

# Customizing Your Graphs

## using GraphPad Prism 8

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Office of Cyber Infrastructure and Computational Biology (OCICB)  
National Institute of Allergy and Infectious Diseases (NIAID)

# OCICB Bioinformatics and Computational Biosciences Branch (BCBB)

- Part of NIAID
- Group of ~60
- Software developers
- Computational Biologists
- Project Management & Analysis Professionals
- Statistics, Genomics, Structural Biology, Machine Learning, Deep Learning, Programming
- Available to all NIAID researchers at no cost



National Institute of  
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# How to contact us?

## 1. Submit Request

*Send emails to [bioinformatics@niaid.nih.gov](mailto:bioinformatics@niaid.nih.gov) OR fill a request online at [Online Request](#)*

**Bioinformatics and Computational Biology Request Form**

COMPLETE AND SUBMIT FORM BELOW:

First Name:<sup>\*</sup>  Last Name:<sup>\*</sup>  Phone:<sup>\*</sup>  Email:<sup>\*</sup>

Project Title:<sup>\*</sup>  Service Request:<sup>\*</sup>

Project Description:<sup>\*</sup>

## 2. Attend our workshops

[http://www.eventzilla.net/user/NIAID\\_OCICB\\_BCBB](http://www.eventzilla.net/user/NIAID_OCICB_BCBB)

# Outline

1. Introduction to GraphPad Prism and its features
2. GraphPad Prism data tables and data entry
3. Format single data points, specified groups, or entire data sets
4. Change the range and measurement scale of X- and Y-axes
5. Create axis breaks, add error bars, and insert special characters
6. Overlay one figure over another using Prism Layouts
7. Export graphs to MS Word, MS PowerPoint, and other options

# What is GraphPad Prism 8?

GraphPad Prism is a versatile statistics tool for **scientists**.

1. *Structured Data Tables for scientific research*
2. *Statistical analyses and explanation*
3. *Countless ways to customize your graphs*
4. *Gain insights and guidance at every step*
5. *Collaborate with colleagues and share your research with the world.*



# Prism Guides

*Prism provides three guides:*

- [Prism User Guide](#)
- [Statistics Guide](#)
- [Curve Fitting \(Regression\) Guide](#)

# BCBB Prism Labs

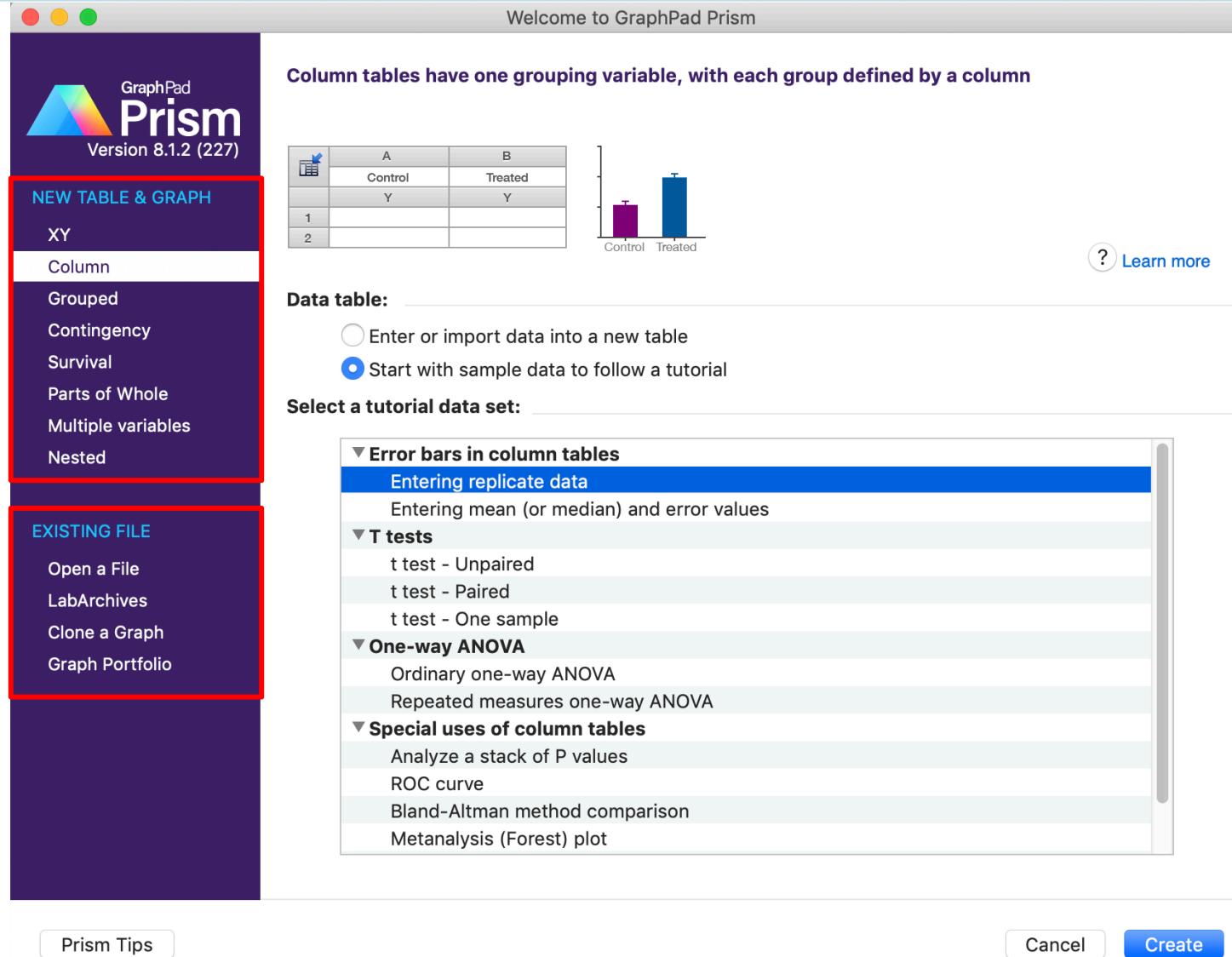
BCBB Prism Labs:  
<https://github.com/niad/Prism>

- [Lab 0](#): How to install Prism 8 on Mac
- [Lab 1](#): Create and edit data tables
- [Lab 2](#): Visualization
- [Lab 3](#): Descriptive Statistics
- [Lab 4](#): Statistical Testing
- [Lab 5](#): Survival Analysis
- [Lab 6](#): Categorical Data Analysis
- [Lab 7](#): Regression and Curve Fitting

# Lab 1 – Create and Edit Data Tables

1<sup>st</sup> Part: 8 Types of Data Tables

2<sup>nd</sup> Part: Read Existed Files



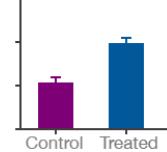
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## 1<sup>st</sup> Part: 8 Types of Data Tables

**Column tables have one grouping variable, with each group defined by a column**

	A	B
	Control	Treated
1	Y	Y
2		



?

