



# CHI-SQUARED

*Genetics... Genetics... Genetics*

You cross two yellow-round (heterozygous) peas. Does it follow independent assortment?

You observed:

Round Yellow Peas	Round Green Peas	Wrinkled Yellow Peas	Wrinkled Green Peas
219	81	69	31

Step 1: Complete the Punnett Squares to determine the EXPECTED values

	Y	y
Y	YY	Yy
y	Yy	yy

Yellow:  $\frac{3}{4}$   
Green:  $\frac{1}{4}$

	R	r
R	RR	Rr
r	Rr	rr

Round:  $\frac{3}{4}$   
Wrinkled:  $\frac{1}{4}$

Yellow & Round:  $\frac{3}{4} \times \frac{3}{4} = \frac{9}{16}$   
Yellow & Wrinkled:  $\frac{3}{4} \times \frac{1}{4} = \frac{3}{16}$   
Green & Round:  $\frac{1}{4} \times \frac{3}{4} = \frac{3}{16}$   
Green & Wrinkled:  $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$

# Step 2: Create & Fill in Your Chart

	Observed	Expected	O-E	$(O-E)^2$	$(O-E)^2/E$
Yellow & Round	219				
Yellow & Wrinkled	69				
Green & Round	81				
Green & Wrinkled	31				
Total	400				

Round Yellow Peas	Round Green Peas	Wrinkled Yellow Peas	Wrinkled Green Peas
219	81	69	31

Yellow & Round: 9/16  
 Yellow & Wrinkled: 3/16  
 Green & Round: 3/16  
 Green & Wrinkled: 1/16

# Step 3: Solve

	<i>Observed</i>	<i>Expected</i>	<i>O-E</i>	$(O-E)^2$	$(O-E)^2/E$
Yellow & Round	219	= 9/16 (400) = 225			
Yellow & Wrinkled	69	= 3/16 (400) = 75			
Green & Round	81	= 3/16 (400) = 75			
Green & Wrinkled	31	= 1/16 (400) = 25			
Total	400	400			

## Step 3: Solve

	Observed	Expected	O-E	(O-E) <sup>2</sup>	(O-E) <sup>2</sup> /E
Yellow & Round	219	= 9/16 (400) = 225	= 219 - 225 = - 6		
Yellow & Wrinkled	69	= 3/16 (400) = 75	= 69 - 75 = - 6		
Green & Round	81	= 3/16 (400) = 75	= 81 - 75 = 6		
Green & Wrinkled	31	= 1/16 (400) = 25	= 31 - 25 = 6		
Total	400	400			

# Step 3: Solve

	Observed	Expected	O-E	(O-E) <sup>2</sup>	(O-E) <sup>2</sup> /E
Yellow & Round	219	= 9/16 (400) = 225	= 219 - 225 = - 6	= (- 6) <sup>2</sup> = 36	
Yellow & Wrinkled	69	= 3/16 (400) = 75	= 69 - 75 = - 6	= (- 6) <sup>2</sup> = 36	
Green & Round	81	= 3/16 (400) = 75	= 81 - 75 = 6	= (- 6) <sup>2</sup> = 36	
Green & Wrinkled	31	= 1/16 (400) = 25	= 31 - 25 = 6	= (- 6) <sup>2</sup> = 36	
Total	400	400			

# Step 3: Solve

	Observed	Expected	O-E	(O-E) <sup>2</sup>	(O-E) <sup>2</sup> /E
Yellow & Round	219	= 9/16 (400) = 225	= 219 - 225 = - 6	= (- 6) <sup>2</sup> = 36	= 36/225 = 0.16
Yellow & Wrinkled	69	= 3/16 (400) = 75	= 69 - 75 = - 6	= (- 6) <sup>2</sup> = 36	= 36/75 = 0.48
Green & Round	81	= 3/16 (400) = 75	= 81 - 75 = 6	= (- 6) <sup>2</sup> = 36	= 36/75 = 0.48
Green & Wrinkled	31	= 1/16 (400) = 25	= 31 - 25 = 6	= (- 6) <sup>2</sup> = 36	= 36/25 = 1.44
Total	400	400			= 2.56



# Step 4: Accept or Reject

Null Hypothesis: The experiment has NO effect. There is no difference between the two treatment groups.

In our case, the experiment follows the 9:3:3:1 ratio demonstrating independent assortment

Degrees of Freedom: Number of Samples – 1  
4 (phenotypes) – 1  
Degrees of Freedom = 3

$$\chi^2 = 2.56$$

**Chi Square Significance Table**

Degrees of Freedom (n)	5% Probability Value (P)
1	3.84
2	5.99
3	7.81
4	9.49

$$7.81 > 2.56$$

Accept the null hypothesis

This demonstrates a 9:3:3:1  
This demonstrates independent assortment