

**AS Level Biology A**  
**H020/01 Breadth in Biology**

**Question Set 15**

1. The downy birch tree, *Betula pubescens*, produces varying numbers of leaf hairs.

These hairs are between 200 μm and 500 μm long in response to different environmental conditions.

- (a) State the **pattern** of variation shown by leaf hair density.

..... **Continuous variation** ..... [1]

- (b) Leaf hair density can be measured in the laboratory.

Outline a practical method that could be used to determine the density of hairs on the underside of a leaf. [3]

**Calibrate a light microscope and determine the area of the field of view. Cut a section of leaf, mount it on a slide and use a light microscope to count the number of hairs observed in the field of view. Repeat the procedure on a different region of the same leaf and calculate the mean number of hairs. Divide the mean number of hairs by the area to determine the mean leaf hair density.**

- (c) A group of students investigated the relationship between the distance of different trees from a river and the mean leaf hair density.

Table 25 shows the results of their investigation.

Distance from river (m)	Rank of distance	Mean leaf hair density (number mm <sup>-2</sup> )	Rank of hair density	Difference in ranks (d)	Difference squared (d <sup>2</sup> )
9.1	4	33.1	2	2	4
13.7	1	34.8	1	0	0
5.5	7	11.3	7	0	0
0.3	10	3.4	10	0	0
5.4	8	27.3	4	4	16
11.5	3	30.3	3	0	0
1.7	9	6.3	8	1	1
6.0	6	22.9	6	0	0
11.9	2	5.7	9	-7	49
6.8	5	23.2	5	0	0

Table 25

- (i) Complete Table 25 by calculating the difference between the ranks and then squaring the difference.

[Answer on Table 25]

- (ii) Use the formula below to calculate Spearman's rank correlation coefficient for this data. [2]

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

$$r_s = 1 - \frac{6(70)}{10(10^2 - 1)} = 1 - \frac{420}{990} = 0.576$$

..... **0.576** ..... [2]

(d) The students concluded that there is a positive correlation between distance of the tree from the river and mean leaf hair density.

(i) Suggest reasons for this positive correlation.

[2]

**The greater the distance of the tree from the river, the less water there is available. Hairs on the underside of the leaf trap water vapour, reducing the water potential gradient between the inside of the leaf and the external environment. This reduces the rate of water loss via transpiration. Therefore, as distance from the river increases, mean leaf hair density increases as an adaptation to reduce water loss.**

(ii) For this investigation, the students randomly selected leaves from ten downy birch trees at varying distances from the river.

Suggest **three** ways in which the students could improve the validity of their sampling method.

[3]

1 **Select leaves from trees of a similar age** .....

2 **Select leaves of a similar size** .....

3 **Collect samples and record the results at the same time of day.** .....

(e) Another group of students repeated this investigation and calculated  $r_s = 0.589$ . The critical value of  $r_s$  at the 5% level for 9 degrees of freedom is 0.600.

They concluded that their results showed a weak positive correlation between leaf hair density and distance of the tree from the river.

Evaluate the conclusion of this group of students.

[2]

**Their conclusion is incorrect. The calculated value of  $r_s$  is less than the critical value therefore  $H_0$  should be rejected. The relationship between leaf hair density and distance from the river is not statistically significant. The correlation observed is due to chance.**

**Total Marks for Question Set 15: 15**

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