Learn more

**Data table:**

- Enter or import data into a new table
- Start with sample data to follow a tutorial

**Select a tutorial data set:**

- ▼ Error bars in column tables
  - Entering replicate data
  - Entering mean (or median) and error values
- ▼ T tests
  - t test - Unpaired
  - t test - Paired
  - t test - One sample
- ▼ One-way ANOVA
  - Ordinary one-way ANOVA
  - Repeated measures one-way ANOVA
- ▼ Special uses of column tables
  - Analyze a stack of P values
  - ROC curve
  - Bland-Altman method comparison
  - Metanalysis (Forest) plot

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Prism Tips

Create

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# Eight Types of Data Tables

1. *XY Tables*
2. *Column Tables*
3. *Grouped Tables*
4. *Contingency Tables*
5. *Survival Tables*
6. *Parts of Whole Tables*
7. *Multiple Variable Tables*
8. *Nested Tables*

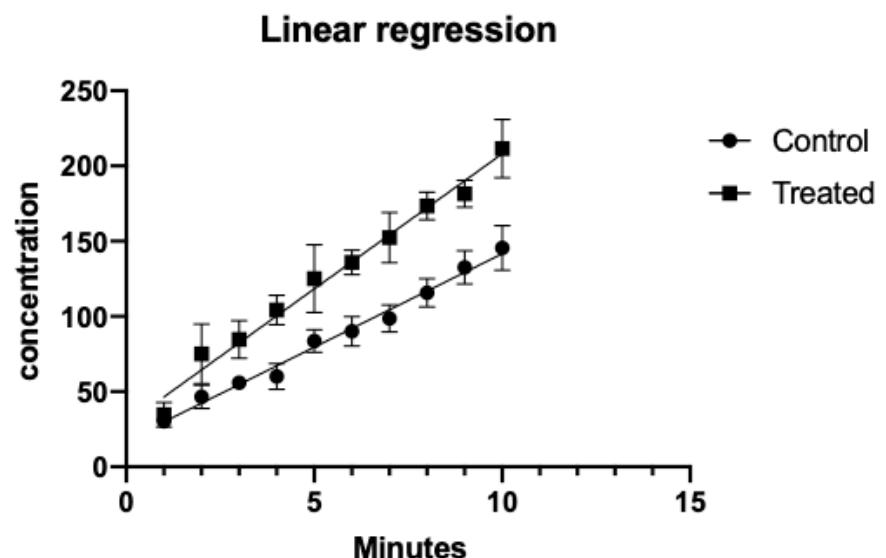
# 1.XY Tables

An XY table is a graph where every point is defined by both an X and a Y value. This kind of data are often fit with linear or nonlinear regression.

## Analyses performed with XY data

- *Nonlinear regression (curve fit)*
- *Linear regression*
- *Area Under Curve*
- *Deming (Model II) Linear regression*
- *Correlation*
- .....

X	X	Group A			Group B			
	Minutes	Control			Treated			
x	X	A:Y1	A:Y2	A:Y3	B:Y1	B:Y2	B:Y3	
1	Title	1.0	34	29	28	31	29	44
2	Title	2.0	38	49	53	61		89
3	Title	3.0	57		55	78	99	77
4	Title	4.0	65	65	50	93	111	109
5	Title	5.0	76	91	84		109	141
6	Title	6.0	79	93	98	134	145	129
7	Title	7.0	100	107	89	156	134	167
8	Title	8.0	105	123	119	167		180
9	Title	9.0	121	143	134	178	192	175
10	Title	10.0	135	156		198	203	234



## 2.Column Tables

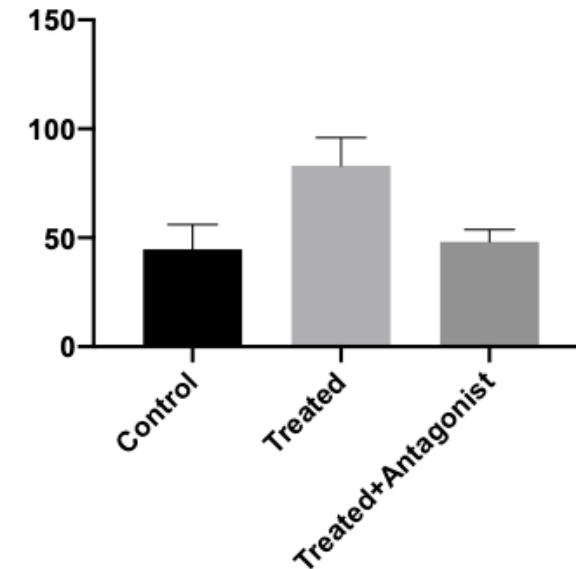
Use column tables if your groups are defined by one scheme, perhaps control vs. treated, or placebo vs. low-dose vs. high-dose. Each column defines one group.

### Analyses performed with Column data

- *Unpaired / Paired t-test*
- *Mann-Whitney / Kolmogorov-Smirnov test / Wilcoxon test*
- *One-way ANOVA / Kruskal-Wallis test / Friedman test*
- *Normality and Lognormality Tests*
- *Frequency Distribution*
- .....

Group A	Group B	Group C
Control	Treated	Treated+Antagonist
Y	Y	Y
54	87	45
23	98	39
45	64	51
54	77	49
45	89	50
47		55

One-way ANOVA data



### 3. Grouped Tables

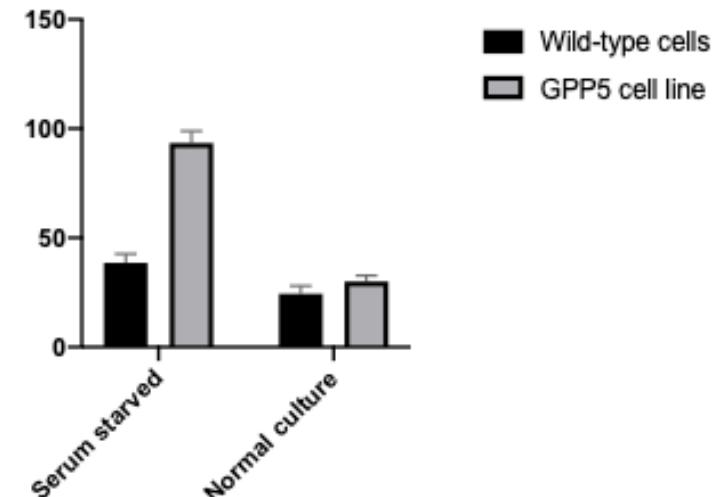
Grouped tables have two or more grouping variables.

