

inkBiology

QUESTION WORKBOOK

Choosing, carrying out and concluding a statistical test

Scientific method and quantitative biology · Unit B00

AQA 3.6.1.1 (taxes and kineses), 3.7.1 (chi-squared against a predicted ratio), MS 1.2, MS 1.3, MS 1.5–1.7, MS 1.9–1.11 · OCR A Module 1.1.4; mathematical requirements (statistics)
Edexcel A Mathematical skills appendix (statistics) · Edexcel B 8.2 vi, 10.1 vi
CAIE 16.2 (chi-squared), 17.1 (the t-test), 18.2 (Spearman and Pearson), Paper 5 (analysis, conclusions and evaluation)

15 questions · 52 marks

NAVY SCREEN EDITION

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SECTION A · Short, 1 to 2 marks**A1**

CCO-Q13

A biologist wants to test whether hydrogen peroxide concentration affects the rate of oxygen production by potato catalase, and records the volume of oxygen released at five different concentrations, each tested in triplicate. Explain why chi-squared would not be a suitable test for this data, and explain which test should be used instead for comparing two of the concentrations. [2]

A2

CCO-Q14

In a Spearman's rank calculation, four quadrats have exactly the same soil moisture reading of 15%. Explain how these four readings should be ranked. [2]

A3

CCO-Q15

A student writes 'there was a significant improvement in growth with the new fertiliser' before running any statistical test. Explain why using the word 'significant' here is premature. [2]

SECTION B · Standard, 3 to 5 marks

B1
CCO-Q4 A calculated chi-squared value of 9.49 is compared with a critical value of 7.81 at $p = 0.05$ with 3 degrees of freedom, and the null hypothesis is rejected. Describe the four elements a complete conclusion should include, illustrating each with this result. [4]

B2
CCO-Q5 A biologist has counts of red, pink and white flowered plants from a genetic cross, and wants to compare them with a predicted 1:2:1 ratio. Identify the statistical test this data calls for, identify what is used as O and E, and identify the degrees of freedom for this design. [3]

B3
CCO-Q6 A study records whether each of 150 patients recovering from a virus is vaccinated or unvaccinated, and whether their illness was mild or severe. State a suitable null hypothesis for testing this data with chi-squared, and state the two conditions this test requires of the data. [3]

B4
CCO-Q7

Two samples of woodlice are timed leaving a lit area: the sample kept at 15 °C has a standard deviation of 1.2 minutes and the sample kept at 25 °C has a standard deviation of 6.5 minutes. A student runs the standard t-test formula on this data regardless. Suggest why running the test in this way is a limitation, and suggest what the student should state in an evaluation. [3]

B5
CCO-Q8

A t-test comparing the mean fruit mass of two tomato varieties gives a calculated value below the critical value at $p = 0.05$. A student concludes that 'the two varieties definitely produce fruit of the same mass.' Explain why this conclusion overstates what the test has shown. [3]

B6
CCO-Q9

A student measures the diameter and the mass of 40 apples from one orchard. Plotted against each other the points rise in a clear straight line with no obvious outliers, and both variables are roughly normally distributed. Suggest which correlation coefficient is more appropriate here, Pearson's or Spearman's, and justify the choice. [3]

B7

CCO-Q10

Outline how the degrees of freedom, or the equivalent quantity, is found for chi-squared against a predicted ratio, for the t-test, and for Spearman's rank correlation.

[3]

B8

CCO-Q11

A student wants to test whether the number of ladybirds per plant differs between plants near a road and plants far from a road, but has only 4 plants in each group. Suggest one problem this small sample size would cause for a t-test on this data, and suggest what would need to be true of the ladybird counts for the test to be appropriate at all.

[3]

B9

CCO-Q12

A cross is expected to give offspring in a 9:3:3:1 ratio. Of 48 offspring, the four phenotypes are observed as 30, 10, 6 and 2. Explain why chi-squared should not be carried out on this data as it stands, and explain one way the data could be fixed so that it can be tested.

[3]

SECTION C · Long, 6 marks or more

C1

CCO-Q1

A test cross between a heterozygous plant and a homozygous recessive plant is expected to give offspring in a 1:1:1:1 ratio across four phenotype classes. Of 160 offspring, the four classes are observed as 48, 38, 34 and 40. Calculate chi-squared, and use it to reach a conclusion. The critical value at $p = 0.05$ with 3 degrees of freedom is 7.81. [6]

C2

CCO-Q2

Two varieties of tomato plant are compared for fruit mass: variety A, 12 plants, has a mean fruit mass of 85 g with a standard deviation of 8 g, and variety B, 12 plants, has a mean fruit mass of 92 g with a standard deviation of 9 g. Calculate Student's t , and use it to write a full conclusion. The critical value at $p = 0.05$ with 22 degrees of freedom is 2.07. [6]

C3

CCO-Q3

The percentage cover of a moss species and the number of springtails per sample are recorded in eight quadrats. Ranking each variable and finding the difference in rank for each quadrat gives squared differences of 0, 1, 1, 4, 1, 0, 1 and 4. Calculate Spearman's rank correlation coefficient, and use it to reach a conclusion. The critical value at $p = 0.05$ for $n = 8$ is 0.738.

[6]

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