Lab # 3: Mendelian Inheritance in Corn: Phenotypic Ratio and The Chi-Square Test

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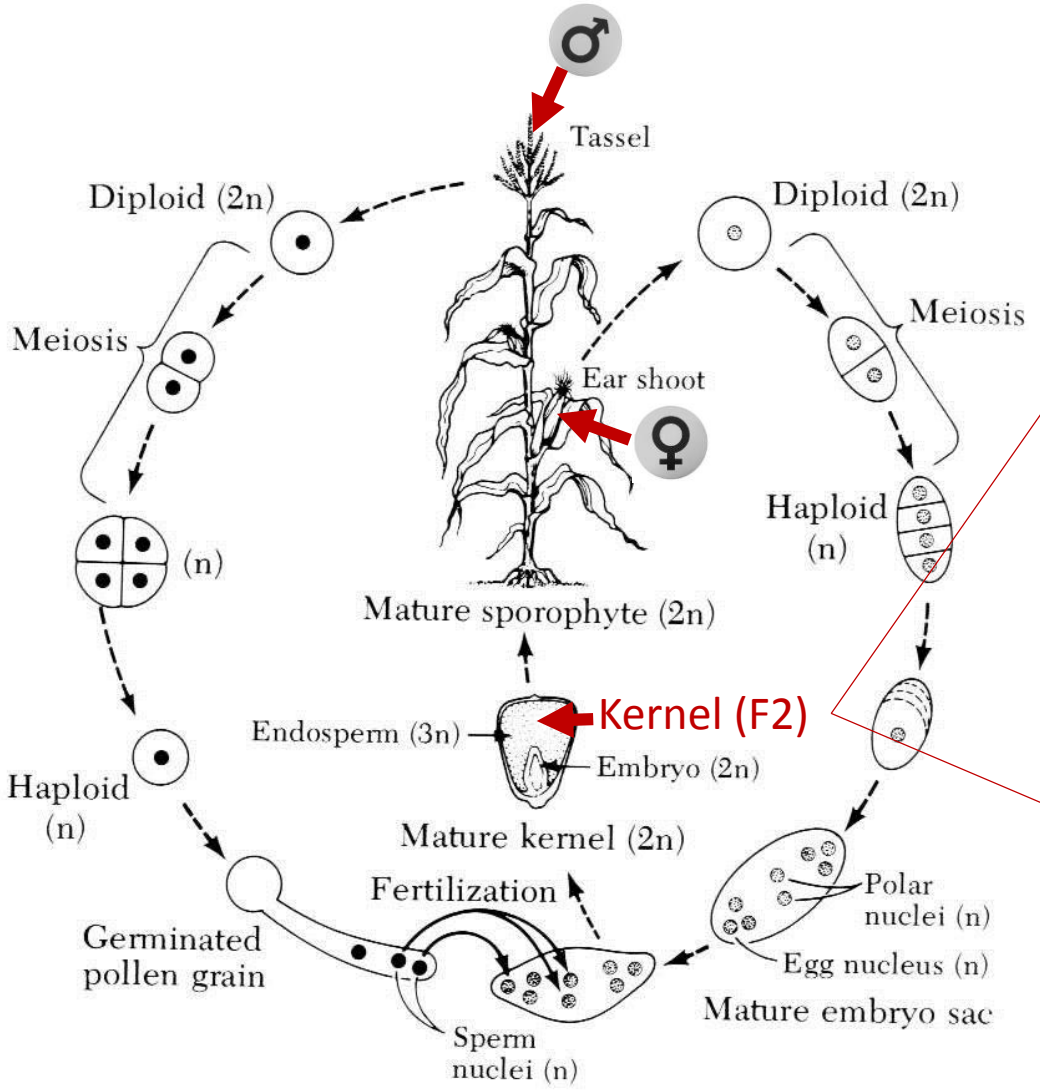
In Previous Labs..

1. The Principle of Segregation and the Principle of Independent Assortment.
2. Gene Interactions: recessive epistasis, dominant epistasis, complementary gene action

Today's Objectives

1. To explore how Mendel's principles can explain transmission of characters from one generation to the next.
2. To understand and perform the Chi-square statistical test to evaluate hypotheses about mechanisms of inheritance.

