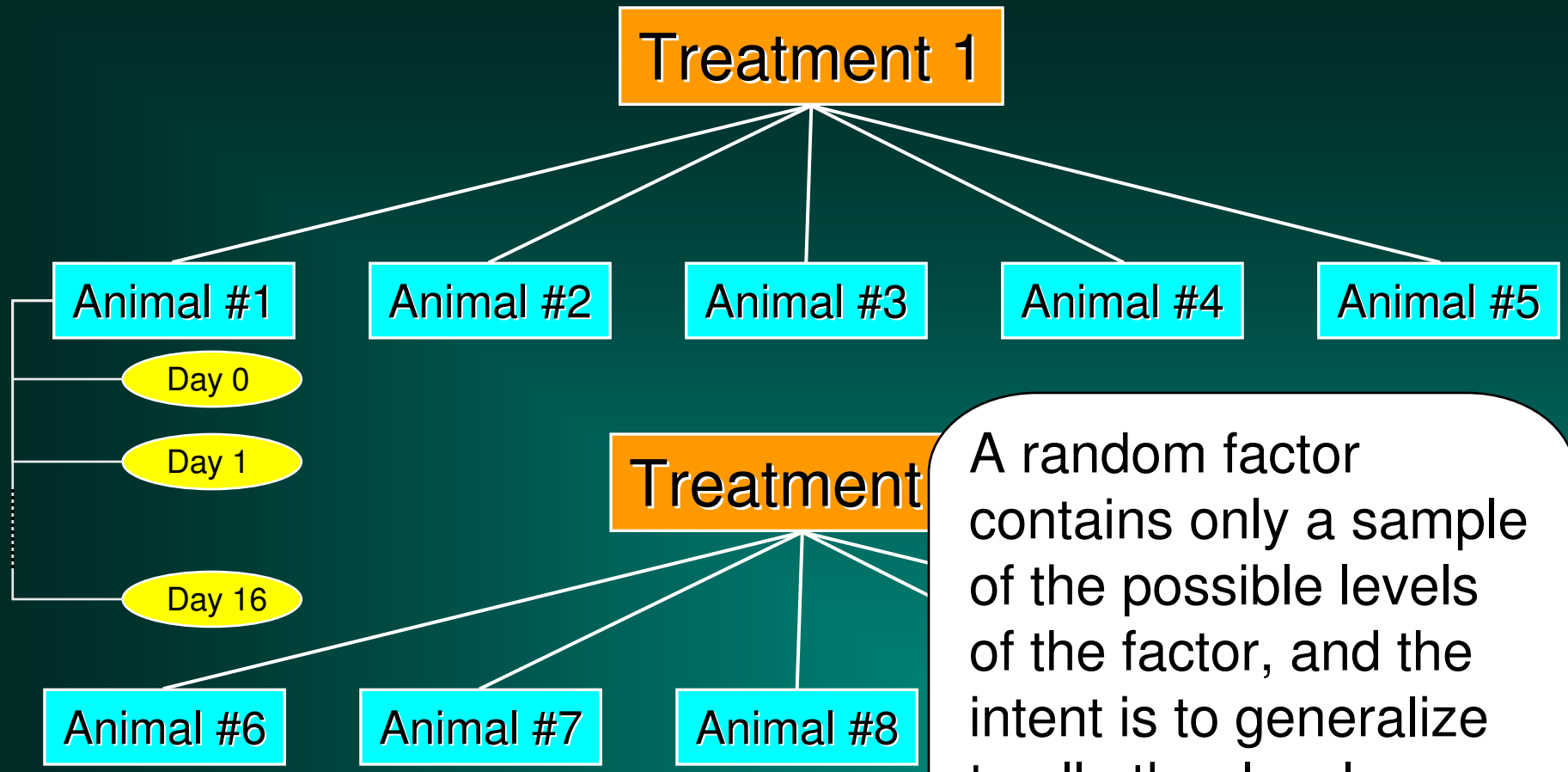
Proc Mixed for Repeated Measures Data

(by a Non-statistician)

Jaswant Singh
Veterinary Biomedical Sciences

Most researchers use statistics the way a drunkard uses a lamp-post –more for support than illumination