Table format: Grouped		Group A					Group B				
		Wild-type cells					GPP5 cell line				
	x	A:Y1	A:Y2	A:Y3	A:Y4	A:Y5	B:Y1	B:Y2	B:Y3	B:Y4	B:Y5
1	Serum starved	34	36	41		43	98	87	95	99	88
2	Normal culture	23	19	26	29	25	32	29	26	33	30

#### Analyses performed with Grouped data

- Two-way ANOVA (and mixed model)
- Three-way ANOVA (and mixed model)
- Row means with SD or SEM
- Multiple t tests - one per row

Two-way ANOVA , not RM

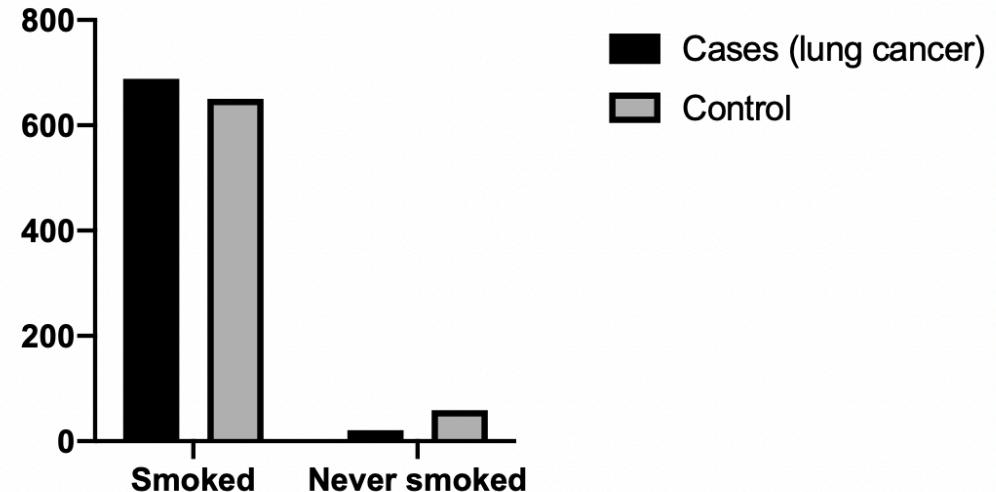


## 4. Contingency Tables

Contingency tables are used to tabulate the actual number of subjects (or observations) that fall into the categories defined by the rows and columns of a table.

Table format: Contingency		Outcome A	Outcome B
		Cases (lung cancer)	Control
1	Smoked	688	650
2	Never smoked	21	59

Retrospective (smoking and cancer)



### Analyses performed from a contingency table

- Chi-square and Fisher's exact test (also computes odds ratios and relative risk)
- Fraction of total

# 5. Survival Tables

Survival tables are used to enter information for each subject. Prism then computes percent survival at each time, plots a Kaplan-Meier survival plot, and compares survival with some tests.

## Analyses performed with survival data

- *Kaplan-Meier*
- *Log-rank test*
- *Wilcoxon-Gehan test*

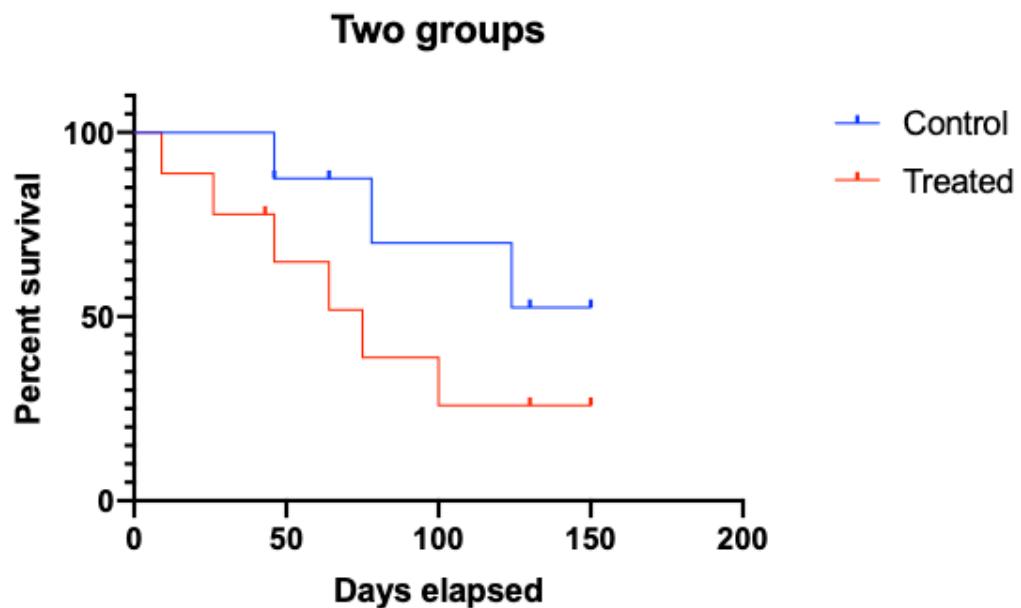
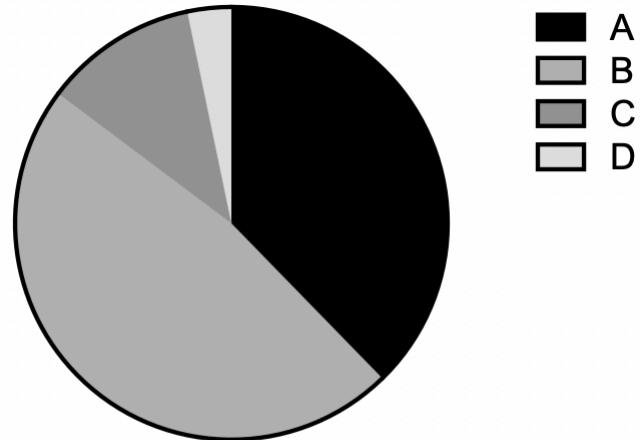


Table format: Survival	X	Group A	Group B
	Days elapsed	Control	Treated
1	Title	46	1
2	Title	46	0
3	Title	64	0
4	Title	78	1
5	Title	124	1
6	Title	130	0
7	Title	150	0
8	Title	150	0
9	Title	9	1
10	Title	26	1
11	Title	43	0
12	Title	46	1
13	Title	64	1
14	Title	75	1
15	Title	100	1
16	Title	130	0
17	Title	150	0

## 6. Parts of Whole Tables

A Parts of whole table is used when it makes sense to ask: What **fraction of the total** is each value? This table is often used to make a pie chart.

