GRAPHICAL PRESENTATION GUIDE

Introduction

Graphical presentation is crucial to conveying your data clearly and professionally. Often, manuscripts contain the typical Microsoft Excel default format (Fig. 1), however there are many flaws present.
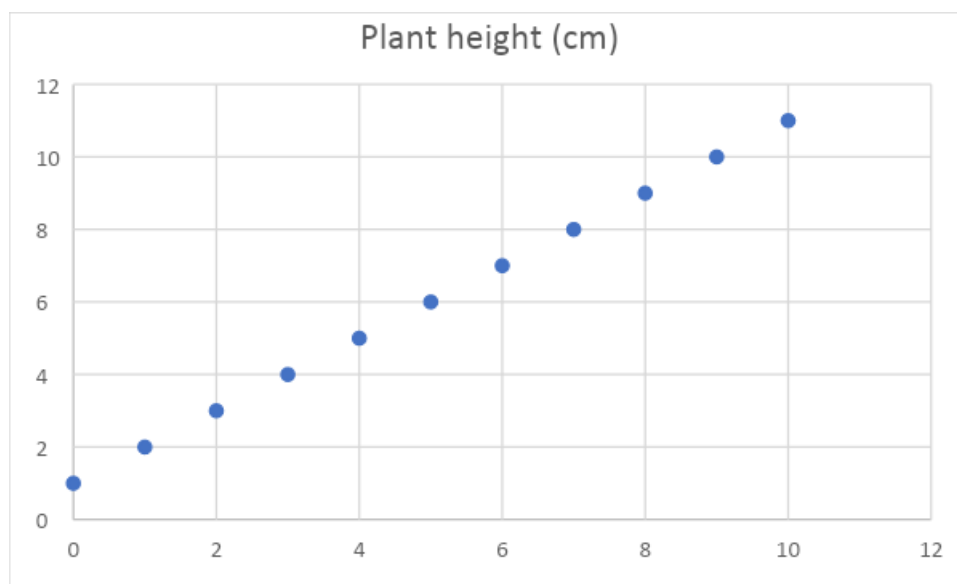

Figure 1 – Plant Growth over time. Example of a typical Excel default 'scatter graph'.

Firstly, there are no **labels on the x or y axis**, which makes it difficult for the reader to identify the independent and dependent variables. There are also no **tick marks** on the axes, the **gridlines** and the **border** distract the reader from the data points and the **text** is grey- if you are low on ink this may be problematic! Also – whilst in this case it is obvious that there is a linear relationship, what if the trends are not as apparent? You want to signpost the reader and make it clear how you are interpreting the data through adding a **relevant trendline** to the data. A much better display of the data, where these issues have been resolved, is shown in Fig. 2.
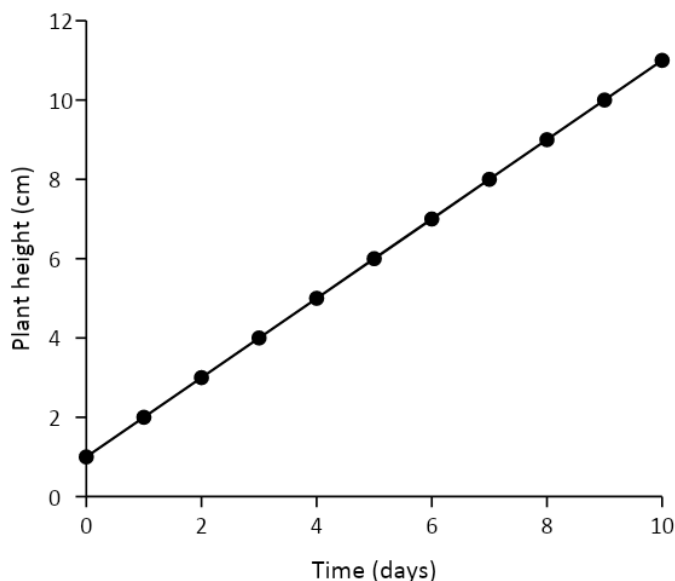
Figure 2 – Plant Growth over time. Through some simple and quick changes, the quality of the graph drastically improves.

So how do we get to the perfect, journal standard, graph? Use this checklist to guide you:

o   Have the gridlines been removed?
o   Have you added the major tick marks to both axes?
o   Are the axes labelled, with units? Has the default title been removed?
o   Is the text black? Are data points clear?
o   Have you conveyed the main message of the data effectively?

Below is a step-by-step tutorial on how to use Microsoft Excel effectively. The 5 checklist points should be applied to any graph, not just a scatter graph! More specific examples and guidelines are also shown below.