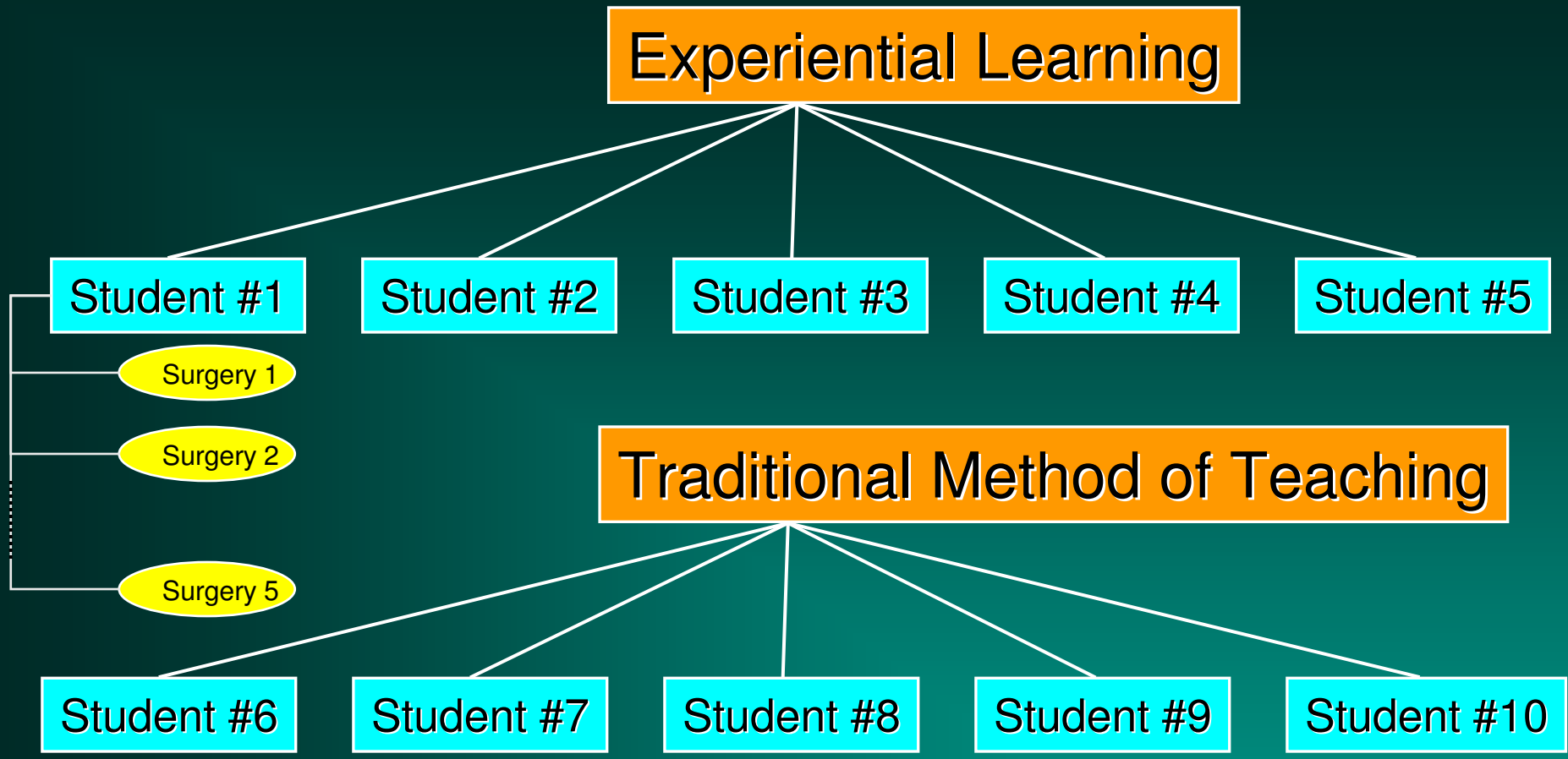
- Winfred Castle



- **Animal ID is nested within treatment**
- **Our model statement for split-plot design will look like:**

