The tubes data (Multiple Comparisons)

id	mcg	r	day	AML	AMS	AMld	PML	PMS	PMld	AMslp	PMslp	SWeight
1	198	1	1	0.6	.	.	0.8	.	.	.	.	
2	198	1	2	1.8	.	.	2.8	.	.	.	.	
3	198	1	3	4.7	1	.	6.1	1	.	.	.	
4	198	1	4	7.8	4	2.0	8.7	5	2.1	.	.	
5	198	1	5	11.2	6	1.8	12.1	7	2.0	.	.	
6	198	1	6	14.3	12	1.9	15.0	11	1.4	.	.	
7	198	1	7	17.5	12	2.1	18.5	13	1.6	.	.	
8	198	1	8	20.9	19	1.1	21.9	19	1.7	.	.	
9	198	1	9	24.0	22	1.6	25.2	22	1.3	.	.	
10	198	1	10	27.2	26	2.1	28.4	26	1.2	.	.	
11	198	1	11	30.7	28	1.4	32.3	28	1.5	.	.	
12	198	1	12	.	31	.	.	31	.	.	.	
13	198	1	13	.	37	.	.	36	.	.	.	
14	198	1	14	.	37	.	.	38	.	3.11	3.18	0.5996
15	198	2	1	0.5	.	.	0.6	.	.	.	.	
16	198	2	2	1.4	.	.	2.3	.	.	.	.	
17	198	2	3	4.15	1	.	5.6	1	.	.	.	
18	198	2	4	7.4	2	2.0	8.7	4	2.1	.	.	
19	198	2	5	10.8	5	2.2	12.0	8	2.0	.	.	
20	198	2	6	14.2	10	1.7	15.3	13	1.6	.	.	
21	198	2	7	17.1	13	2.2	18.1	16	1.7	.	.	
22	198	2	8	21.3	18	1.1	22.2	18	1.4	.	.	
23	198	2	9	24.4	27	1.4	25.6	24	1.2	.	.	
24	198	2	10	27.6	26	2.1	28.8	28	1.2	.	.	
25	198	2	11	31.2	29	1.9	32.5	29	1.3	.	.	
26	198	2	12	.	33	.	.	36	.	.	.	
27	198	2	13	.	38	.	.	41	.	.	.	
28	198	2	14	.	42	.	.	42	.	3.21	3.26	0.6040

224	221	4	14	33.0	63	1.5	.	52	.	2.64	2.65	0.6433
225	223	1	1	0.5	.	.	0.8	.	.	.	.	
226	223	1	2	2.2	.	.	3.1	.	.	.	.	
227	223	1	3	5.0	.	.	4.9	.	.	.	.	
227	223	1	4	6.2	9	1.6	8.6	9	1.6	.	.	
228	223	1	5	10.4	11	1.6	11.3	11	1.4	.	.	
229	223	1	6	13.1	13	1.5	13.7	11	1.3	.	.	

