WJEC Wales Biology A Level

SP 4.3: Experiment to illustrate gene segregation

Practical notes

Introduction

Mendel's **law of segregation** states that only **one** of the two copies of each gene is transferred to a gamete and that this is **random**.

The **patterns of inheritance** for different **phenotypes** can be explained by **Mendelian genetics**.

The X^2 (or chi-squared) test can be used to analyse whether such inheritance patterns are **statistically equivalent** to the **Mendelian ratio**.

Equipment

- *Zea mays* corn cob

Risk assessment

Hazard	Risk	Precaution	Emergency
Biohazard	Contamination	Cover any cuts; wash hands after handling kernels	Seek medical advice

Method

1. Identify the different corn cob **phenotypes.**
2. Total the **observed** number of kernels of each phenotype. Record your results.
3. Establish a **null hypothesis**, the **theoretical** Mendelian phenotypic ratio.
4. Use the X^2 test to analyse whether the inheritance pattern is **statistically equivalent** to the **Mendelian ratio**:
    a. Calculate the **expected** frequencies using the phenotypic ratio
    b. Calculate the **X^2** value
    c. Work out the **degrees of freedom**
    d. Find the critical value and test the significance
5. Deduce the **parent genotypes.**

Worked example

1. **Identify the different corn cob phenotypes.**

   Four different corn cob phenotypes: tall green, tall albino, dwarf green and dwarf albino.

2. **Total the observed number of kernels of each phenotype. Record your results.**

Phenotype	Number of kernels
Tall green	87
Tall albino	31
Dwarf green	35
Dwarf albino	7

3. **Establish a null hypothesis, the theoretical Mendelian phenotypic ratio.**

   9 Tall green: 3 Tall albino: 3 Dwarf green: 1 Dwarf albino

   H_0 - there is no statistically significant difference between the observed and expected numbers of offspring phenotypes.

4. a. **Calculate the expected frequencies using the phenotypic ratio**

   Tall green: $\frac{160}{16} \times 9 = \mathbf{90}$

   Tall albino: $\frac{160}{16} \times 3 = \mathbf{30}$

   Dwarf green: $\frac{160}{16} \times 3 = \mathbf{30}$

   Dwarf albino: $\frac{160}{16} \times 1 = \mathbf{10}$

   b. **Calculate the X^2 value**

Phenotype	Observed no.	Expected no.	(O-E)	$(O-E)^2$	$(O-E)^2/E$
Tall green	87	90	-3	9	0.10

Tall albino	31	30	1	1	0.03
Dwarf green	35	30	5	25	0.83
Dwarf albino	7	10	-3	9	0.90

$X^2 = \sum(O-E)^2/E = 0.10 + 0.03 + 0.83 + 0.90 =$ **1.86**

c. **Work out the degrees of freedom** *(this is one less than the number of phenotypes).*

df = 4 - 1 = 3

d. **Find the critical value and test the significance.**

Probability of 0.05, df of 3, critical value for $X^2 = 7.81$.

1.86 < 7.81
The null hypothesis is accepted.
The mendelian ratio is 9:3:3:1. Any deviations from this are down to chance.

5. **Deduce the parent genotypes**

The phenotypes are determined by two alleles at different gene loci. ‘Tall’ is dominant over ‘dwarf’ and ‘green’ is dominant over ‘albino’.This F_2 generation is produced by the breeding of two heterozygous parents.