Table format: Parts of whole		A
	X	Y
1	A	23
2	B	29
3	C	7
4	D	2
5	E	0



### Analyses performed on parts of whole data

- *Fraction of total*
- *Chi-square goodness of fit (compare observed distribution with theoretical distribution)*

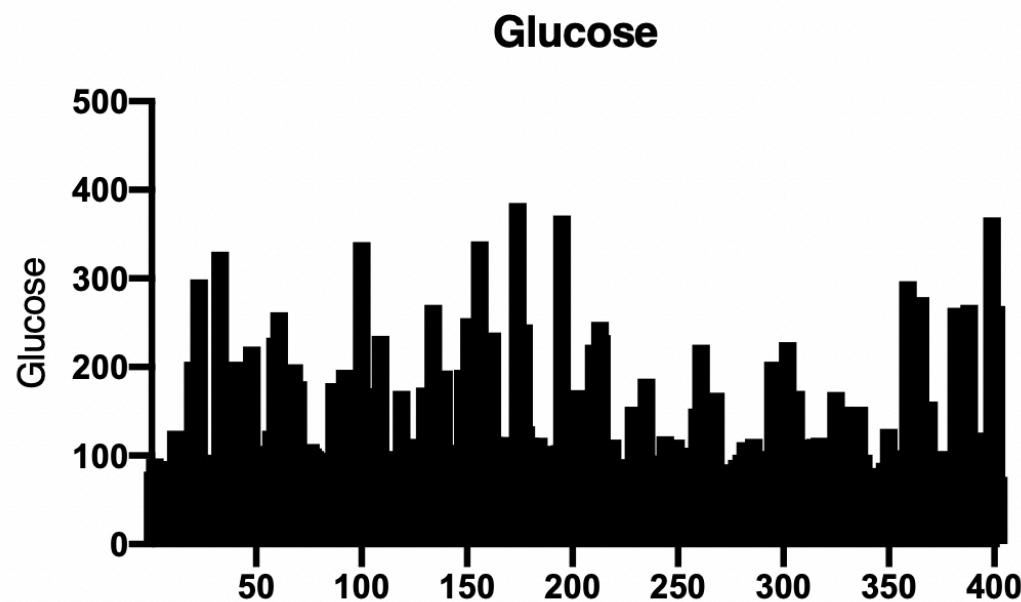
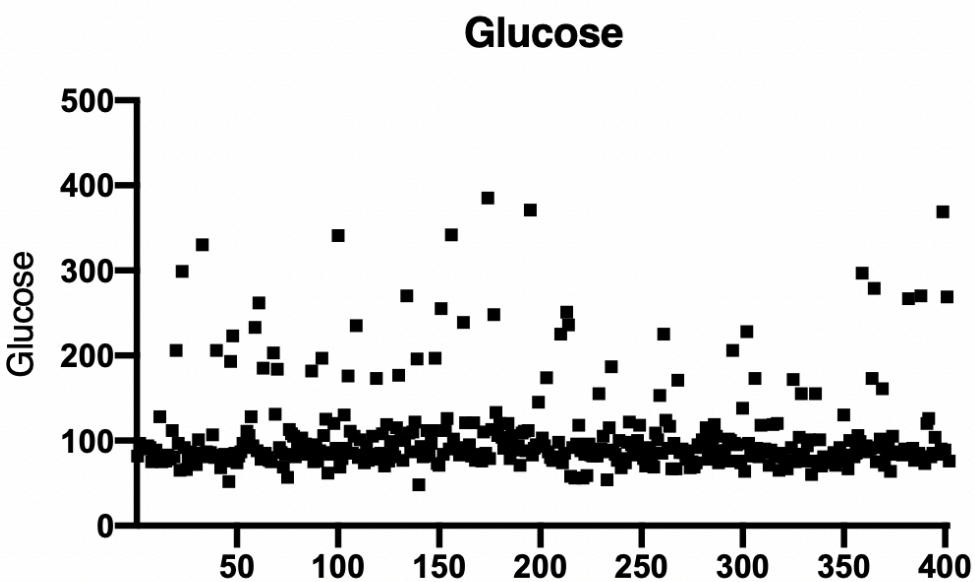
# 7. Multiple Variable Tables

A multiple variable table is arranged the same way most statistics programs organize data.

		Variable A	Variable B	Variable C	Variable D	Variable E	Variable F	Variable G	Variable H	Variable I	Variable J
		Glycosylated hemoglobin %	Total cholesterol	Glucose	HDL	Age in years	Male?	Height in inches	Weight in pounds	Waist in inches	Hip in inches
	X	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
1	Title	4.309999943	203	82	56	46	0	62	121	29	38
2	Title	4.440000057	165	97	24	29	0	64	218	46	48
3	Title	4.639999866	228	92	37	58	0	61	256	49	57
4	Title	4.630000114	78	93	12	67	1	67	119	33	38
5	Title	7.719999790	249	90	28	64	1	68	183	44	41
6	Title	4.809999943	248	94	69	34	1	71	190	36	42
7	Title	4.840000153	195	92	41	30	1	69	191	46	49
8	Title	3.940000057	227	75	44	37	1	59	170	34	39
9	Title	4.840000153	177	87	49	45	1	69	166	34	40
10	Title	5.780000210	263	89	40	55	0	63	202	45	50

## Analyses performed on multiple variable data

- Correlation matrix
- Multiple linear regression
- .....

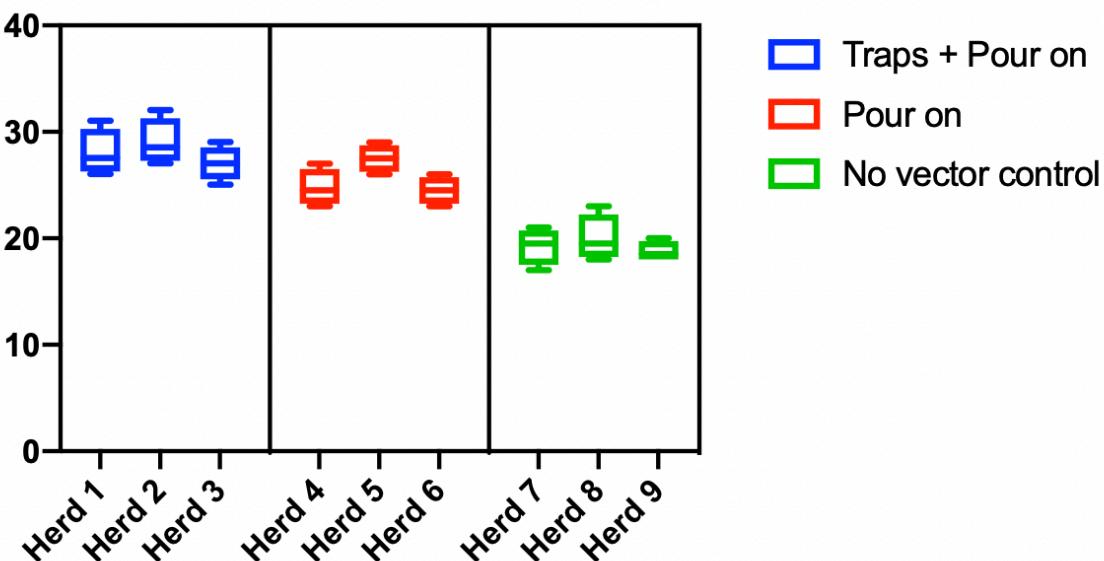


## 8. Nested Tables

A nested table is used when there are two levels of nested or hierarchical replication.

