

Useful Functions in Google Sheets:

In what follows, **RANGE** refers to a set of Google Sheet cells that you can highlight with your mouse, while **VALUE** refers to a single Google Sheet cell that you can highlight with your mouse.

To take the sum of the values across some **RANGE**:

`=SUM(RANGE)`

To take the average of the values across some **RANGE**:

`=AVERAGE(RANGE)`

To count the number of cells in some **RANGE**:

`=COUNT(RANGE)`

To count the number of cells in some **RANGE** that have a certain **VALUE**:

`=COUNTIF(RANGE, VALUE)`

To take the exponential function of a **VALUE**:

`=EXP(VALUE)`

To compute the factorial of a **VALUE**:

`=FACT(VALUE)`

To take the natural logarithm of a **VALUE**:

`=LN(VALUE)`

To compute the standard error of the mean (SEM) of values across some **RANGE**:

`=STDEV.S(RANGE)/SQRT(COUNT(RANGE))`

To take the variance of values across some **RANGE**:

`=VAR.S(RANGE)`

To compute the slope of the best fit line to some data (where x values are in **RANGE_X** and y values are in **RANGE_Y**):

`=SLOPE(RANGE_Y, RANGE_X)`

Operation	Expression
$a \times b$	<code>=(VALUE_a * VALUE_b)</code>
$a \div b$	<code>=(VALUE_a / VALUE_b)</code>
a^b	<code>=(VALUE_a ^ VALUE_b)</code>

Remember-- parentheses are your friend ☺

A few more things

Estimating density

When trying to estimate the density of cells in some culture (CFUs/mL), the following formula will be generally useful:

$$D = C \times \frac{1000}{V} \times 10^{-d}$$

Where

D is the density of cells in the original culture (CFUs/mL)

C is the count of colonies on the Petri dish (CFUs)

V is the volume of the dilution plated on the Petri dish (μL)

d is the exponent of the dilution factor for the plating (e.g., -7)

So, with $C=52$ CFUs, $V=100 \mu\text{L}$, and $d=-4$, we would have:

$$D = 52 \text{ CFUs} \times \frac{1000 \frac{\mu\text{L}}{\text{mL}}}{100 \mu\text{L}} \times 10^4 = 5.2 \times 10^6 \frac{\text{CFUs}}{\text{mL}}$$

When computing the cell density, you should pay careful attention to what culture you are trying to estimate density of (e.g., the *Liquid Competition Tubes* in the Public Goods lab were not diluted directly and plated for the $t=0$ count, so you will have to take this into account for your calculation). Also, occasionally there are extra dilution factors to consider (e.g., the *Agar Competition Dishes* in the Public Goods lab were scraped into saline for the $t=24$ counts, which is an extra dilution). It may be helpful to consult with the protocol (e.g., for Public Goods) to make sure these extra considerations are clear. For the Public Goods lab, there is a pdf giving an overview on the Protocols page on the course website, which might be helpful to visualize all the steps.

Reporting statistics

A fairly standard way to report a statistical test yielding a significant result is to use the word “significantly” in a sentence describing the result and then cite the test and the P-value in parentheses. For instance:

- “We found that treatment with the experimental drug led to significantly greater recovery (unpaired t-test, $p=0.013$).”
- “We found that the distribution of births across months differed significantly from a uniform distribution (chi-squared test, $p<0.001$).”

When you do not find a significant result, you can report a failure to reject the null hypothesis, for instance:

- “We were unable to reject the null hypothesis that crows eat an equivalent amount of food as ravens (unpaired t-test, $p=0.4$).”

Generally, these ways of framing statistical results will suffice for this class. However, you should know that often measures of key quantities (e.g., means, standard deviation) and the test statistic with degrees of freedom are also reported in the scientific literature.