CHI-SQUARE PRACTICE PROBLEMS

1. A poker-dealing machine is supposed to deal cards at random, as if from an infinite deck.

In a test, you counted 1600 cards, and observed the following:

Spades	404
Hearts	420
Diamonds	400
Clubs	376

a. Is the machine equally likely to deal a card of any of the four suits? Are these discrepancies too much to be considered the result of random chance?

2. You are testing the same machine in #1 but this time jokers are included in the infinite deck. You counted 1662 cards, with these results:

Spades	404
Hearts	420
Diamonds	400
Clubs	356
Jokers	82

a. How many jokers would you expect out of 1662 random cards? How many of each suit?

a. Is it possible that the cards are distributed by the machine randomly? Or are the discrepancies too large?

3. A genetics engineer was attempting to cross a tiger and a cheetah (It's a Chester Cheeger!). She predicted a phenotypic outcome of the traits she was observing to be in the following ratio: 4 stripes only: 3 spots only: 9 both stripes and spots. When the cross was performed and she counted the individuals she found 50 with stripes only, 41 with spots only and 85 with both. According to the Chi-square test, did she get the expected outcome?

4. In the garden pea, yellow cotyledon color is dominant to green, and inflated pod shape is dominant to the constricted form. Considering both of these traits jointly in self-fertilized dihybrids, the progeny appeared in the following numbers:

193 green, inflated
184 yellow constricted
556 yellow, inflated
61 green, constricted

Do these genes assort independently? Support your answer using Chi-square analysis.

5. Use the *Drosophila* genetics class data to determine if their is a significant difference between the observed and expected results for the following:

    a. Male vs. Female (Parental and F_1 crosses)
    b. All Winged vs. All Apterous (non-winged) (Parental and F_1 crosses)

Questions modified from: lasabiology.com/sitebuildercontent/.../**chi**-**squarepractice**.doc

ANSWERS

1.

observed	expected (percent)	expected (counts)	z
404	0.25	400	0.200
420	0.25	400	1.000
400	0.25	400	0.000
376	0.25	400	-1.200

chi-square-> 2.480

critical value-> 7.815

Compute each z from its own row as (observed-expected)/sqrt(expected). Be sure to use the counts in this formula, not the percentages. The chi-square statistic is the sum of the squares of the z-values.

The number of degrees of freedom is 3 (number of categories minus 1).

The critical value is from a table you'll have on the exam (using $\alpha = 0.05$).

2.

observed	expected (percent)	expected (counts)	z
404	0.2407	400.1	0.194
420	0.2407	400.1	0.994
400	0.2407	400.1	-0.006
356	0.2407	400.1	-2.205
82	0.0370	61.6	2.606
1662		1662	

chi-square-> 12.680

critical value-> 9.488

This time, the chi-square statistic (12.68) is above the $\alpha=0.05$ critical value, so you could reject the null hypothesis and declare that the cards are not random. The problem is clearly that there are too many jokers at the expense of clubs – you can see that from the z statistics.

3. A genetics engineer was attempting to cross a tiger and a cheetah. She predicted a phenotypic outcome of the traits she was observing to be in the following ratio 4 stripes only: 3 spots only: 9 both stripes and spots. When the cross was performed and she counted the individuals she found 50 with stripes only, 41 with spots only and 85 with both. According to the Chi-square test, did she get the predicted outcome?

Chi-square = $\Sigma\ (O-E)^2/E$

D.F.	Value
1	3.841
2	5.991
3	7.815

Set up a table to keep track of the calculations:

Expected ratio	Observed #	Expected #	O-E	$(O-E)^2$	$(O-E)^2/E$
4 stripes	50	44	6	36	0.82

3 spots	41	33	8	64	1.94
9 stripes/spots	85	99	-14	196	1.98
16 total	176 total	176 total	0 total		Sum = 4.74

4/16 * 176 = expected # of stripes = 44
3/16 * 176 = expected # of spots = 33
9/16 * 176 = expected # stripes/spots = 99

Degrees of Freedom = 3 - 1 = 2 (3 different characteristics - stripes, spots, or both)

Since 4.74 is less than 5.991, I can accept the null hypothesis put forward by the engineer.

4.) Genes assort independently (are NOT on the same chromosome and NOT linked) if they follow the 9:3:3:1 rule (on the 16 square Punnett square) resulting from a dihybrid cross. In this dihybrid cross:

Observed	556	184	193	61
Expected	559	186	186	62

The total observed is 994, so I found the expected values as so:

9/16= x/994 x= 559
3/16= x/994 x= 186
1/16= x/994 x= 62

Chi square= $[(556-559)^2 /559] + [(184-186)^2/186] + [(193-186)^2/ 186] + [(61-62)^2/62]$

= (0.016) + (0.02) + (0.26) + (0.016)

= 0.312

df= 3
p value from table at 0.05 is 7.815

My calculated value is much lower than the p value from the table, so we cannot reject the null hypothesis. The genes assort independently according to a 9:3:3:1 ratio and are not on the same chromosome.