $t = -2.708$
- C) $t = 2.708$
- D) $t = 8.205$