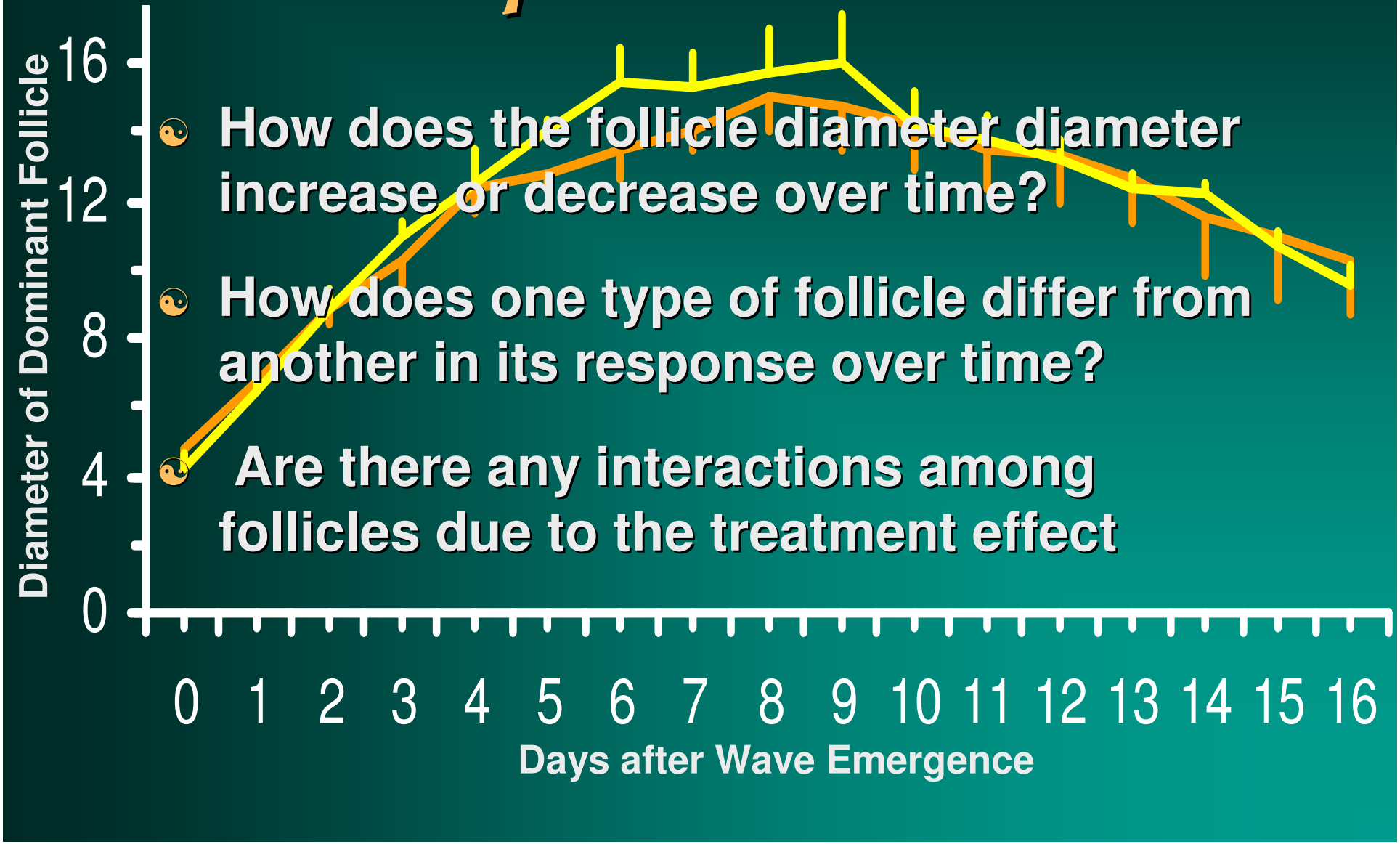
  Model Diameter = trt animal(trt) day trt*day

- **Animals are considered a 'random factor' in the analysis**



- Student ID is nested within Method
- Students are considered a 'random factor' in the analysis

Our questions are:



- How does the follicle diameter diameter increase or decrease over time?
- How does one type of follicle differ from another in its response over time?
- Are there any interactions among follicles due to the treatment effect

What do we want to accomplish?