Group A			Group B			Group C		
Traps + Pour on			Pour on			No vector control		
Herd 1	Herd 2	Herd 3	Herd 4	Herd 5	Herd 6	Herd 7	Herd 8	Herd 9
28	32	27	25	26	25	21	19	18
26	27	25	24	28	26	19	18	20
27	28	29	27	29	24	17	23	19
31	29	27	23	27	23	20	20	18

Nested ANOVA



### Analyses performed from nested tables

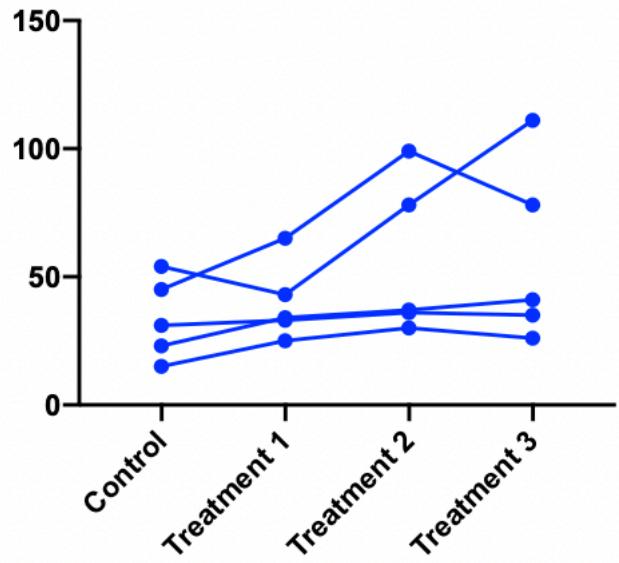
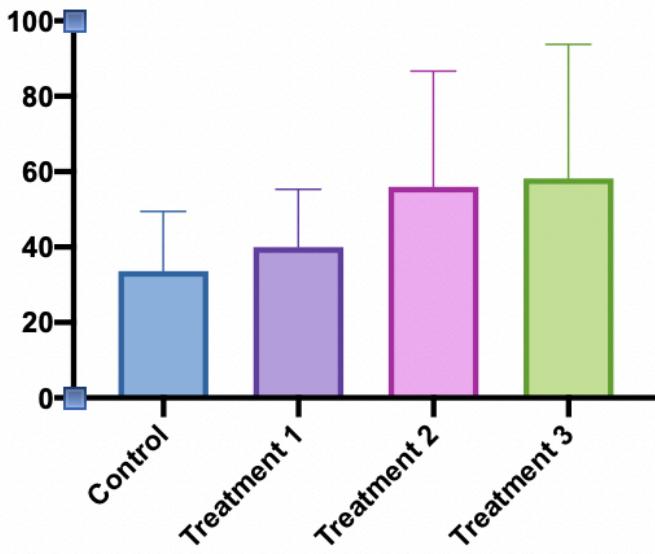
- *Nested t test*
- *Nested one-way ANOVA*
- *Descriptive statistics*
- *Normality and lognormality tests*
- *Outlier tests*
- *One-sample t test*

# Quiz: What kind of data table is it?

Table format:		Group A	Group B	Group C	Group D	
		Control	Treatment 1	Treatment 2	Treatment 3	
	x	Y	Y	Y	Y	
1	GS		54	43	78	111
2	JM		23	34	37	41
3	HM		45	65	99	78
4	DR		31	33	36	35
5	PS		15	25	30	26

## 1<sup>st</sup> Data Table

- The four columns represent four sequential treatments.
- Each row represents a different subject

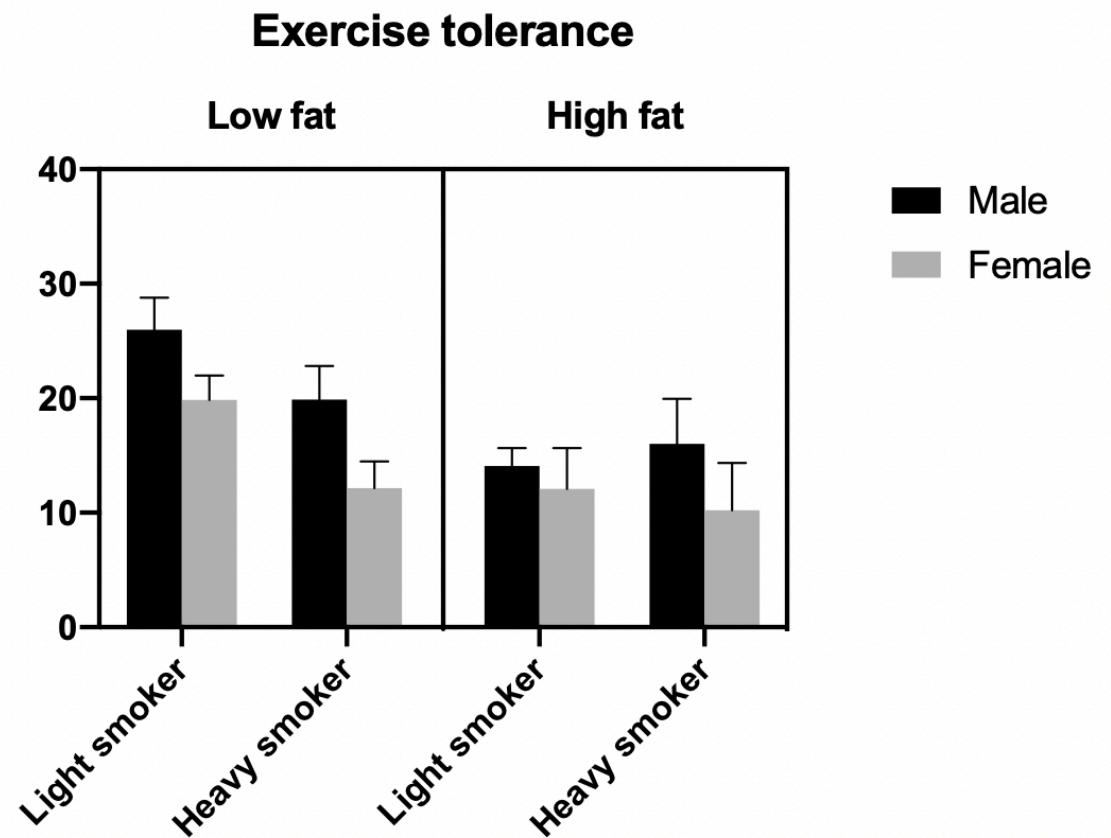
**Repeated measures one-way ANOVA data****Repeated measures one-way ANOVA data**

# Quiz: What kind of data table is it?

Table format: [REDACTED]		Group A			Group B			Group C			Group D		
		Low fat Male		Low fat Female		High fat Male		High fat Female					
	x	A:Y1	A:Y2	A:Y3	B:Y1	B:Y2	B:Y3	C:Y1	C:Y2	C:Y3	D:Y1	D:Y2	D:Y3
1	Light smoker	24.1	29.2	24.6	20.0	21.9	17.6	14.6	15.3	12.3	16.1	9.3	10.8
2	Heavy smoker	17.6	18.8	23.2	14.8	10.3	11.3	14.9	20.4	12.8	10.1	14.4	6.1

## 2<sup>nd</sup> Data Table

This example examines factors that affect exercise tolerance: gender, low vs. high fat diet, and light vs. heavy smoker.

