*Steps
1. Determine frequencies and find out expected numbers
2. Determine observed values

Chi-Square Magic!!!

Name: KEY

Please make sure to box/circle your answers for full credit. These will hopefully be graded during class tomorrow.

1. In the year 2374, humans finally developed the technology necessary for time travels. You are a scientist interested in the population genetics of extinct animals. Taking advantage of this technological advance, you decide to go to the past 8 million years to conduct a field work in Venezuela to study a population of Phoberomys pattersoni*, the world's largest extinct rodent weighing approximately 700 kg (1500 lb) and looking vaguely like a giant guinea pig. The coat color of this rodent varies between tan (dominant) and brown (recessive). Assume the population is in Hardy-Weinberg equilibrium. You observed 336 tan Phoberomys and 64 brown Phoberomys during your study.

   a) What is the frequency of the homozygous recessive genotype?

   $q^2 = \frac{64}{400} = 0.16 = q^2$

   b) What is the allelic frequency of the dominant (tan) allele in the population?

   $\sqrt{0.16} = q$

   $0.4 = q$

   $p = 0.6$

   c) Of the animals you observed, how many were heterozygous?

   $400 * 2(0.6)(0.4)$

   $400 * 0.48$

   192 heterozygous

   d) You make another trip to Venezuela and this time you observe 650 animals. d) How many of the 650 animals would you expect to be tan, assuming the population is still in Hardy-Weinberg equilibrium?

   0.36 · p^2

   $+0.48$ $2pq$

   $0.84 * 650 = 546$ tan

e) How many of these tan animals are homozygous for the dominant allele?

$0.36 * 650 = 234$

f) How many of these 650 animals would you expect to be brown, assuming the population is still in Hardy-Weinberg equilibrium?

104

g) As you observe the animals, you count 200 brown Phoberomys and 450 tan. Conduct a chi-square test to determine if your observations are significantly different from what you expect.

	Observed	Expected	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Brown	200	104	96	9,216	88.62
Tan	450	546	-96	9,216	16.88

$X^2 = 105.5$

Df = 1

Significantly different, population is evolving!

2. a. A population of camels shows a variation in coat color. A white coat is a recessive trait (bb) while brown is dominant (BB, Bb). In a population of 1000 camels, 910 show the dominant phenotype. What are the three genotypic frequencies? How many camels would you expect to be heterozygous?

90 recessive

$\frac{90}{1000} = 0.09 = q^2$

$\sqrt{0.09}$

$q = 0.3$

$p = 0.7$

$p^2 = 0.49$

$2(0.7)(0.3) = .42 = 2pq$

420 heterozygous camels

b. Surprisingly, white male camels are not selected for by female camels. After 3 generations, you notice that 10 camels out of 1000 are homozygous recessive, 300 are heterozygous, and 690 are homozygous dominant. Conduct a Chi-square test to determine whether or not the population still in Hardy-Weinberg equilibrium. If the population is not in Hardy-Weinberg, what evolutionary agent is most likely responsible?

	O	E	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
p^2	690	490	200	40,000	81.6
$2pq$	300	420	-120	14,400	34.3
q^2	10	90	-80	6,400	71.1

$\chi^2 = 187$

Yes, evolving and population is not in H-W

* Sexual selection is most likely responsible because females are choosing males based on appearance

3. In a certain population of newts, being poisonous (P) is dominant over not being poisonous (p). You count 200 newts, and 8 are not poisonous. What are the allele frequencies of the parent population?

$\frac{8}{200} = q^2$

$0.04 = q^2$

$0.2 = q$

$p = 0.8$

$q^2 = 0.04$

$p^2 = 0.64$

$2(0.8)(0.2) = 0.32 = 2pq$

4. You count the new population of newts and find 21 homozygous poisonous newts, 23 heterozygous poisonous newts, and 6 homozygous non-poisonous newts. Is this what you expect? (Test using Chi square). If it is not, what are the new allele frequencies?

	O	E	O-E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
p^2	21	32	11	121	3.78
$2pq$	23	16	7	49	3.06
q^2	6	2	4	16	8

$\chi^2 = 14.8$

Significant difference! evolving

50 total newts

$p^2 = 21/50 = 0.42$

$2pq = 0.46$

$q^2 = 0.12$

$p = 0.46$

$q = 0.54$

5. Walking through the forest, you find a large population of toadstools. From your extensive knowledge of the kingdom fungi, you know that the allele for being spotted (S) is dominant over the allele for being plain (s). In this population of 1007, you find 14 toadstools that are not spotted. What are the allele frequencies? In a different forest, you find a somewhat smaller population of 549. Through genetic testing, you determine that there are 308 homozygous spotted, 206 heterozygous, and 34 homozygous plain toadstools. Is this what you expected? If not, what are the allele frequencies of this population?

$\frac{14}{1007} = q^2$

$0.02 = q^2$

$0.12 = q$

$0.88 = p$

$0.77 = p^2$

$2(0.88)(0.12) = 0.21 = 2pq$

	O	E	O−E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
p^2	308	422.73	114.73	13,162.97	31.14
2pq	206	115	91	8,281	72.01
q^2	34	10.98	23.02	529.92	48.26

$\chi^2 = 151.35$

Evolving

$p^2 = \frac{308}{548} = 0.56$

$q^2 = \frac{34}{548}$

$p = 0.75$

$q = 0.25$

6. In a population of Venus fly traps in North Carolina, you observe 150 that can eat large flies, and 400 that can eat only small flies. If the ability to eat large flies (s) is recessive, what is the allele frequency? Back in the MI, you visit a specialty store that sells Venus fly traps. Of the 56 plants in the store, how many do you expect to eat large flies? You count and see that 25 can eat large flies. Is this what you expected? (Test with the Chi square.) If not, what are the new allele frequencies?

$\frac{150}{550} = q^2 = 0.27$

$q = 0.52$ allele frequency

$p = 0.48$

$p^2 = 0.23$

$2(0.48)(0.52)$

$2pq = 0.50$

expected small flies $= 56 * 0.73 =$

	O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
Large	25	15.12	97.61	6.46
Small	31	40.88	97.61	2.39

$\chi^2 = 8.85$

No, not what expected

New frequencies $q^2 = 0.45$

$q = 0.67$

$p = 0.33$

NASA finally sends a manned flight to Mars. The astronauts discover that Martian rocks are alive and can reproduce. In a sample of 290 rocks, they count 130 red rocks and 160 brown rocks (red is dominant over brown). What are the allele frequencies for red and brown? The astronauts bring a group of 20 rocks back with them for further study. Of these rocks, 10 are red and 10 are brown. Given the parental population's allele frequencies, is this what you would expect (test with Chi square)? If not, what are the new allele frequencies?

$\frac{160}{290} = 0.55 = q^2$

$0.74 = q$

$0.26 = p$

$p^2 = 0.0676$

$2pq = 2(0.74)(0.26) = 0.3848$

	O	E	$(O-E)^2$	$\frac{(O-E)^2}{E}$
red	10	9	1	.11
brown	10	11	1	.091

$\chi^2 = 0.20$

$20 * (2pq + p^2) = .4524$

This is what you would expect