321	225	3	14	.	38	.	.	38	.	2.78	2.79	0.5753
322	225	4	1	0.5	.	.	0.6	.	.	.	.	
323	225	4	2	1.3	.	.	1.9	.	.	.	.	
324	225	4	3	3.7	1	.	4.8	3	.	.	.	
325	225	4	4	6.7	3	2.1	7.6	12	2.0	.	.	
326	225	4	5	9.6	14	2.0	10.7	15	2.0	.	.	
327	225	4	6	12.7	25	1.7	13.3	27	1.8	.	.	
328	225	4	7	15.8	27	1.8	16.1	27	1.7	.	.	
329	225	4	8	18.1	32	0.8	19.1	32	1.1	.	.	
330	225	4	9	20.9	33	1.4	21.8	34	1.3	.	.	
331	225	4	10	23.4	32	1.5	24.3	32	1.4	.	.	
332	225	4	11	26.2	35	1.6	27.0	37	1.5	.	.	
333	225	4	12	28.8	36	1.6	29.4	37	1.6	.	.	
334	225	4	13	31.5	41	1.5	32.2	42	1.4	.	.	
335	225	4	14	.	41	.	.	46	.	2.70	2.71	0.6627

```
/******************** tuberead.sas ***********************/
options linesize=79 noovp formdlim='_';
title 'Fungus Tube data'; /* Data definition file */

data mould;
     infile 'tubes.data'  firstobs=2;
input
line1  mcg   replic1  day1  amlng1  amscl1  amlead1  pmlng1  pmscl1  pmlead1  empa1   empb1
line2  mcg2  replic2  day2  amlng2  amscl2  amlead2  pmlng2  pmscl2  pmlead2  empa2   empb2
line3  mcg3  replic3  day3  amlng3  amscl3  amlead3  pmlng3  pmscl3  pmlead3  empa3   empb3
line4  mcg4  replic4  day4  amlng4  amscl4  amlead4  pmlng4  pmscl4  pmlead4  empa4   empb4
line5  mcg5  replic5  day5  amlng5  amscl5  amlead5  pmlng5  pmscl5  pmlead5  empa5   empb5
line6  mcg6  replic6  day6  amlng6  amscl6  amlead6  pmlng6  pmscl6  pmlead6  empa6   empb6
line7  mcg7  replic7  day7  amlng7  amscl7  amlead7  pmlng7  pmscl7  pmlead7  empa7   empb7
line8  mcg8  replic8  day8  amlng8  amscl8  amlead8  pmlng8  pmscl8  pmlead8  empa8   empb8
line9  mcg9  replic9  day9  amlng9  amscl9  amlead9  pmlng9  pmscl9  pmlead9  empa9   empb9
line10 mcg10 replic10 day10 amlng10 amscl10 amlead10 pmlng10 pmscl10 pmlead10 empa10  empb10
line11 mcg11 replic11 day11 amlng11 amscl11 amlead11 pmlng11 pmscl11 pmlead11 empa11  empb11
line12 mcg12 replic12 day12 amlng12 amscl12 amlead12 pmlng12 pmscl12 pmlead12 empa12  empb12
line13 mcg13 replic13 day13 amlng13 amscl13 amlead13 pmlng13 pmscl13 pmlead13 empa13  empb13
line14 mcg14 replic14 day14 amlng14 amscl14 amlead14 pmlng14 pmscl14 pmlead14
amslope  pmslope weight;
rate=(amslope+pmslope)/2;

label mcg = 'Mycelial Compatibility Group';
label weight = 'Sclerotial Weight';
label rate = 'Regression Growth Rate'; /* Average of am & pm slope */
/*****  Average morning and evening observations  ***/
array am{28} amlng1-amlng14 amscl1-amscl14;
array pm{28} pmlng1-pmlng14  pmscl1-pmscl14;
array aver{28} length1-length14 sclr1-sclr14;
do i=1 to 28; /* Length and sclerotia at the same time */
   aver{i}=(am{i}+pm{i})/2;
end;
```

```
/************************ tubeclean.sas ******************************/
/* Data cleaning for TUBES Data: There is no point in doing the right */
/* statistical analysis on data that are full of errors.              */
/*********************************************************************/

title2 'Data cleaning for tubes data';
%include 'tuberead.sas';
options pagesize=500; /* Long piece of paper! Less frequent headings. */
/* More data step */

/* Error check variables (internal consistency) */

/* MCG must be the same on each line */
if mcg ne mcg2 then mcger1=line1;
if mcg2 ne mcg3 then mcger2=line2;
if mcg3 ne mcg4 then mcger3=line3;
if mcg4 ne mcg5 then mcger4=line4;
if mcg5 ne mcg6 then mcger5=line5;
if mcg6 ne mcg7 then mcger6=line6;
if mcg7 ne mcg8 then mcger7=line7;
if mcg8 ne mcg9 then mcger8=line8;
if mcg9 ne mcg10 then mcger9=lin9e;
if mcg10 ne mcg11 then mcger10=line10;
if mcg11 ne mcg12 then mcger11=line11;
if mcg12 ne mcg13 then mcger12=line12;
if mcg13 ne mcg14 then mcger13=line13;

/* REPLIC must be the same on each line */
if replic1 ne replic2 then replicer1=line1;
if replic2 ne replic3 then replicer2=line2;
if replic3 ne replic4 then replicer3=line3;
if replic4 ne replic5 then replicer4=line4;
if replic5 ne replic6 then replicer5=line5;
if replic6 ne replic7 then replicer6=line6;
if replic7 ne replic8 then replicer7=line7;
if replic8 ne replic9 then replicer8=line8;
if replic9 ne replic10 then replicer9=line9;
if replic10 ne replic11 then replicer10=line10;
if replic11 ne replic12 then replicer11=line11;
if replic12 ne replic13 then replicer12=line12;
if replic13 ne replic14 then replicer13=line13;

/* Increase in length and number of sclerotia from am to pm */
array diff{28} ldiff1-ldiff14 sdiff1-sdiff14;
do i=1 to 28;
   diff{i}=pm{i}-am{i}; /* am and pm are defined in tuberead */
end;

proc freq;
     title3 'Frequency distributions';
     tables line1-line14 mcg mcg2-mcg14 replic1-replic14 day1-day14
            mcger1-mcger13 replicer1-replicer13;
```

```
proc means n mean min max;
     title3 'Means of quantitative variables';
     var amlng1-amlng14 pmlng1-pmlng14 length1-length14
         amscl1-amscl14 pmscl1-pmscl14  sclr1-sclr14
         amslope pmslope rate weight;

proc freq;
     title3 'Look at am to pm change each day';
     tables ldiff1-ldiff14 sdiff1-sdiff14;

/* At this point it looks like length10 is the primary DV. Data set is small,
so look at the whole thing */

proc sort;
     by mcg length10;

proc print;
     var line1 mcg length10 sclr10 weight rate;
```

