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STATISTICS Ph.D. QUALIFYING EXAM: TAKE HOME
Due 4:45PM Fri. August 19, 2005. Return to Donna George in the Dept Office

Directions: The exam has three questions. Problem one is worth 35 points, while problems 2 and 3 are worth 15 and 50 points, respectively. Your answer to each problem should be word-processed, double spaced, and should be no longer than four pages. An appendix is allowed for each problem but will be examined only at the discretion of the graders. The better constructed your appendix, the more likely it is to get examined. Please use your ID number (last 4 digits of your Social Security Number) for identification. Do not put your name on the exam.

ALL WORK IS TO BE YOUR OWN. YOU ARE NOT PERMITTED TO SPEAK TO ANY OTHER STUDENTS ABOUT ANY ASPECT OF THIS EXAM.

1. Thickness of a film was studied to determine the effect of two types of resin, three gate settings, and three weight fractions on the thickness. The data are given below. Analyze them.

	Resin Type					
	1			2		
Gate Setting	Weight Fraction			Weight Fraction		
(mm)	0.20	0.25	0.30	0.20	0.25	0.30
2	1.6	1.5	1.5	1.5	1.4	1.6
	1.5	1.3	1.3	1.4	1.3	1.4
4	2.7	2.5	2.4	2.4	2.6	2.2
	2.7	2.5	2.3	2.3	2.4	2.1
6	3.9	3.6	3.5	4.0	3.7	3.4
	4.0	3.8	3.4	4.0	3.6	3.3

2. For a $1/4$ replication of a 2^8 factorial with defining effects $CDEF$ and ABH, give the aliases for G and CD. Show how they are found.

3. The human brain is protected from bacteria and toxins, which course through the bloodstream, by a single layer of cells called the blood-brain barrier. This barrier normally allows only a few substances, including some medications, to reach the brain. Because chemicals used to treat brain cancer have such large molecular size, they can not pass through the barrier to attack tumor cells. Dr. E. A. Neuwelt developed a method of disrupting the barrier by infusing a solution of concentrated sugars. As a test of the disruption mechanism, researchers conducted a study on rats, which possess a similar barrier to humans. The rats were inoculated with human lung cancer cells to induce brain tumors. After 9 to 11 days they were infused with either the barrier disruption (BD) solution or, as a control, a normal saline (NS) solution. Fifteen minutes

later, the rats received a standard dose of the therapeutic antibody L6 – $F(ab')_2$. After a set time (from .5 to 72 hours) they were sacrificed and the amounts of antibody in the brain tumor and in normal (liver) tissue were measured.

An EXCEL spreadsheet with data on 34 rats can be found on the WWW at

`http://www.stat.unm.edu/~bedrick/brain.xls`.

The data set contains information on 9 variables. From left to right the columns are

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Column
 1     BRAIN: Brain tumor concentration (count per gram)
 2     LIVER: Liver concentration (count per gram)
 3     TIME: Sacrifice Time in hours
 4     TREATMENT: BD or NS
 5     DAYS: Days after inoculation that treatment was given
 6     SEX: Sex of rat
 7     WEIGHT: Initial weight of rat (in grams)
 8     LOSS: Weight loss in grams during experiment
 9     TUMOR: Tumor Weight (times .0001 grams)
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Since the amount of the antibody in normal tissue indicates how much of it the rat actually received, a key measure of the effectiveness of transmission across the blood-brain barrier is the ratio of the antibody concentration (count per gram) in the brain tumor to the antibody concentration (count per gram) in normal tissue outside the brain, measured here by the concentration in the liver.

We are interested in whether the antibody concentration in the tumor (normalized by the concentration in the liver) is increased by the use of the infusion treatment (relative to the control saline treatment), and if so, by how much. Furthermore, does the treatment effect depend on the length of time after the infusion (from .5 to 72 hours) or any of the other covariates such as weight loss, tumor weight, and so on? Do a complete and careful analysis to address these issues, paying attention to all statistical assumptions. Provide a careful summarization of your findings, including any limitations of the study design, or ways in which the study design could have been improved.