

## EXAMPLE HOMEWORK ANSWERS

**Question 1:**

Test required: model I ANOVA (with all pairwise multiple comparison)  
 Independent variable: density of *Diadema* (4 levels: 0 urchins/m<sup>2</sup>; 1 urchins/m<sup>2</sup>; 3 urchins/m<sup>2</sup>; 9 urchins/m<sup>2</sup>;)   
 Dependent variable: algal biomass (kg) per m<sup>2</sup>   
 Number & description of replicates: 32 reef patches (samples), 8 replicates per treatment   
 Statistical hypotheses: Ho: no significant differences among means of trt groups   
 Ha: is a significant difference among means of trt groups   
 Assumption check: original data had zero values, therefore a +1 was added to original data; assumption checking of residuals (see below) suggests that the original data does not meet assumptions close enough; original values were transformed (ln, log10, SQRT, inverse, square, cube); original data: 4 of 4 trt groups normality test P > 0.05; variance test P =0.002. Inverse transformed data OK: 4 of 4 trt groups normality test P > 0.05; variance test P =0.040; so conduct analysis on inverse transformed data.

Results based on inverse transformed data: ANOVA is highly significant & multiple comparison tests reveal differences.

Conclusion: Urchin density treatments significantly altered the macroalgae biomass in the reef patches (F = 63.447; df = 3, 28; P < 0.0005) in a complex way. In general, macroalgal biomass declined with increasing urchin density. However, macroalgal biomass in the control did not differ significantly from the one urchin/m<sup>2</sup> treatment, and it was significantly higher in the control than in the 3 urchin/m<sup>2</sup> and 9 urchin/m<sup>2</sup> treatments. Macroalgal biomass also did not differ between the 1 urchin/m<sup>2</sup> and the 3 urchin/m<sup>2</sup> treatments.

### Tests of Between-Subjects Effects

Dependent Variable: INVERSE

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Corrected Model	1.752(a)	3	.584	64.447	.000
Intercept	6.877	1	6.877	758.671	.000
Density	1.752	3	.584	<b>64.447</b>	.000
Error	.254	28	.009		
Total	8.883	32			
Corrected Total	2.006	31			

a R Squared = .873 (Adjusted R Squared = .860)

	Urchins/m <sup>2</sup>	N	Subset		
			1	2	3
Ryan-Einot-Gabriel-Welsch F(b)	0	8	<b>.2615</b>		
	1	8	<b>.3176</b>	<b>.3176</b>	
	3	8		<b>.4181</b>	
	9	8			<b>.8571</b>
Sig.			.435	.086	1.000

REGWF Result      Trts:    0 urchins/m<sup>2</sup>    1 urchins/m<sup>2</sup>    3 urchins/m<sup>2</sup>    9 urchins/m<sup>2</sup>

**Question 2:**

Test required: model II ANOVA & variance components  
 Independent variable: Region effect (6 levels: randomly chosen regions: A, B, C, D, E, and F)  
 Dependent variable: body fat (% fat in glycogen reserve liver cells)  
 Number & description of replicates: 6 voles per region (replicates); 36 total samples  
 Statistical hypotheses: Ho: Regions (trt groups) do not explain significant amount variation in the % of body fat  
 Ha: Regions (trt groups) explain significant amount variation in the % of body fat

Assumption check: assumption checking of residuals suggests that neither the original data or the following transformations (ln, log10, SQRT, inverse, square, cube) meet assumptions close enough; therefore analysis were conduct on rank values obtained from original data.

Results: Marginally significant ANOVA; 76.62% variance explained by region effect and 23.34% variance attributable to individual effect (error)

Conclusion: A significant amount (76.62%) of the variance in the % of body fat can be attributed to an “region effect”, leaving 23.34% of the variance in the % of body fat unexplained among individual voles.

**Tests of Between-Subjects Effects**

**Dependent Variable:** % fat in glycogen reserve liver cells

Source	Type III Sum of Squares	df	Mean Square	F	Sig.
Intercept Hypothesis	712.000	1	712.000	16.415	.010
Error	216.878	5	43.376(a)		
Region Hypothesis	216.878	5	43.376	25.823	.005
Error	50.392	30	1.680(b)		

a MS(Region)  
 b MS(Error)

**Variance Estimates**

Component	Estimate
Var(Region)	95.326
Var(Error)	29.078

Dependent Variable: % fat  
 Method: ANOVA (Type III Sum of Squares)

**Variance due to region = (95.326/124.404) x100 = 76.62%**  
**Error variance= (29.078/124.404) x100 = 23.34%**