There is a lot of output from tubeclean.sas. Here are a few highlights with comments. First output from proc freq:

The FREQ Procedure

line1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	1	4.17	1	4.17
15	1	4.17	2	8.33
29	1	4.17	3	12.50
43	1	4.17	4	16.67
57	1	4.17	5	20.83
71	1	4.17	6	25.00
85	1	4.17	7	29.17
99	1	4.17	8	33.33
113	1	4.17	9	37.50
127	1	4.17	10	41.67
141	1	4.17	11	45.83
155	1	4.17	12	50.00
169	1	4.17	13	54.17
183	1	4.17	14	58.33
197	1	4.17	15	62.50
211	1	4.17	16	66.67
225	1	4.17	17	70.83
238	1	4.17	18	75.00
252	1	4.17	19	79.17
266	1	4.17	20	83.33
280	1	4.17	21	87.50
294	1	4.17	22	91.67
308	1	4.17	23	95.83
322	1	4.17	24	100.00

Entries must all be odd, but I see a line 238. Checking the raw data file, see -- ahha! two line 227s. But the rest o
data look okay. This is just cosmetic. Forget it.

Mycelial Compatibility Group

mcg	Frequency	Percent	Cumulative Frequency	Cumulative Percent
198	4	16.67	4	16.67
205	4	16.67	8	33.33
213	4	16.67	12	50.00
221	4	16.67	16	66.67
223	4	16.67	20	83.33
225	4	16.67	24	100.00

mcg2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
198	4	16.67	4	16.67
205	4	16.67	8	33.33
213	4	16.67	12	50.00
221	4	16.67	16	66.67
223	4	16.67	20	83.33
225	4	16.67	24	100.00

replic1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	6	25.00	6	25.00
2	6	25.00	12	50.00
3	6	25.00	18	75.00
4	6	25.00	24	100.00

replic2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	6	25.00	6	25.00
2	6	25.00	12	50.00
3	6	25.00	18	75.00
4	6	25.00	24	100.00

day1	Frequency	Percent	Cumulative Frequency	Cumulative Percent
1	24	100.00	24	100.00

day2	Frequency	Percent	Cumulative Frequency	Cumulative Percent
2	24	100.00	24	100.00

mcger1	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Frequency Missing = 24

mcger2	Frequency	Percent	Cumulative Frequency	Cumulative Percent

Frequency Missing = 24

Part of `proc means` output, just for length:

The MEANS Procedure

Variable	Label	N	Mean	Minimum	Maximum
length1		24	0.5895833	0.3750000	0.7500000
length2		24	1.8239583	0.8000000	2.7500000
length3		24	4.4489583	3.2750000	5.7250000
length4		24	7.2447917	5.8500000	8.4500000
length5		24	10.2979167	8.8000000	11.6500000
length6		24	13.1479167	11.6500000	14.7500000
length7		24	16.1145833	14.6000000	18.0000000
length8		24	19.1166667	17.3000000	21.7500000
length9		24	22.1041667	20.0000000	25.0000000
length10		24	24.9395833	22.3000000	28.2000000
length11		24	28.1145833	25.1000000	31.8500000
length12		19	30.0131579	27.2500000	32.3000000
length13		7	31.2642857	29.7000000	32.7500000
length14		0	.	.	.

Looking at proc means: The last day with no missing observations for am length is day 11, but max is 31.2. Thes
30cm race tubes, so we'd better stick with day 10. pmlng11 has a max length of 32.8. It's growing beyond the enc
the tube. Stick to day 10.

Also, it looks like they recorded missing values instead of zeros for sclerotia. I could fix this, but I'm not sure I n
to.

```
if amscl1=. then amscl1=0; if pmscl1=. then pmscl1=0;
if amscl2=. then amscl2=0; if pmscl2=. then pmscl2=0;
```

sdiff12	Frequency	Percent	Cumulative Frequency	Cumulative Percent
-17	1	4.17	1	4.17
-2	1	4.17	2	8.33
-1	3	12.50	5	20.83
0	3	12.50	8	33.33
1	6	25.00	14	58.33
2	3	12.50	17	70.83
3	2	8.33	19	79.17
4	4	16.67	23	95.83
8	1	4.17	24	100.00

Looking at difference variables. This is a careful lab study, but still there is measurement error. Especially look a
-17 for sdiff12. We could track it down and hide it, which is something a Biologist might do. But to a statistician
everything has a piece of random error attached. It's a fact of life. So we model it or live with it. In this case, we l
with it. By the way, the length readings were "fixed" to eliminate most of not all decreases, and unfortunately I d
not keep the original data.

At this point I'm looking at length10 as my primary dependent variable. There is a good justification, but I don't
to type it now. Other good DVs are sclr10, weight and rate.

Linda wanted to get rid of the case with line1=113. Let's see why. Here is `proc print` output.

Obs	line1	mcg	length10	sclr10	weight	rate
1	43	198	27.50	24.5	0.6053	3.140
2	29	198	27.60	28.0	0.6172	3.160
3	1	198	27.80	26.0	0.5996	3.145
4	15	198	28.20	27.0	0.6040	3.235
5	57	205	24.95	28.0	0.6769	2.975
6	99	205	25.30	27.5	0.6029	2.915
7	85	205	25.40	27.5	0.7271	2.930
8	71	205	25.70	29.0	0.7057	2.975
9	127	213	**24.35**	29.5	0.6976	2.915
10	155	213	**24.35**	27.0	0.6575	2.915
11	141	213	**24.70**	34.5	0.7154	2.935
12	113	213	**26.85**	33.5	0.6023	3.030
13	197	221	22.30	43.5	0.6965	2.540
14	183	221	23.00	38.5	0.6789	2.600
15	211	221	23.15	31.5	0.6433	2.645
16	169	221	23.35	34.0	0.5958	2.645
17	225	223	24.10	16.0	0.5479	2.690
18	252	223	24.35	18.0	0.5446	2.705
19	266	223	24.40	15.0	0.5398	2.715
20	238	223	24.55	18.0	0.5604	2.700
21	280	225	23.55	21.5	0.5615	2.700
22	322	225	23.85	32.0	0.6627	2.705
23	294	225	24.55	34.0	0.6363	2.770
24	308	225	24.70	27.0	0.5753	2.785

Note that the tubes within a MCG are supposed to be genetically identical. We have to go with the biologist's judgment that it must have been an error in lab procedure, most likely contamination with the wrong strain of fungus.

