BCG Vaccine

A Level

Spearman's Rank Correlation Coefficient

The Bacillus Calmette–Guérin (BCG) vaccine is used to provide immunity against tuberculosis (TB).

Ten patients were studied to determine whether there is a negative correlation between age at BCG vaccination and the length of time that immunity against TB is effective.

The results are shown below in part A.

Part A Calculate Σd^2

Complete the table below to help you calculate Spearman's rank correlation coefficient.

Give your answers as exact decimals.

Patient	Age at vaccination (years)	Rank	Time immune (years)	Rank	d	d^2
A	13		16			
B	12		17			
C	14		18			
D	1		22			
E	30		4			
F	35		1			
G	15		18			
H	14		17			
I	0		23			
J	13		16			
					Σd^2	

Part B Calculate r_s

Using your answer in part A and the formula below, calculate Spearman's rank correlation coefficient for this dataset.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Give your answer to 4 dp.

Part C Critical value of r_s

Identify the critical value at the 5% level of significance.

Part D Test conclusion

The magnitude of the calculated r_s value is [ ] the critical value.

Therefore, the probability that the negative correlation occurred by chance is [ ] 5%. In other words, the negative correlation in this study is [ ].

We [ ] the null hypothesis, and conclude that there [ ] evidence to suggest that there is a negative correlation between age at BCG vaccination and the length of time that immunity against TB is effective.

Items:

greater than **less than** **equal to** **significant** **not significant** **reject** **do not reject** **is** **is insufficient**

Adapted with permission from OCR A Level Biology B, June 2018, Practical Skills in Biology, Question 4c

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Physics. You work it out.

Zebrafish Spawning

A Level

Spearman's Rank Correlation Coefficient

During mating, zebrafish females release their eggs into the water, where they are fertilised by sperm from the zebrafish males. This release of eggs and sperm into the water is called "spawning".

A researcher wanted to investigate whether there is any correlation between the size of a female and the number of eggs a female releases during spawning. The researcher measured the body lengths of 8 females and counted the number of eggs released by each one during a single spawning event.

The results are shown below in part A.

Part A Calculate Σd^2

Complete the table below to help you calculate Spearman's rank correlation coefficient.

Give your answers as exact decimals.

Body length (cm)	Rank	Number of eggs	Rank	d	d^2
1.8		92			
3.7		95			
2.5		81			
2.1		70			
1.8		42			
3.0		70			
2.9		59			
3.0		35			
				Σd^2	

Part B Calculate r_s

Using your answer in part A and the formula below, or otherwise, calculate Spearman's rank correlation coefficient for this dataset.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Give your answer to 4 dp.

Part C Null and alternative hypotheses

Select the correct null hypothesis (H_0) and the correct alternative hypothesis (H_1) below.

- [ ] null hypothesis: there is **no** correlation between female body length and number of eggs released
- [ ] null hypothesis: there **is** a correlation between body length and number of eggs released
- [ ] alternative hypothesis: there is **no** correlation between female body length and number of eggs released
- [ ] alternative hypothesis: there **is** a correlation between body length and number of eggs released

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Part D Critical value of r_s

Identify the critical value at the 5% level of significance.

Part E Test conclusion

The magnitude of the calculated r_s value is [ ] the critical value.

Therefore, the probability that the correlation occurred by chance is [ ] 5%. In other words, the correlation in this study is [ ].

We [ ] the null hypothesis, and conclude that there [ ] evidence to suggest that there is a correlation between the size of a female and the number of eggs released during spawning.

Items:

greater than **less than** **equal to** **significant** **not significant** **reject** **do not reject** **is** **is insufficient**

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Gameboard:
STEM SMART Biology Week 46 - Spearman's Rank Correlation Coefficient

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Bird Body Mass and Lifespan

A Level

P P P

Spearman's Rank Correlation Coefficient

A researcher wanted to investigate whether there is a positive correlation between species body size and lifespan in birds. For 12 different species, they recorded the mean adult body mass and the mean lifespan.

The data is shown below in part A.

Part A Calculate Σd^2

Complete the table below to help you calculate Spearman's rank correlation coefficient.

Give your answers as exact decimals.

Species	Mean adult body mass (g)	Rank	Mean lifespan (years)	Rank	d^2
A	10		4.0		
B	35		2.5		
C	20		3.3		
D	75		4.4		
E	40		3.8		
F	15		3.3		
G	25		2.9		
H	195		3.3		
I	90		4.2		
J	20		5.5		
K	305		6.1		
L	480		5.9		
				Σd^2	

Part B Calculate r_s

Using your answer in part A and the formula below, or otherwise, calculate Spearman's rank correlation coefficient for this dataset.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Give your answer to 4 dp.

Part C Null and alternative hypotheses

Select the correct null hypothesis (H_0) and the correct alternative hypothesis (H_1) below.

- [ ] null hypothesis: there is **no** correlation between species body size and lifespan in birds
- [ ] null hypothesis: there is a **positive** correlation between species body size and lifespan in birds
- [ ] null hypothesis: there is a **negative** correlation between species body size and lifespan in birds
- [ ] alternative hypothesis: there is **no** correlation between species body size and lifespan in birds
- [ ] alternative hypothesis: there is a **negative** correlation between species body size and lifespan in birds
- [ ] alternative hypothesis: there is a **positive** correlation between species body size and lifespan in birds

---

Part D Critical value of r_s

Identify the critical value at the 5% level of significance.

Part E Test conclusion

The magnitude of the calculated r_s value is [ ] the critical value.