Basic Guide to using Excel

1. Open Excel and input your data. Generate the default Excel graph (Fig. 1).
2. Click on the gridlines and delete (Fig. 3A)
3. Delete the default generated title – you don't need one, any important descriptions about the graph should be in the Figure legend (Fig. 3B).
4. Go to 'Chart Design' in the toolbar → Click 'Add Chart Element' then 'Axis Titles' – add both the 'primary horizontal' and 'primary vertical' labels (Fig. 3C). Input your axis titles, remember units!
5. Right click on the x-axis and go to 'Format Axis…'
    a. Go to 'Axis Options', check if the upper and lower bounds are sensible. You want your data to fill up the maximum amount of space. The x-axis finishes at 10 days (Appendix A) so the upper bound can be changed to stop at 10 days (Fig. 3D).
    b. Change the major units if necessary, make informed decisions. The major units here are 2 days which produces a scale with good clarity, so this does not need to be changed.
    c. Go to 'Labels' and add 'Major' tick marks on the 'Outside' (Fig. 3E)
    d. Click on the 'Fill & Line' icon (paintbrush) and click 'Line'. Change to a Black Line (Fig. 3F)
6. Repeat Step 5 for the y-axis.
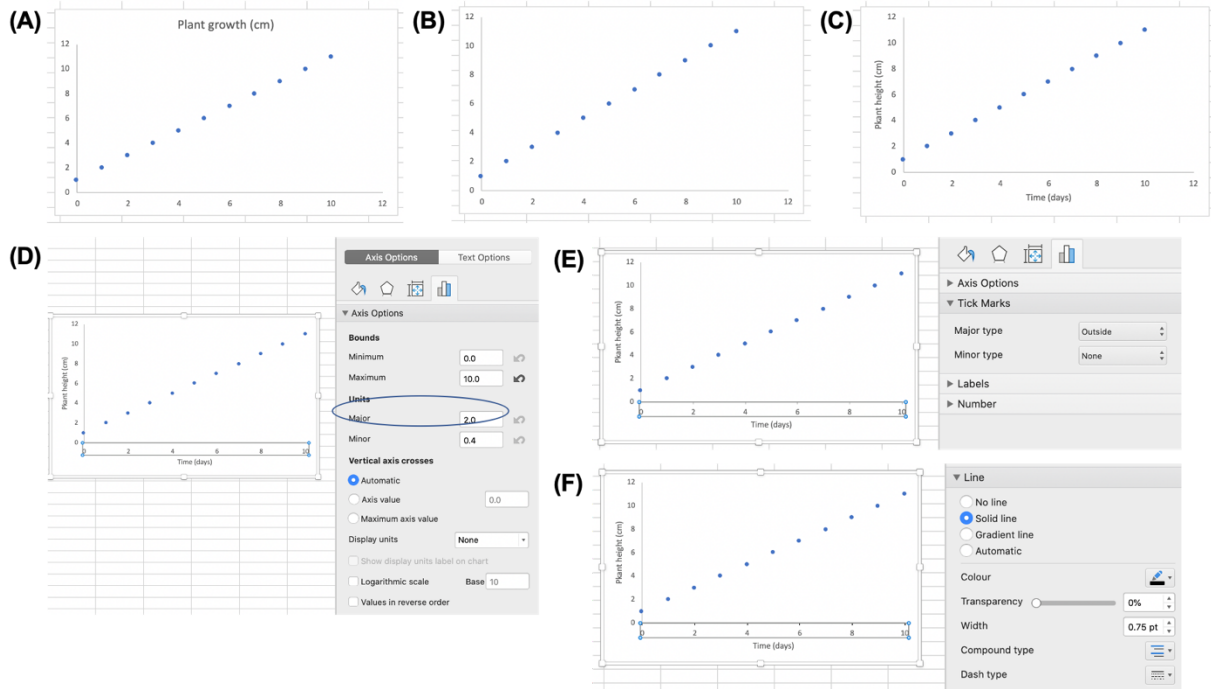7. Click on the graph and change the font colour to black.

Figure 3 – Excel Steps.