So we create a new file called `tuberead2.sas` It is just like `tuberead.sas`, except that it has the following at the end:

```
data no113;
     set mould;
     if line1 ne 113;
```

```
************** tubedescr.sas ****************/
/* Basic descriptive statistics on tubes data */
/*********************************************/

title2 'Basic descriptive statistics';
%include 'tuberead2.sas';

proc freq;
     tables mcg*replic1 / nocol norow nopercent;
proc means n mean stddev;
     var length10 sclr10 weight  rate;
proc corr;
     var length10 sclr10 weight rate;
proc univariate plot;
     var length10 sclr10 weight rate;
proc sort;
     by mcg length10;
proc print;
     var mcg length10 sclr10 weight rate;
proc plot;
     plot length10*mcg;
```

```
                 Pearson Correlation Coefficients, N = 23
                        Prob > |r| under H0: Rho=0

                           length10        sclr10        weight          rate

length10                    1.00000      -0.27816      -0.11164       0.94155
                                          0.1987        0.6120        <.0001

sclr10                     -0.27816       1.00000       0.72672      -0.13731
                            0.1987                       <.0001        0.5321

weight                     -0.11164       0.72672       1.00000       0.12713
Sclerotial Weight           0.6120        <.0001                       0.5632

rate                        0.94155      -0.13731       0.12713       1.00000
Regression Growth Rate      <.0001        0.5321        0.5632
```

```
/*************** tubes.sas ***************/
/* One-way analysis of tubes data         */
/*****************************************/

%include 'tuberead2.sas';
title2 'One-way analysis of tubes data';
title3 'with multiple comparisons and contrasts';
proc glm;
     class mcg;
     model length10 = mcg;
     means mcg;
     means mcg / Tukey Bon Scheffe;
     /* Test custom contrasts, or "planned comparisons" */
     contrast '198vs205'      mcg   1   -1     0   0   0  0;
     contrast '223vs225'      mcg   0    0     0   0   1 -1;
     contrast  '223n225vsRest' mcg -1   -1    -1  -1   2  2;;
     /* Test equality of mcgs excluding 198: a COLLECTION of contrasts */
     contrast 'AllBut198'     mcg   0   1  -1   0   0   0,
                              mcg   0   0   1  -1   0   0,
                              mcg   0   0   0   1  -1   0,
                              mcg   0   0   0   0   1  -1;
     /* Replicate overall F test just to check. */
     contrast 'OverallF=78.34' mcg   1  -1   0   0   0   0,
                               mcg   0   1  -1   0   0   0,
                               mcg   0   0   1  -1   0   0,
                               mcg   0   0   0   1  -1   0,
                               mcg   0   0   0   0   1  -1;
     /* Estimate will print the value of a sample contrast and do a t-test */
     estimate '223n225vsRest'  mcg -.25 -.25 -.25 -.25 .5 .5;
     estimate 'AnotherWay'     mcg  -3   -3    -3  -3   6  6 / divisor=12;

/* Can make tests of contrasts into Scheffe followups to the initial oneway
   Just modify numdf and dendf below, and re-use this code for any ANOVA
   or regression problem.  */

proc iml;
title4 'Table of Scheffe critical values';
     numdf = 5;   /* Numerator degrees of freedom for initial test */
     dendf = 17;  /* Denominator degrees of freedom for initial test */
     alpha = 0.05;
     critval = finv(1-alpha,numdf,dendf);
     zero = {0 0}; S_table = repeat(zero,numdf,1);  /* Make empty matrix */
     /* Label the columns */
     namz = {"Number of Contrasts in followup test"
             "    Scheffe Critical Value"};
     mattrib S_table colname=namz;
     do i = 1 to numdf;
        s_table(|i,1|) = i;
        s_table(|i,2|) = numdf/i *  critval;
     end;
     reset noname; /* Makes output look nicer in this case */
     print "Initial test has"  numdf " and " dendf "degrees of freedom."
           "Using significance level alpha = " alpha;
     print s_table;
```

