Homework from Lecture 3

Try this one at home

- A large ear of corn has a total of 433 grains, including 271 Purple & Smooth (A in picture), 73 Purple & Shrunken (B in picture), 63 Yellow & Smooth (C in picture), and 26 Yellow & Shrunken (D in picture).

Your null hypothesis:

This ear of corn was produced by a dihybrid cross (PpSs x PpSs) involving two pairs of heterozygous genes resulting in a theoretical (expected) ratio of 9:3:3:1.

Test your hypothesis using chi square and probability values.

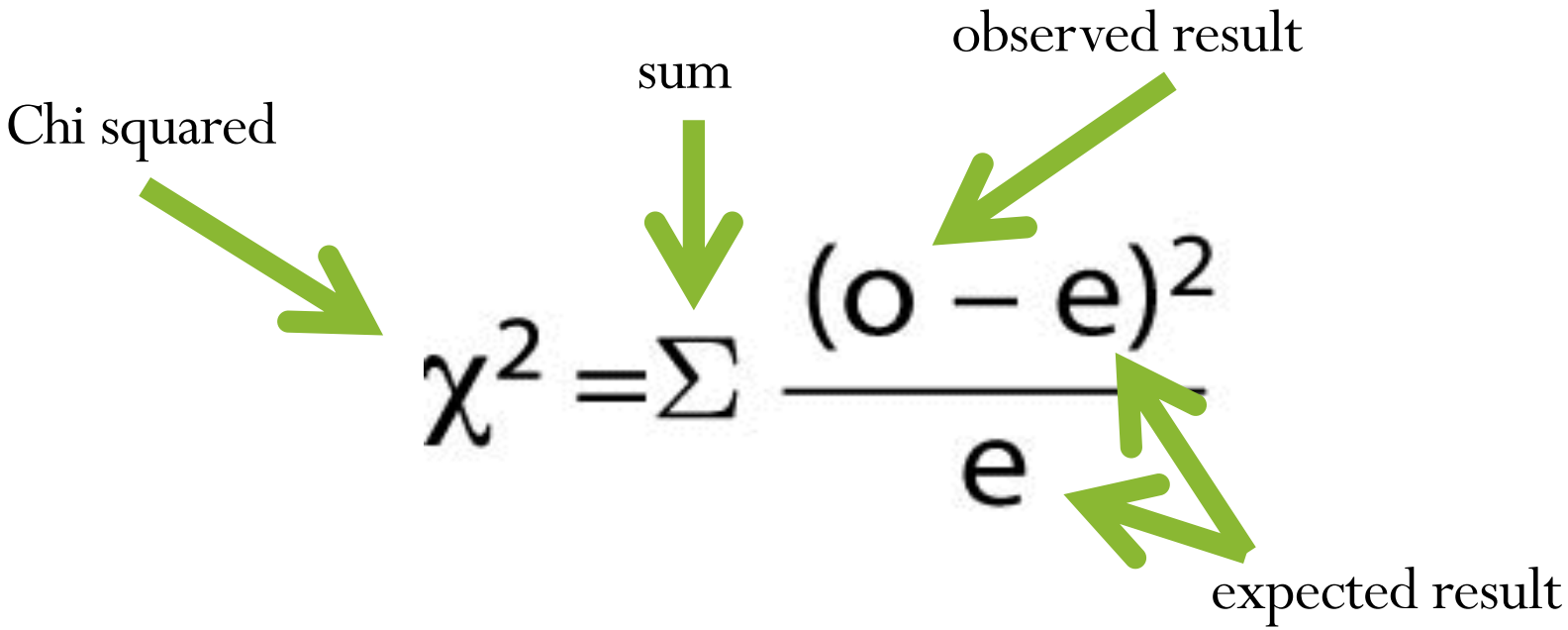
The Chi-Square Test

- The chi-square test compares your expected values to your observed (experimental) values and determines if any deviation can be explained by chance.

- A judgement can then be made as to whether we accept or reject the deviation as being significant

- We therefore have a means of testing the validity of a hypothesis that formed the basis for an experiment

The Chi-Square Test



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PpSs x PpSs				
	PS	Ps	pS	ps
PS	PPSS (purple smooth)	PPSs (purple smooth)	PpSS (purple smooth)	PpSs (purple smooth)
Ps	PPSs (purple smooth)	PPss (purple shrunken)	PpSs (purple smooth)	Ppss (purple shrunken)
pS	PpSS (purple smooth)	PpSs (purple smooth)	ppSS (yellow smooth)	ppSs (yellow smooth)
ps	PpSs (purple smooth)	Ppss (purple shrunken)	ppSs (yellow smooth)	ppss (yellow shrunken)

Step 1: Calculate cross expected ratio

PpSs x PpSs				
	PS	Ps	pS	ps
PS	PPSS (purple smooth)	PPSs (purple smooth)	PpSS (purple smooth)	PpSs (purple smooth)
Ps	PPSs (purple smooth)	PPss (purple shrunken)	PpSs (purple smooth)	Ppss (purple shrunken)
pS	PpSS (purple smooth)	PpSs (purple smooth)	ppSS (yellow smooth)	ppSs (yellow smooth)
ps	PpSs (purple smooth)	Ppss (purple shrunken)	ppSs (yellow smooth)	ppss (yellow shrunken)

	Expected ratio in a dihybrid cross	Cross expected ratio
Purple smooth	9 out of 16	0.5625
Purple shrunken	3 out of 16	0.1875
Yellow smooth	3 out of 16	0.1875
Yellow shrunken	1 out of 16	0.0625

Step 1: Based on our experimental set up how many different kernels would you expect to have if your corn was following Mendelian rules (9:3:3:1)?