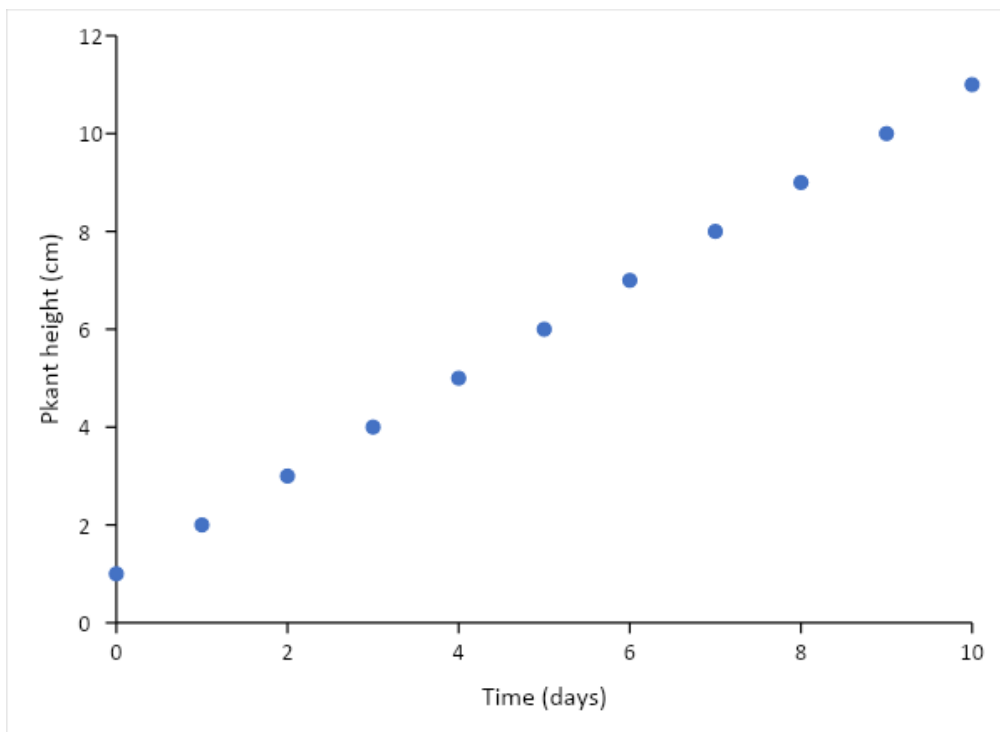At this stage your graph should look like what is shown in Fig. 4.

Figure 4 – Mediocre Graph. We're getting there! ☺ Just a few more steps!

8. Right click on an individual data point and click 'Format Data Series'
    a. Click on the 'Fill & Line' icon (paintbrush) and click 'Marker'. Go to 'Fill' and select 'Solid Fill', change the colour to black. Go to 'Border' and select 'Solid line' and change the colour to black.

9. Right click on an individual data point and click 'Add Trendline'. Choose an appropriate trendline to add depending on your data fit. Ensure you display the line of the equation (if appropriate) and the R-squared value if a linear trendline has been fitted.
10. Finally, right click on the overall graph and click 'Format Chart Area'. Click on the 'Fill & Line' icon (paintbrush) and click 'Border'. Remove the border by choosing 'No line'
11. Voila! You have successfully created a graph similar to that of Fig. 2.

NB! You can save the graph as a "template" by right clicking on the graph and clicking "Save as Template". That way when you have to construct a similar graph again you can automatically create the perfect looking graph!

Now, you might be thinking why black, how boring! Why not add some colour? The answer to this is simple- you need to produce graphs that are simple yet effective. If someone is colour blind, for example, they will struggle to see the colour points. Alternatively, a bad print job can result in misconstrued data. So, when you have multiple data sets what do you do?

Multiple Data Sets

Say you want to compare the growth of two different plants, under the same experimental conditions. Rather than having two separate graphs it could be more convenient to present the two data sets as one, see Fig. 5.
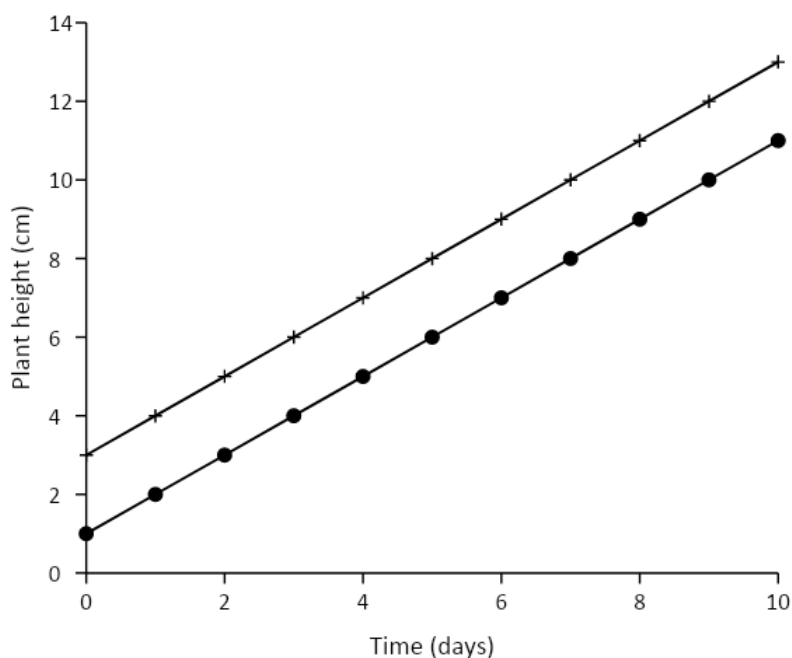

Figure 5 – Plant Growth over time. The plant growth was monitored for Plant A (●) and Plant B (+).