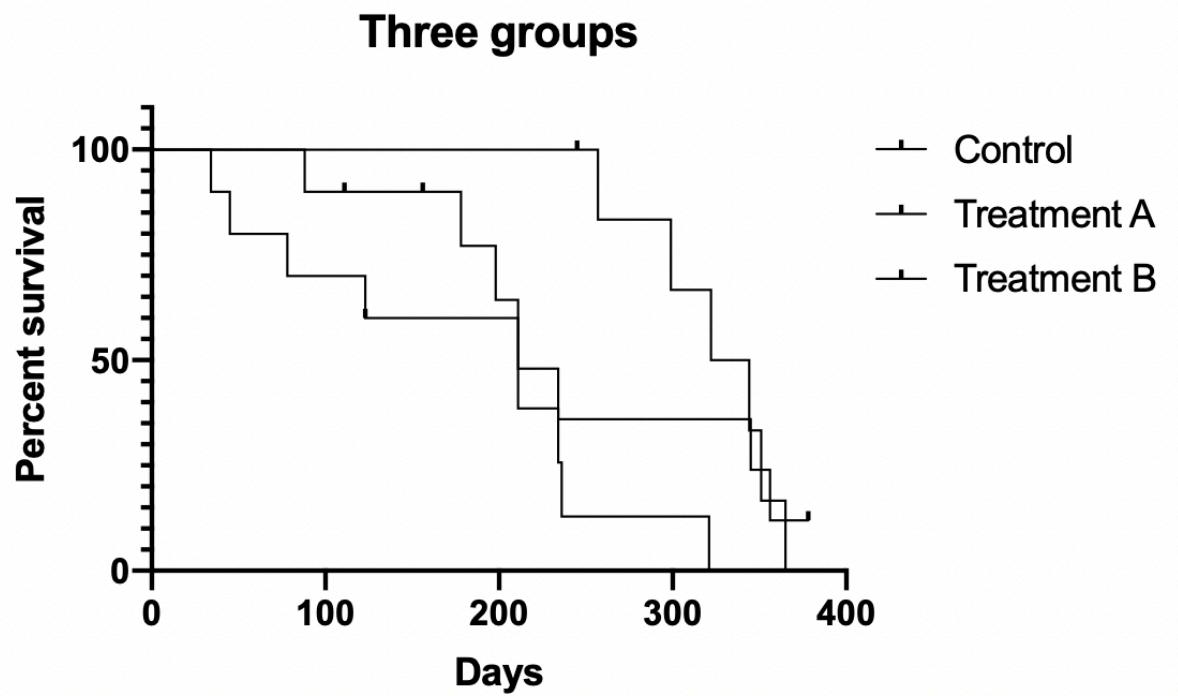


# Quiz: What kind of data table is it?

## 3<sup>rd</sup> Data Table

- Each row represents one subject.
- The X values are time.
- The Y values are entered into three columns that define the treatment groups
- The Y value is "1" when the subject died at the specified time, and "0" when the subject's data was censored at that time

	CO	NT	RO	LT	RE	AT	ME	NT	WO	RK	PL	AC	EB	OT	RE	AT	ME	NT	XX	XY	BO	OW	HO	TO	YO	UT	OO	X	Group A	Group B	Group C
																												Days	Control	Treatment A	Treatment B
1	CO							78		1																					
2	NT							34		1																					
3	RO							123		0																					
4	LT							45		1																					
5	RE							234		1																					
6	AT							345		1																					
7	ME							123		1																					
8	NT							211		1																					
9	WO							356		1																					
10	RK							378		0																					
11	PL							88																						1	
12	AC							321																						1	
13	EB							211																						1	
14	OT							111																						0	
15	RE							156																						0	
16	AT							178																						1	
17	ME							236																						1	
18	NT							198																						1	
19	XX							211																						1	
20	XY							234																						1	
21	BO							257																						1	
22	OW							322																						1	
23	HO							344																						1	
24	TO							365																						1	
25	YO							245																						0	
26	UT							299																						1	
27	OO							351																						1	



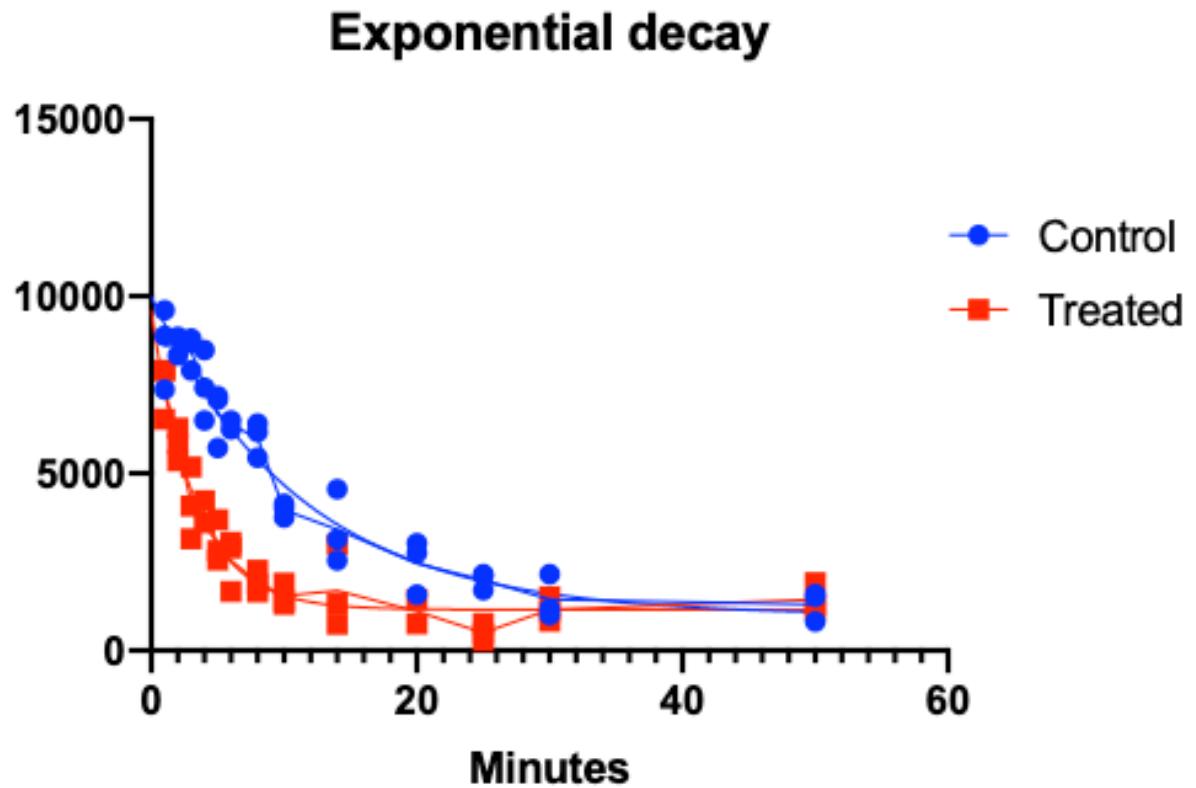
# Quiz: What kind of data table is it?

