More Chi Square Practice Problems
AP Biology

Key

Y_ = Yellow
yy = green

1. In peas, yellow seeds are dominant over green seeds. In a cross between two plants both heterozygous for seed color, the following was observed: Yy × Yy

yellow = 4400
green = 1624

What do you predict the expected phenotypic ratio to be? Yellow : green 3 : 1

State a NULL hypothesis for this experiment:
The phenotypic ratio of the offspring for this cross will be 3:1

Phenotype	Observed (o)	Expected (e)	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
Yellow	4400	$6024 \times \frac{3}{4} = 4518$	-118	13924	4.41
Green	1624	$6024 \times \frac{1}{4} = 1506$	118	13924	9.25
Total 6024				$\chi^2 = \frac{(o-e)^2}{e}$	13.66

Degrees of freedom (df) = 1

Does the analysis support or reject the null hypothesis? rejects ($p < .05$)

What does this mean in "real life" language? The differences b/w the observed & expected are too large to be due to random chance alone.

2. In peas, smooth seeds are dominant over wrinkled seeds. In the P generation, a plant homozygous for smooth seeds is crossed with a plant with wrinkled seeds. The resulting F_1 plants are crossed. The seeds of the observed F_2 generation were:

S_ = smooth
ss = wrinkled

smooth = 5474
wrinkled = 1850

P → SS × ss
F_1 = Ss Ss × Ss

What do you predict the expected phenotypic ratio to be? Smooth : wrinkled 3 : 1

State a NULL hypothesis for this experiment:
The phenotypic ratio of the offspring in the F_2 generation will be 3:1

Phenotype	Observed (o)	Expected (e)	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
Smooth	5474	$7324 \times \frac{3}{4} = 5493$	-19	361	.07
wrinkled	1850	$7324 \times \frac{1}{4} = 1831$	19	361	.20
Total = 7324				$\chi^2 = \frac{(o-e)^2}{e}$	.27

Degrees of freedom (df) = 1

Does the analysis support or reject the null hypothesis? Supports ($p > .05$)

What does this mean in "real life" language?

The difference b/w the observed values & the expected values are small enough that they are due to random chance.

W_ = white
ww = red
S_ = short
ss = tall

3. In a flowering plant, white flowers are dominant over red, and short plants are dominant over tall plants. When two plants heterozygous for both traits were crossed, the resulting phenotypes were observed: WwSs × WwSs

white, short	=	206
red, short	=	83
white, tall	=	65
red, tall	=	30

What do you predict the expected phenotypic ratio to be? 9:3:3:1, white short : red short : white tall : red tall

State a NULL hypothesis for this experiment: The phenotypic ratio of the offspring of this cross will be 9:3:3:1.

Phenotype	Observed (o)	Expected (e)	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
white short	206	$384 \times \frac{9}{16} = 216$	-10	100	.46
red short	83	$384 \times \frac{3}{16} = 72$	11	121	1.68
white tall	65	$384 \times \frac{3}{16} = 72$	-7	49	.68
red tall	30	$384 \times \frac{1}{16} = 24$	6	36	1.5
Total = 384				$\chi^2 = \frac{(o-e)^2}{e}$	4.32

Degrees of freedom (df) = 3

Does the analysis support or reject the null hypothesis? support ($p > .05$)

What does this mean in "real life" language? The differences b/w the observed data & the expected are small enough that they can be attributed to random chance.

4. In corn, purple kernels are dominant over yellow, and smooth kernels are dominant over shrunken. The offspring below are the result of a true dihybrid cross. The F_1 ear of corn has 381 kernels with the following types:

purple/smooth	=	216
purple/shrunken	=	79
yellow/smooth	=	65
yellow/shrunken	=	21

What do you predict the expected phenotypic ratio to be? 9:3:3:1, purple/smooth : purple/shrunken : yellow/smooth : yellow shrunken

State a NULL hypothesis for this experiment: The phenotypic ratio will be 9:3:3:1

Phenotype	Observed (o)	Expected (e)	(o-e)	$(o-e)^2$	$\frac{(o-e)^2}{e}$
pur./sm.	216	$381 \times \frac{9}{16} = 215$	1	1	.005
pur./shr.	79	$381 \times \frac{3}{16} = 71$	8	64	.90
yell./sm.	65	$381 \times \frac{3}{16} = 71$	-6	36	.51
yell./shr.	21	$381 \times \frac{1}{16} = 24$	3	9	.38
Total 381				$\chi^2 = \frac{(o-e)^2}{e}$	1.79

Degrees of freedom (df) = 3

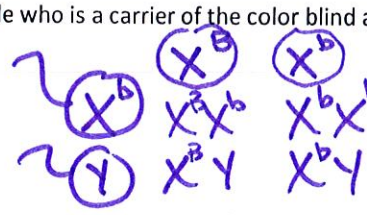
Does the analysis support or reject the null hypothesis? support ($p > .05$)

What does this mean in "real life" language? The differences b/w the observed & expected are small enough to be due to chance alone

X^BX^b = N ♀
X^bX^b = C.B. ♀
X^BY = N ♂
X^bY = C.B ♂

5. Color blindness is a sex-linked trait in Wombats. A female who is a carrier of the color blind allele mates with a male who is color blind. The phenotypes of their offspring are:

Normal female	=	132
Color blind female	=	124
Normal male	=	126
Color blind male	=	136



What do you predict the expected phenotypic ratio to be? State a 1:1:1:1 normal ♀ : color blind ♀ : normal ♂ : colorblind ♂

NULL hypothesis for this experiment: There should be equal # of all four types of offspring

	obs	exp.	$\frac{(o-e)^2}{e}$
Normal ♀	132	$518 \times \frac{1}{4} = 129.5$	.05
Cb. ♀	124	$518 \times \frac{1}{4} = 129.5$	.23
Normal ♂	126	$518 \times \frac{1}{4} = 129.5$	.09
Cb. ♂	136	$518 \times \frac{1}{4} = 129.5$	.33
Total = 518			

$\chi^2 = .43$

$df = 3$

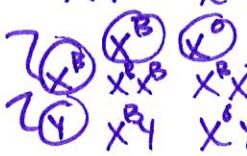
Does the analysis support or reject the null hypothesis? supports ($p > .05$)

What does this mean in "real life" language? Differences b/w the observed data & expected are small enough to be due to chance.

6. In cats, fur color is determined by the codominant, sex-linked alleles: black and orange. A calico female has several litters of kittens with a black male. They produce the following offspring:

black female	=	78
calico female		65
black male	=	81
orange male	=	45

$X^BX^O \times X^BY$



X^BX^B - black ♀
X^BX^O - calico ♀
X^BY - black ♂
X^OY - orange ♂

What do you predict the expected phenotypic ratio to be? 1:1:1:1

State a NULL hypothesis for this experiment: There should be equal numbers of each listed phenotype

	obs	Exp	$\frac{(o-e)^2}{e}$
Black ♀	78	$269 \times \frac{1}{4} = 67.25$	1.72
Calico ♀	65	$269 \times \frac{1}{4} = 67.25$	.08
Black ♂	81	$269 \times \frac{1}{4} = 67.25$	2.81
Orange ♂	45	$269 \times \frac{1}{4} = 67.25$	7.36
Total = 269			

$\chi^2 = 11.97$

$df = 3$

Does the analysis support or reject the null hypothesis? reject ($p < .05$)

What does this mean in "real life" language? The differences b/w the observed outcomes & the expected are too large to be due to chance alone. There must be another factor contributing to the outcome.