Cross expected ratio x with total number of samples = expected number of samples

	Expected ratio in a dihybrid cross	Cross expected ratio		Observed (o)	Expected (e)
Purple smooth	9 out of 16	0.5625		271	243.5625
Purple shrunken	3 out of 16	0.1875		73	81.1875
Yellow smooth	3 out of 16	0.1875	X	63	81.1875
Yellow shrunken	1 out of 16	0.0625		26	27.0625
				Total: 433	

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			Total: 433	

x

Step 3: Plug your numbers into equation

$$\chi^2 = \Sigma \frac{(o - e)^2}{e}$$

	Expected ratio in a dihybrid cross	Cross expected ratio	Observed (o)	Expected (e)	(o-e)
Purple smooth	9 out of 16	0.5625	271	243.5625	27.4375
Purple shrunken	3 out of 16	0.1875	73	81.1875	-8.1875
Yellow smooth	3 out of 16	0.1875	63	81.1875	-18.1875
Yellow shrunken	1 out of 16	0.0625	26	27.0625	-1.0625
			Total: 433		

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			Total: 433		

Step 4: Plug your numbers into equation

$$\chi^2 = \Sigma \frac{(o - e)^2}{e}$$

On the power of 2

	Expected ratio in a dihybrid cross	Cross expected ratio	Observed (o)	Expected (e)	(o-e)	Deviation $(o-e)^2 = (d^2)$	d^2/e
Purple smooth	9 out of 16	0.5625	271	243.5625	27.4375	752.8164	3.0909
Purple shrunken	3 out of 16	0.1875	73	81.1875	-8.1875	67.0352	0.8257
Yellow smooth	3 out of 16	0.1875	63	81.1875	-18.1875	330.7852	4.0743
Yellow shrunken	1 out of 16	0.0625	26	27.0625	-1.0625	1.1289	0.0417
			Total: 433				

X^2

Step 4: Plug your numbers into equation

$$\chi^2 = \Sigma \frac{(o - e)^2}{e}$$

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Yellow shrunken	1 out of 16	0.0625	26	27.0625	-1.0625	1.1289	0.0417
			Total: 433				

Red/blue

Step 5: Plug your numbers into equation

$$\chi^2 = \Sigma \frac{(o - e)^2}{e}$$

	Expected ratio in a dihybrid cross	Cross expected ratio	Observed (o)	Expected (e)	(o-e)	Deviation $(o-e)^2 = (d^2)$	d^2/e
Purple smooth	9 out of 16	0.5625	271	243.5625	27.4375	752.8164	3.0909
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Yellow shrunken	1 out of 16	0.0625	26	27.0625	-1.0625	1.1289	0.0417
			Total: 433				8.0326

Sum up!

Step 6: Compare your chi square value to the critical chi square value table and interpret your results!

	Probability (p)					
	0.90	0.50	0.20	0.05	0.01	0.001
1	0.02	0.46	1.64	3.84	6.64	10.83
2	0.21	1.39	3.22	5.99	9.21	13.82
3	0.58	2.37	4.64	7.82 *	11.35	16.27
4	1.06	3.36	5.99	9.49	13.28	18.47
5	1.61	4.35	7.29	11.07	15.09	20.52
6	2.20	5.35	8.56	12.59	16.81	22.46
7	2.83	6.35	9.80	14.07	18.48	24.32
8	3.49	7.34	11.03	15.51	20.09	26.13
9	4.17	8.34	12.24	16.92	21.67	27.88
10	4.87	9.34	13.44	18.31	23.21	29.59
15	8.55	14.34	19.31	25.00	30.58	37.30
25	16.47	24.34	30.68	37.65	44.31	52.62
50	37.69	49.34	58.16	67.51	76.15	86.60

χ^2 values

Your result: 8.03

What's your degree of freedom?

df = n-1

df = 4-1 =3

Step 7: Compare your chi square value to the critical chi square value table and interpret your results!

	Probability (*p*)					
	0.90	0.50	0.20	0.05	0.01	0.001
1	0.02	0.46	1.64	3.84	6.64	10.83
2	0.21	1.39	3.22	5.99	9.21	13.82
3	0.58	2.37	4.64	7.82 *	11.35	16.27

Your result: 8.03

By comparing the chi square value calculated above to the critical chi square value table above what's your conclusion?

The chi square value is larger than the critical chi square value and therefore you **reject** the null hypothesis that any differences between observed and expected numbers are due to chance.

The two traits don't segregate independently, they are potentially linked or other factors might influence their inheritance