The GLM Procedure

Class Level Information

Class	Levels	Values
mcg	6	198 205 213 221 223 225

Number of observations 23

The GLM Procedure

Dependent Variable: length10

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	5	52.94360507	10.58872101	78.34	<.0001
Error	17	2.29791667	0.13517157		
Corrected Total	22	55.24152174			

R-Square	Coeff Var	Root MSE	length10 Mean
0.958402	1.479116	0.367657	24.85652

Source	DF	Type I SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
mcg	5	52.94360507	10.58872101	78.34	<.0001

The GLM Procedure

Level of mcg	N	length10 Mean	length10 Std Dev
198	4	27.7750000	0.30956959
205	4	25.3375000	0.30923292
213	3	24.4666667	0.20207259
221	4	22.9500000	0.45643546
223	4	24.3500000	0.18708287
225	4	24.1625000	0.55132416

The GLM Procedure

Tukey's Studentized Range (HSD) Test for length10

NOTE: This test controls the Type I experimentwise error rate.

Alpha	0.05
Error Degrees of Freedom	17
Error Mean Square	0.135172
Critical Value of Studentized Range	4.52365

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
198 - 205	2.4375	1.6059	3.2691	***
198 - 213	3.3083	2.4101	4.2065	***
198 - 223	3.4250	2.5934	4.2566	***
198 - 225	3.6125	2.7809	4.4441	***
198 - 221	4.8250	3.9934	5.6566	***
205 - 198	-2.4375	-3.2691	-1.6059	***
205 - 213	0.8708	-0.0274	1.7690	
205 - 223	0.9875	0.1559	1.8191	***
205 - 225	1.1750	0.3434	2.0066	***
205 - 221	2.3875	1.5559	3.2191	***
213 - 198	-3.3083	-4.2065	-2.4101	***
213 - 205	-0.8708	-1.7690	0.0274	
213 - 223	0.1167	-0.7815	1.0149	
213 - 225	0.3042	-0.5940	1.2024	
213 - 221	1.5167	0.6185	2.4149	***
223 - 198	-3.4250	-4.2566	-2.5934	***
223 - 205	-0.9875	-1.8191	-0.1559	***
223 - 213	-0.1167	-1.0149	0.7815	
223 - 225	0.1875	-0.6441	1.0191	
223 - 221	1.4000	0.5684	2.2316	***
225 - 198	-3.6125	-4.4441	-2.7809	***
225 - 205	-1.1750	-2.0066	-0.3434	***
225 - 213	-0.3042	-1.2024	0.5940	
225 - 223	-0.1875	-1.0191	0.6441	
225 - 221	1.2125	0.3809	2.0441	***
221 - 198	-4.8250	-5.6566	-3.9934	***
221 - 205	-2.3875	-3.2191	-1.5559	***
221 - 213	-1.5167	-2.4149	-0.6185	***
221 - 223	-1.4000	-2.2316	-0.5684	***
221 - 225	-1.2125	-2.0441	-0.3809	***

The GLM Procedure

Bonferroni (Dunn) t Tests for length10

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha	0.05
Error Degrees of Freedom	17
Error Mean Square	0.135172
Critical Value of t	3.41020

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
198 - 205	2.4375	1.5509	3.3241	***
198 - 213	3.3083	2.3507	4.2659	***
198 - 223	3.4250	2.5384	4.3116	***
198 - 225	3.6125	2.7259	4.4991	***
198 - 221	4.8250	3.9384	5.7116	***
205 - 198	-2.4375	-3.3241	-1.5509	***
205 - 213	0.8708	-0.0868	1.8284	
205 - 223	0.9875	0.1009	1.8741	***
205 - 225	1.1750	0.2884	2.0616	***
205 - 221	2.3875	1.5009	3.2741	***
213 - 198	-3.3083	-4.2659	-2.3507	***
213 - 205	-0.8708	-1.8284	0.0868	
213 - 223	0.1167	-0.8409	1.0743	
213 - 225	0.3042	-0.6534	1.2618	
213 - 221	1.5167	0.5591	2.4743	***
223 - 198	-3.4250	-4.3116	-2.5384	***
223 - 205	-0.9875	-1.8741	-0.1009	***
223 - 213	-0.1167	-1.0743	0.8409	
223 - 225	0.1875	-0.6991	1.0741	
223 - 221	1.4000	0.5134	2.2866	***
225 - 198	-3.6125	-4.4991	-2.7259	***
225 - 205	-1.1750	-2.0616	-0.2884	***
225 - 213	-0.3042	-1.2618	0.6534	
225 - 223	-0.1875	-1.0741	0.6991	
225 - 221	1.2125	0.3259	2.0991	***
221 - 198	-4.8250	-5.7116	-3.9384	***
221 - 205	-2.3875	-3.2741	-1.5009	***
221 - 213	-1.5167	-2.4743	-0.5591	***
221 - 223	-1.4000	-2.2866	-0.5134	***
221 - 225	-1.2125	-2.0991	-0.3259	***