- To analyze time series data
- To find out if there is a treatment effect

Experimental designs

	Control	Estradiol 0.1mg i/m	Estradiol 0.5mg i/m	Estradiol 1.0mg i/m
Animal ID in each group →	12	69	11	68
	14	71	23	70
	21	9	20	8
	34	6	33	5
	58	31	57	30

- **Experimental Units:** Animals
- **Experimental Design:** Completely random or one-way
- **Treatment Design:** Gradient
- **Response Design:** Repeated

SAS® PROC MIXED

- A new analysis tool which is appropriate for analyzing repeated measures data because it models the covariance of the data as well as the mean and the variance.
  - In repeated measures data, the data collected at one point in time is often not independent of the data collected at another time in the study (i.e., heterogeneity of residuals, the existence of covariance in your data set).
- Capable of analyzing data with missing values.

Correlation Matrices

1	0	0	0
0	1	0	0
0	0	1	0
0	0	0	1

Independent

No correlation

1	α	α	α
α	1	α	α
α	α	1	α
α	α	α	1

Compound Symmetry

Fixed and constant Correlation within a subject is presumed

1	α_{21}	α_{31}	α_{41}
α_{21}	1	α_{32}	α_{42}
α_{31}	α_{32}	1	α_{43}
α_{41}	α_{42}	α_{43}	1

Unstructured

Correlation matrix is completely unspecified

1	α	α^2	α^3
α	1	α	α^2
α^2	α	1	α
α^3	α^2	α	1

Autoregressive

Correlation decrease with distance

SAS® PROC MIXED

- Assumptions:
  - Data is normally distributed
  - Variances and covariances of the data exhibit a structure matching one of those available in PROC MIXED
  - Means (expected values) of the data are linear in terms of a certain set of parameters

SAS® PROC MIXED:
How does it work?

- **Run PROC MIXED using different covariance structures:**
  - ***Compound Symmetry*** **CS**
  - ***Huynh-Feldt*** **HF**
  - ***Unstructured*** **UN, UN(1)**
  - ***Autoregressive*** **AR(1)**
- **Select the model with the best fit**
  - **The highest (I.e., most positive) values of Akaike's Information and Schwarz's Bayesian Criterion**

First thing first
Test of Homogeneity of Variance

```
proc glm;
   class trt;
   model folliclediameter = trt;
   means trt / hovtest;
   run;
```

The Syntax

```
data;
    input trt id day follicldiameter;
    cards;
    ..    ..        ..        ..
    ..    ..        ..        ..

proc mixed;
    class id trt day;
    model  follicldiameter = trt day trt*day / htype=3;
    repeated day / subject=id(trt) type=*;

run;
```

Run multiple analyses by replacing * with

***CS** for Compound Symmetry*

***HF** for Huynh-Feldt*

***UN, UN(1)** for Unstructured*

***AR(1)** for Autoregressive*

SAS® PROC MIXED:

Which model do we use?

	Akaike's Criterion	Schwarz's Criterion
CS	-280.9	-283.2
AR(1)	**-245.1**	**-245.4**
UN	No fit	No fit
UN(1)	-306.2	-308.7
HF	No fit	No fit

SAS® PROC MIXED

- To determine where differences exist:
  - Least Squares Means
  - Contrasts
  - Estimates
- In contrast to PROC GLM, PROC MIXED averages across the repeated measures and computes standard errors accounting for the appropriate covariance structure.

SAS® PROC MIXED

- PROC GLM provides more extensive results for the traditional univariate and multivariate approaches to repeated measures
- PROC MIXED offers a richer class of both mean and variance-covariance models, and you can apply these to more general data structures and obtain more general inferences on the fixed effects

SAS® PROC MIXED

References:

1. Wolfinger, R; Chang, M. Comparing the SAS GLM and MIXED Procedures for Repeated Measures. SAS Institute Inc., Cary, NC
2. Littell, R; Henry, P; Ammerman, C. Statistical Analysis of Repeated Measures Data Using SAS Procedures. 1998. J Anim Sci, 76:1216-1231.
3. The Mixed Procedure. SAS/STAT User's Guide. Version 8. Chapter 41. 1999. Volume 2: 2083-2226.