Corn: Genes and Phenotypes



RRSuSu

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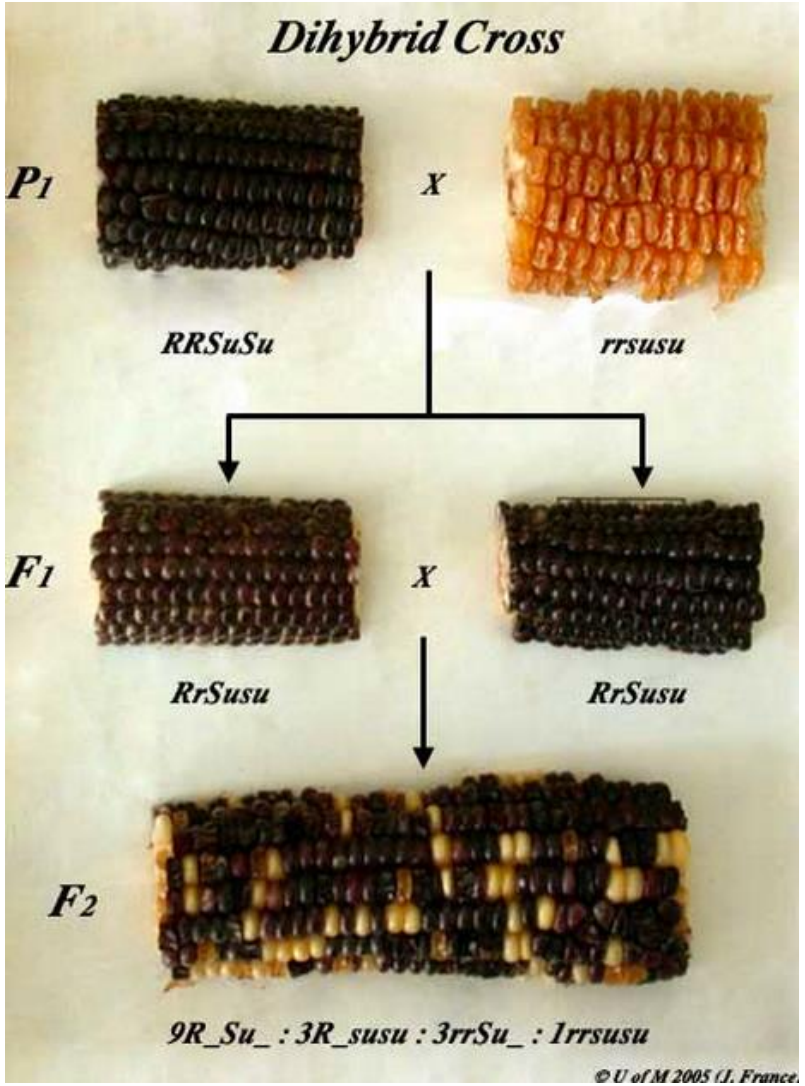
Corn: Genes and Phenotypes



C and R

C^{I} and R

Pr and R

Phenotypic ratio?

Observed and Expected Values

	Grain Phenotype	Expected Ratio	Expected Number	Observed Number
A	Purple & Smooth	9/16	9/16 * 381 = 214.31	216
B	Purple & Shrunken	3/16	3/16 * 381 = 71.43	79
C	Yellow & Smooth	3/16	3/16 * 381 = 71.43	65
D	Yellow & Shrunken	1/16	1/16 * 381 = 23.81	21
	Total Number:	381		

Can we consider observed and expected values to be the same?

The Chi-Square Test

- The chi square test is designed to test the statistical significance of an experimental outcome.
- We use the Chi-square test to compare observed data with the data we would expect to obtain according to our hypothesis (=Mendelian ratios).

- Null hypothesis – observed values are not different from the expected values
- Alternative hypothesis – observed values are different from expected values

The Chi-Square Test

$$\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{number expected}}$$

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$\chi^2 = (216\text{-}214.31)^2 / 214.31 + (79\text{-}71.43)^2 / 71.43 + (65\text{-}71.43)^2 / 71.43 + (21\text{-}23.81)^2 / 23.81 = 0.97$

Chi-Square Table of Critical Values

$\chi^2 = 0.97$

TABLE 5.1 Critical Chi Square Values

Degrees of Freedom	*p* Values						
	Cannot Reject the Null Hypothesis				Null Hypothesis Rejected		
	0.99	0.90	0.50	0.10	0.05	0.01	0.001
	χ^2 calculations						
1	—	0.02	.45	2.71	3.84	6.64	10.83
2	0.02	0.21	1.39	4.61	5.99	9.21	13.82
3	0.11	0.58	2.37	6.25	7.81	11.35	16.27
4	0.30	1.06	3.36	7.78	9.49	13.28	18.47
5	0.55	1.61	4.35	9.24	11.07	15.09	20.52

χ^2 values that lie in the yellow-shaded region of this table allow you to reject the null hypothesis with > 95% confidence, and for recombination experiments, to postulate linkage.

df

χ^2 values

Degrees of Freedom

df = # observations which are free to vary

Total # of hats (n) = 7
# of hats which are free to vary = 6
# of hats which are not free to vary (must wear them) = 1

df = n-1

n = # of classes (e.g., phenotypes)
df = 4 - 1 = 3

Chi-Square Table of Critical Values

$\chi^2 = 0.97$
df = 3

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0.97

df

χ^2 values

Concluding Questions

1. Purple color in corn kernels:
    - dominant
    - recessive

2. Starchy kernels:
    - dominant
    - recessive

3. Which hypothesis do we test using the Chi-square test?
    - null hypothesis
    - alternative hypothesis