## 4<sup>th</sup> Data Table

- The X column records time.
- The response at each time point is entered in triplicate for Control and Treated conditions.
- Some cells are blank to denote missing data.

Table format: [REDACTED]	X	Group A			Group B		
	Minutes	Control			Treated		
	X	A:Y1	A:Y2	A:Y3	B:Y1	B:Y2	B:Y3
1	Title	1.0	8887	7366	9612	6532	7905
2	Title	2.0	8329		8850	5352	5841
3	Title	3.0	7907	8810	8669	5177	4082
4	Title	4.0	7413	8481	6489	3608	
5	Title	5.0	7081	7178	5716	2559	3697
6	Title	6.0	6249	6492		1671	3053
7	Title	8.0	5442	6172	6409	2264	1658
8	Title	10.0	4020	3758	4138	1905	1302
9	Title	14.0	4559	3146	2547	2994	1338
10	Title	20.0	3033	6587	2754	1444	
11	Title	25.0	2105	1707	2152	281	484
12	Title	30.0	1005	2156	1185	1103	1517
13	Title	50.0	820	1513	1591	1918	1128

An exponential decay example – Nonlinear regression





NEW TABLE &amp; GRAPH

XY

Column

Grouped

Contingency

Survival

Parts of Whole

Multiple variables

Nested

## EXISTING FILE

Open a File

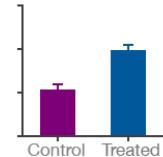
LabArchives

Clone a Graph

Graph Portfolio

**Column tables have one grouping variable, with each group defined by a column**

	A	B
	Control	Treated
Y	Y	
1		
2		

[? Learn more](#)**Data table:**

- Enter or import data into a new table  
 Start with sample data to follow a tutorial

**Select a tutorial data set:**

## ▼ Error bars in column tables

## Entering replicate data

Entering mean (or median) and error values

## ▼ T tests

t test - Unpaired

t test - Paired

t test - One sample

## ▼ One-way ANOVA

Ordinary one-way ANOVA

Repeated measures one-way ANOVA

## ▼ Special uses of column tables

Analyze a stack of P values

ROC curve

Bland-Altman method comparison

Metanalysis (Forest) plot

**2<sup>nd</sup> Part: Read Existed Files**National Institute of  
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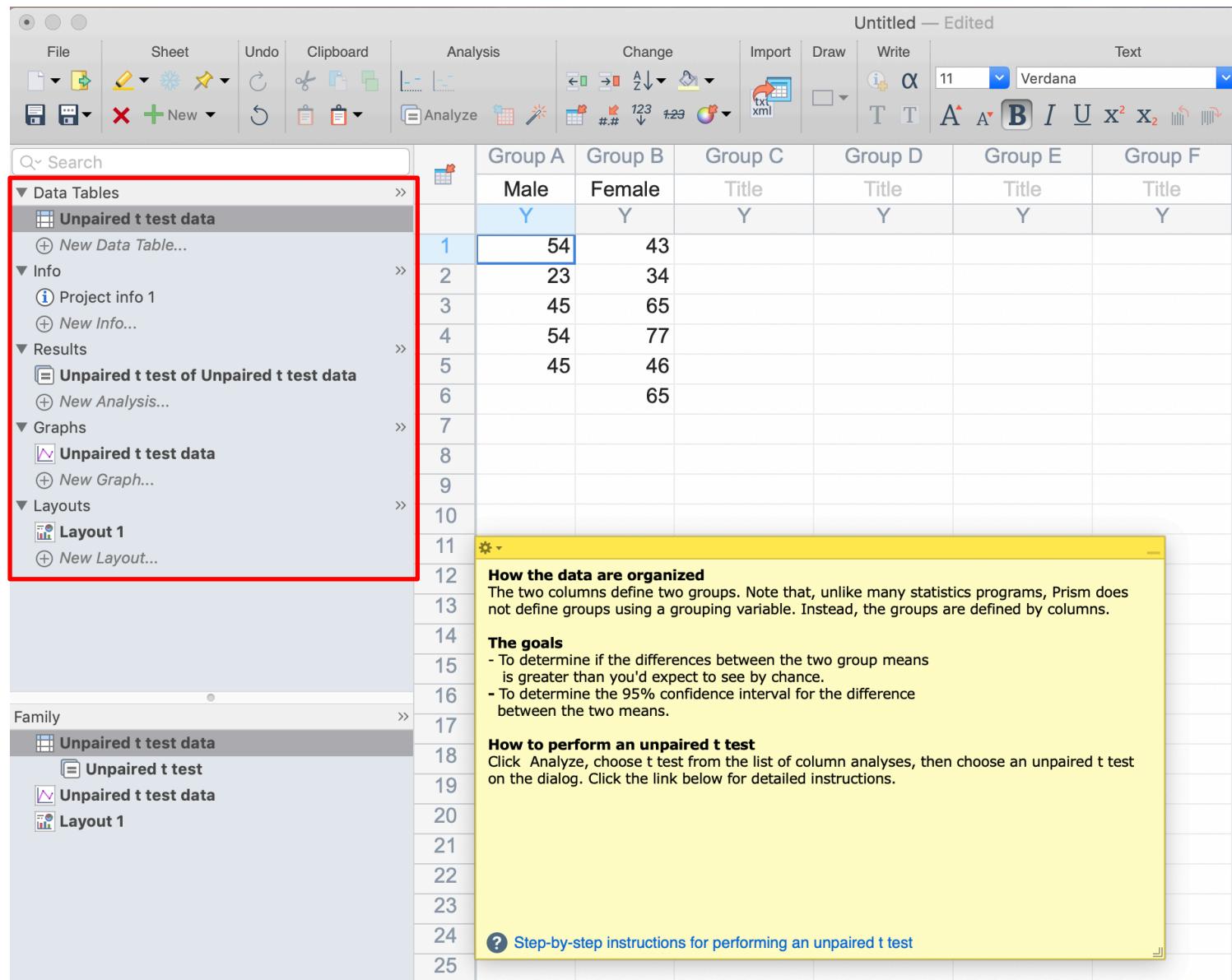
Prism Tips

Cancel

Create

NIH

# The 5 Sections of a Prism Project



The screenshot shows the Prism software interface with a red box highlighting the 'Data Tables' section in the left sidebar. The main area displays a data table with columns for Group A (Male/Female), Group B (Female), Group C (Title), Group D (Title), Group E (Title), and Group F (Title). The data rows show values for each group across the columns.

