BIO 300 ASSIGNMENT #3

NOTE: This assignment is due Friday, October 8, 2004.

1. In a recently-discovered species of freshwater snail, a researcher observed that the coiling of the shell is clockwise in some individuals and counter-clockwise in others. The species is rare, and the researcher was able to obtain only eight individuals (assume that they constitute a random sample). Six of the eight snails had clockwise shells, and the shells of the remaining two were counter-clockwise. With these data, test whether the two forms are equally prevalent in the population.

2. Some researchers have suggested that animals should prefer mates that are distantly related but not too distant, because both inbreeding and wide outbreeding may lead to reduced offspring fitness. An experiment with Japanese quail tested their hypothesis. In each trial a single female quail was placed in the centre of a ring of 5 compartments, each of which contained a single male. One of the five males was a sibling of the female, the second male was a half-sib, the third was a first cousin, the fourth was a third cousin, and the last was unrelated. Males were assigned randomly to compartments. The females could view the males through one-way glass, but the males could not see her or each other. Preference was measured by the amount of time spent viewing individual males. A total of 25 trials was carried out. Each male and female was used only once. The number of trials in which each category of male was preferred is listed below.

Male relatedness	Frequency of trials
Sibling	2
Half sib	3
First cousin	5
Third cousin	12
Unrelated	3
Total	25

   (a) Test whether females prefer some males over others according to their degree of relatedness to her.
   (b) What assumption of your test would have been violated had males and females been used more than once?

3. In a controlled study of extrasensory perception, 20 subjects chosen at random were required to carry out a series of mental trials. Each subject was placed in a room out of sight and hearing from an audience of 100 volunteers. In each trial, one of the volunteers would roll a fair die and call out the number that came up (1, 2, 3, 4, 5, or 6). The audience would then concentrate on that number in unison for 30 seconds, after which time the subject was asked to guess the correct number. This process was repeated 25 times on each subject. A binomial test of the null hypothesis that guesses would be accurate no more than 1 time in 6 was then carried out for each of the 20 subjects at the conventional significance level of $\alpha = 0.05$. That is, 20 statistical tests were performed, one for each subject, and in each test the null hypothesis of no extrasensory perception was rejected only if the calculated *P*-value was less than or equal to $\alpha = 0.05$.

(a) What is the probability of a Type I error in any one of the 20 tests performed?
(b) If the null hypothesis is true in all 20 cases, i.e., no subject has extrasensory perception, what is the probability that the null hypothesis will be erroneously rejected at least once in the series of 20 tests performed? Assume that the 20 tests are independent.
(c) Reduce the probability of making a Type 1 error in any one trial to $\alpha = 0.01$. How does this change the probability of committing at least one Type I error when carrying out 20 independent tests?
(d) Can you determine what α should be to ensure that the probability of committing at least one Type I error when carrying out 20 independent tests is only 0.05? An approximate answer will do.

4. A field study of a species of wrasse, a coral reef fish, involved a survey of groups of individuals inhabiting coral outcrops in the northern section of the Great Barrier Reef. The number and sex of adult individuals was recorded on a random sample of outcrops. Shown below are numbers of males and females observed on 22 outcrops on which exactly 6 adult fish occurred.

Number of males	Number of females	Number of outcrops
0	6	4
1	5	14
2	4	4
> 2	< 4	0
	Total	22

(a) Estimate the mean number of males per outcrop. Provide a standard error for this estimate.
(b) Does the number of males on outcrops having 6 fish have a binomial distribution? Show all steps in carrying out your test.
(c) If the number of males on outcrops does not have a binomial distribution, what is the likely statistical explanation (i.e., what assumption of the binomial distribution is likely violated)?
(d) Bonus: Can you suggest a biological explanation for a non-binomial pattern?

5. A recent study investigated the link between child abuse and relatedness in a large Canadian city in 1990. 68 independent cases were confirmed in which fathers injured children under 5 years of age. The father was the biological father of the child in 45 of these cases. The father was the child's stepfather in the remaining 23 cases. In the city as a whole, 15% of children under 5 that live with a father live with stepfathers, whereas 85% live with their biological fathers.

(a) Are injury rates to children under 5 random with respect to relatedness to their fathers?
(b) Which group is at greatest risk of abuse? State how you determined this.