One-way analysis of tubes data
with multiple comparisons and contrasts

The GLM Procedure

Scheffe's Test for length10

NOTE: This test controls the Type I experimentwise error rate, but it generally has a higher Type II error rate than Tukey's for all pairwise comparisons.

Alpha	0.05
Error Degrees of Freedom	17
Error Mean Square	0.135172
Critical Value of F	2.81000

Comparisons significant at the 0.05 level are indicated by ***.

mcg Comparison	Difference Between Means	Simultaneous 95% Confidence Limits		
198 - 205	2.4375	1.4630	3.4120	***
198 - 213	3.3083	2.2558	4.3609	***
198 - 223	3.4250	2.4505	4.3995	***
198 - 225	3.6125	2.6380	4.5870	***
198 - 221	4.8250	3.8505	5.7995	***
205 - 198	-2.4375	-3.4120	-1.4630	***
205 - 213	0.8708	-0.1817	1.9234	
205 - 223	0.9875	0.0130	1.9620	***
205 - 225	1.1750	0.2005	2.1495	***
205 - 221	2.3875	1.4130	3.3620	***
213 - 198	-3.3083	-4.3609	-2.2558	***
213 - 205	-0.8708	-1.9234	0.1817	
213 - 223	0.1167	-0.9359	1.1692	
213 - 225	0.3042	-0.7484	1.3567	
213 - 221	1.5167	0.4641	2.5692	***
223 - 198	-3.4250	-4.3995	-2.4505	***
223 - 205	-0.9875	-1.9620	-0.0130	***
223 - 213	-0.1167	-1.1692	0.9359	
223 - 225	0.1875	-0.7870	1.1620	
223 - 221	1.4000	0.4255	2.3745	***
225 - 198	-3.6125	-4.5870	-2.6380	***
225 - 205	-1.1750	-2.1495	-0.2005	***
225 - 213	-0.3042	-1.3567	0.7484	
225 - 223	-0.1875	-1.1620	0.7870	
225 - 221	1.2125	0.2380	2.1870	***
221 - 198	-4.8250	-5.7995	-3.8505	***
221 - 205	-2.3875	-3.3620	-1.4130	***
221 - 213	-1.5167	-2.5692	-0.4641	***
221 - 223	-1.4000	-2.3745	-0.4255	***
221 - 225	-1.2125	-2.1870	-0.2380	***

The GLM Procedure

Dependent Variable: length10

Contrast	DF	Contrast SS	Mean Square	F Value	Pr > F
198vs205	1	11.88281250	11.88281250	87.91	<.0001
223vs225	1	0.07031250	0.07031250	0.52	0.4806
223n225vsRest	1	3.98243806	3.98243806	29.46	<.0001
AllBut198	4	11.70089912	2.92522478	21.64	<.0001
OverallF=78.34	5	52.94360507	10.58872101	78.34	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
223n225vsRest	-0.87604167	0.16139606	-5.43	<.0001
AnotherWay	-0.87604167	0.16139606	-5.43	<.0001

Initial test has 5 and 17 degrees of freedom.
Using significance level alpha = 0.05

Number of Contrasts in followup test	Scheffe Critical Value
1	14.049981
2	7.0249904
3	4.683327
4	3.5124952
5	2.8099962