	Group A	Group B	Group C	Group D	Group E	Group F
	Male	Female	Title	Title	Title	Title
1	Y	54	43			
2		23	34			
3		45	65			
4		54	77			
5		45	46			
6			65			
7						
8						
9						
10						
11						
12						
13						
14						
15						
16						
17						
18						
19						
20						
21						
22						
23						
24						
25						

**How the data are organized**  
The two columns define two groups. Note that, unlike many statistics programs, Prism does not define groups using a grouping variable. Instead, the groups are defined by columns.

**The goals**

- To determine if the differences between the two group means is greater than you'd expect to see by chance.
- To determine the 95% confidence interval for the difference between the two means.

**How to perform an unpaired t test**  
Click Analyze, choose t test from the list of column analyses, then choose an unpaired t test on the dialog. Click the link below for detailed instructions.

[Step-by-step instructions for performing an unpaired t test](#)

## Two Formats

When you save a Prism file, you save the entire project into one file. You have a choice of two file formats:

- **PZF format:** This is a binary format that can be opened by Prism 4 or later, but not by other applications.
- **PZFX format:** This is a format that can be opened only by Prism 5 or later. The first part of the file contains all the data tables and info sheets in a plain-text XML format that can be viewed by other programs. After that comes information about results, graphs and layouts in a format that is incomprehensible to any program but Prism.

# Lab 2 – Visualization

- How to create graphs in Prism
- Eight ways to change a graph
- Rotating, flipping, reversing
- Changing a graph's shape and size
- Breaking Y axis into two segments
- Overlaying two column graphs
- Graphing Example: XY plots – Nonlinear curve fitting
- Exporting images from Prism

## Exporting images from Prism

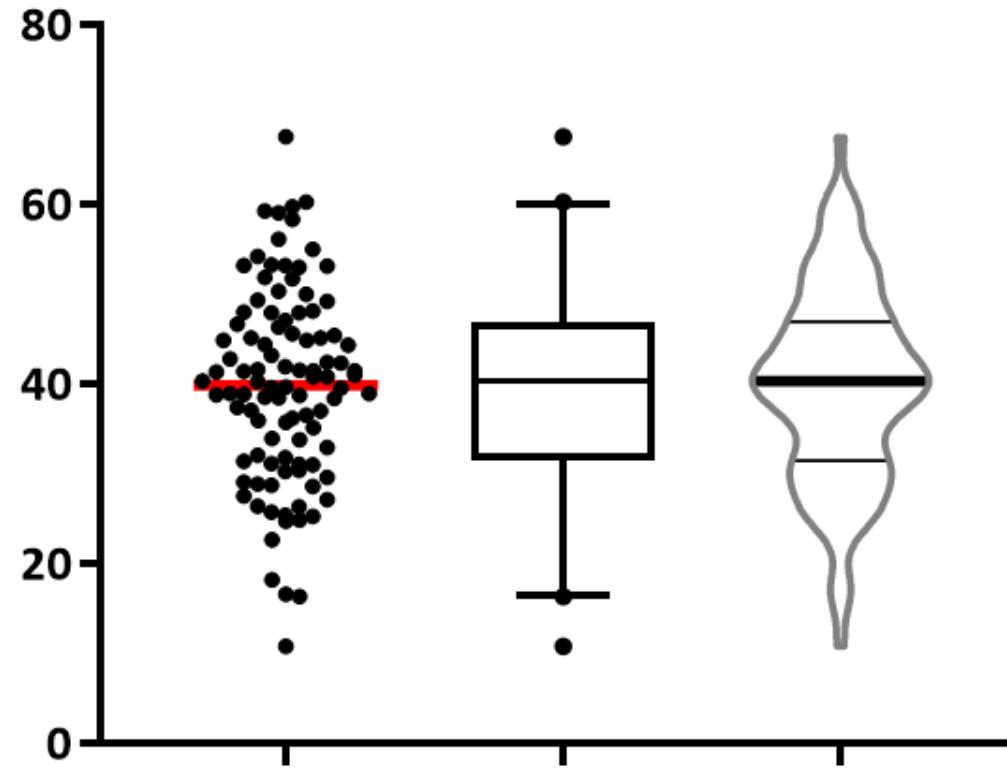
Export Formats	PDF	TIFF / TIF
Advantages	File can be stretched to any size with no loss of quality	Tend to be trouble-free when submitted to journals
Disadvantages	<ol style="list-style-type: none"><li>1. Few Windows programs import pdf images</li><li>2. Few Journals accept them.</li></ol>	You need to choose resolution and size

# Viewing Data Distributions

Left: Scatter Plot

Middle: Box-and-Whiskers Graph

Right: Violin Plot



# Lab 5 – Survival Analysis

In many clinical and animal studies, the outcome is survival time. The goal of the study is to determine whether a treatment changes survival. Prism creates survival curves, using the product limit method of Kaplan and Meier, and compares survival curves using both the **log-rank test** and the **Gehan-Wilcoxon test**.

Examples of **events** and **censor**:

Events	Censor
1. Death 2. Targeted Events	1. Still alive at the end of the study 2. Drop out of the study

## Log-rank Test

- Gives equal weights to all time points
- More standard
- More powerful if the assumptions of proportional hazards\*\* is true.

## Gehan-Breslow-Wilcoxon test

- Gives more weight to deaths at early time points
- The results can be misleading when a large fraction of patients is censored at early time points.
- Doesn't require a consistent hazard ratio, but does require that one group consistently have a higher risk than the other.

\*\* Proportional hazards mean that the ratio of hazard functions (deaths per time) is the same at all time points.

# How to report statistical results

## Overall:

- Every statistical paper should report all methods completely enough so someone else could reproduce the work exactly.
- Every figure and table should present the data clearly
- All the results should be reported completely enough that no one wonders what you actually did.

## Statistical Methods:

- State the full name of the test.
- Identify the program or the program that did the calculations
- State all options you selected. Repeated measures? Report enough detail so anyone could start with your data and get precisely the same results you got.

## Graphing Data:

- Make main title, X- and Y-axes, legends, or any labels clear.
- Present data clearly. Focus on letting the reader see the data, and not only your conclusions.
- When possible, graph the individual data, not a summary of the data.

# Conclusions

- The materials of this seminar will be updated on: [Github - Graphing with Prism](#)
- If you have any further statistical problem, please send email to  
[bioinformatics@niaid.nih.gov](mailto:bioinformatics@niaid.nih.gov)
- Check our training schedule: [http://www.eventzilla.net/user/NIAID\\_OCICB\\_BCBB](http://www.eventzilla.net/user/NIAID_OCICB_BCBB)

# Thank You!