Therefore, the probability that the positive correlation occurred by chance is [ ] 5%. In other words, the positive correlation in this study is [ ].

We [ ] the null hypothesis, and conclude that there [ ] evidence to suggest that there is a positive correlation between species body size and lifespan in birds.

Items:

greater than **less than** **significant** **not significant** **reject** **do not reject** **is** **is insufficient**

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Gameboard:
STEM SMART Biology Week 46 - Spearman's Rank Correlation Coefficient

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Habitat Rainfall and Species Diversity

A Level

Spearman's Rank Correlation Coefficient

A researcher wanted to investigate whether there is a positive correlation between rainfall and species diversity. For 8 different habitats (A-H) they recorded the annual rainfall and calculated Simpson's Index of Diversity (a measure of species diversity).

The results are shown in the table below.

Habitat	A	B	C	D	E	F	G	H
Annual rainfall (mm per year)	540	1430	1920	1430	750	1190	910	1600
Simpsons Index of Diversity	0.34	0.52	0.78	0.60	0.56	0.78	0.35	0.71

Part A Type of test

The researcher decided to use Spearman's rank correlation coefficient to test for a significant correlation.

Why did they decide to use this type of test?

- Both variables (annual rainfall and Simpson's Index of Diversity) are categorical.
- Both variables (annual rainfall and Simpson's Index of Diversity) are continuous.
- One variable (annual rainfall) is continuous and the other variable (Simpson's Index of Diversity) is categorical.
- One variable (Simpson's Index of Diversity) is continuous and the other variable (annual rainfall) is categorical.

Part B Null and alternative hypotheses

Select the correct null hypothesis (H_0) and the correct alternative hypothesis (H_1) below.

- [ ] null hypothesis: there is **no** correlation between annual rainfall and species diversity
- [ ] null hypothesis: there is a **positive** correlation between annual rainfall and species diversity
- [ ] null hypothesis: there is a **negative** correlation between annual rainfall and species diversity
- [ ] alternative hypothesis: there is **no** correlation between annual rainfall and species diversity
- [ ] alternative hypothesis: there is a **negative** correlation between annual rainfall and species diversity
- [ ] alternative hypothesis: there is a **positive** correlation between annual rainfall and species diversity

Part C Calculate r_s

Calculate Spearman's rank correlation coefficient for this dataset using the formula below, or otherwise.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Give your answer to 4 dp.

Part D Critical value of r_s

Identify the critical value at the 5% level of significance.

Part E Test conclusion

The magnitude of the calculated r_s value is [ ] the critical value.

Therefore, the probability that the positive correlation occurred by chance is [ ] 5%. In other words, the positive correlation in this study is [ ].

We [ ] the null hypothesis, and conclude that there [ ] evidence to suggest that there is a positive correlation between rainfall and species diversity.

Items:

greater than **less than** **equal to** **significant** **not significant** **reject** **do not reject** **is** **is insufficient**

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Gameboard:
STEM SMART Biology Week 46 - Spearman's Rank Correlation Coefficient

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Environmental Temperature and Flowering Time

A Level

Spearman's Rank Correlation Coefficient

In temperate regions, most flowering plants only produce flowers for a particular period of the year. The duration of this period is referred to as the "flowering time" of the plant.

A researcher wanted to investigate, for a particular group of plants, whether there is any correlation between the flowering time of each species and the temperature of the environments those species are found in. For 7 closely-related plant species, they recorded the mean flowering time and the mean environmental temperature.

The data are shown in the table below.

Species	A	B	C	D	E	F	G
Mean environmental temperature $(^\circ\mathrm{C})$	12	19	10	13	11	25	23
Mean flowering time (days)	36	34	38	21	33	34	24

Part A Type of test

The researcher decided to use Spearman's rank correlation coefficient to test for a significant correlation.

Why did they decide to use this type of test?

- Both variables (mean environmental temperature and mean flowering time) are categorical.
- Both variables (mean environmental temperature and mean flowering time) are continuous.
- One variable (mean environmental temperature) is continuous and the other variable (mean flowering time) is categorical.
- One variable (mean flowering time) is continuous and the other variable (mean environmental temperature) is categorical.

Part B Null and alternative hypotheses

Select the correct null hypothesis (H_0) and the correct alternative hypothesis (H_1) below.

- [ ] null hypothesis: there is **no** correlation between mean environmental temperature and mean flowering time
- [ ] null hypothesis: there **is** a correlation between mean environmental temperature and mean flowering time
- [ ] alternative hypothesis: there is **no** correlation between mean environmental temperature and mean flowering time
- [ ] alternative hypothesis: there **is** a correlation between mean environmental temperature and mean flowering time

Part C Calculate r_s

Calculate Spearman's rank correlation coefficient for this dataset using the formula below, or otherwise.

$$r_s = 1 - \frac{6\Sigma d^2}{n(n^2-1)}$$

Give your answer to 4 dp.

Part D Critical value of r_s

Identify the critical value at the 5% level of significance.

Part E Test conclusion

The magnitude of the calculated r_s value is [ ] the critical value.

Therefore, the probability that the correlation occurred by chance is [ ] 5%. In other words, the correlation in this study is [ ].

We [ ] the null hypothesis, and conclude that there [ ] evidence to suggest that there is a correlation between mean environmental temperature and mean flowering time in plants.

Items:

greater than **less than** **equal to** **significant** **not significant** **reject** **do not reject** **is** **is insufficient**

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