Note, that the Figure legend details the difference between the two data sets – that being the symbols represent different plant species. It's best to use different symbols and not different colours, for the reasons that have been mentioned before. Follow the step-by-step instructions below:

1. Input your first set of data, following the guidelines above, to create Fig. 1.
2. Right click on your formatted graph and click "Select Data" → Click the [+] button to add another set of data → Input your additional data set for X and Y (Fig. 6).
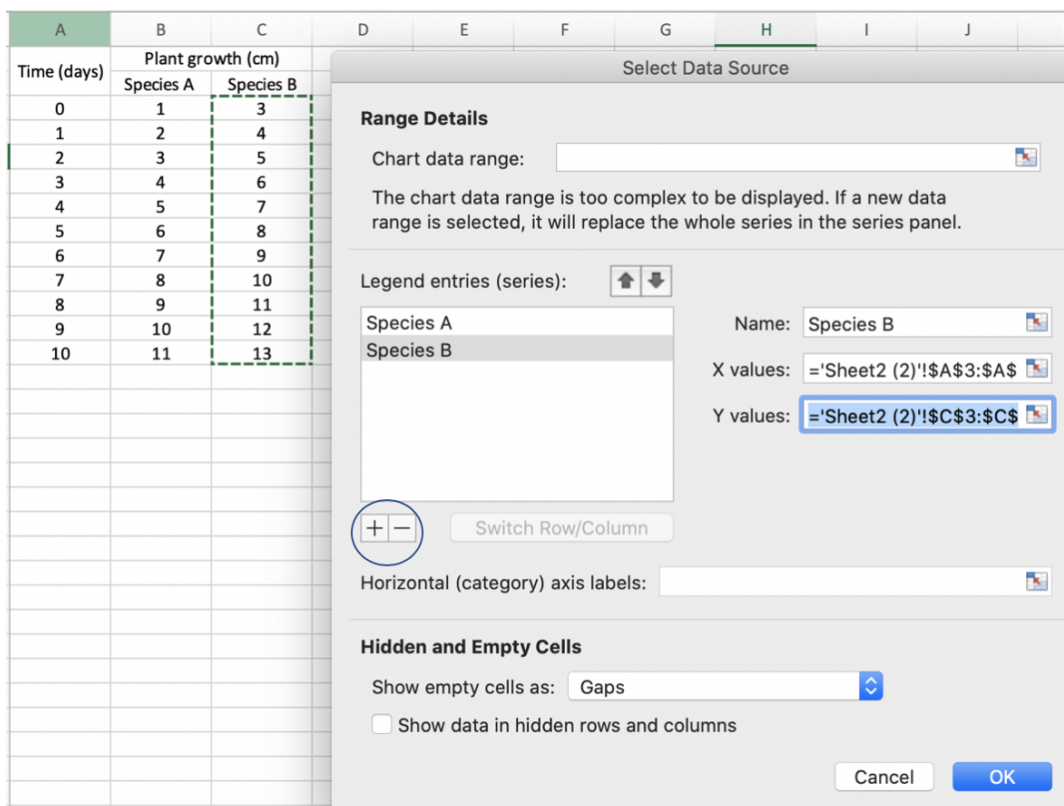

Figure 6 – Adding additional data.

3. Right click on an individual data point and click 'Format Data Series'
    a. Click on the 'Fill & Line' icon (paintbrush) and click 'Marker Options'. You can change the marker to a different shape, i.e. a square, triangle etc
4. Format the graph per the steps mentioned in "Basic Guide to Excel".

However, sometimes data doesn't always follow a linear trend, and this can complicate graphical presentations. Take the data below for Plant C:

Table 1 – Plant growth for Species C.

Time (days)	Plant height (cm)
0	4
2	8
4	12
6	16
8	20
10	20
12	20
14	20

You may have noticed that the plant height seems to stop at 20cm after 8 days, so when you plot the graph you would get a "plateau" which if you plot a trendline it would not be a linear curve, which is what we want. So, you want to only plot a curve in the linear portion of the graph (Fig. 7).
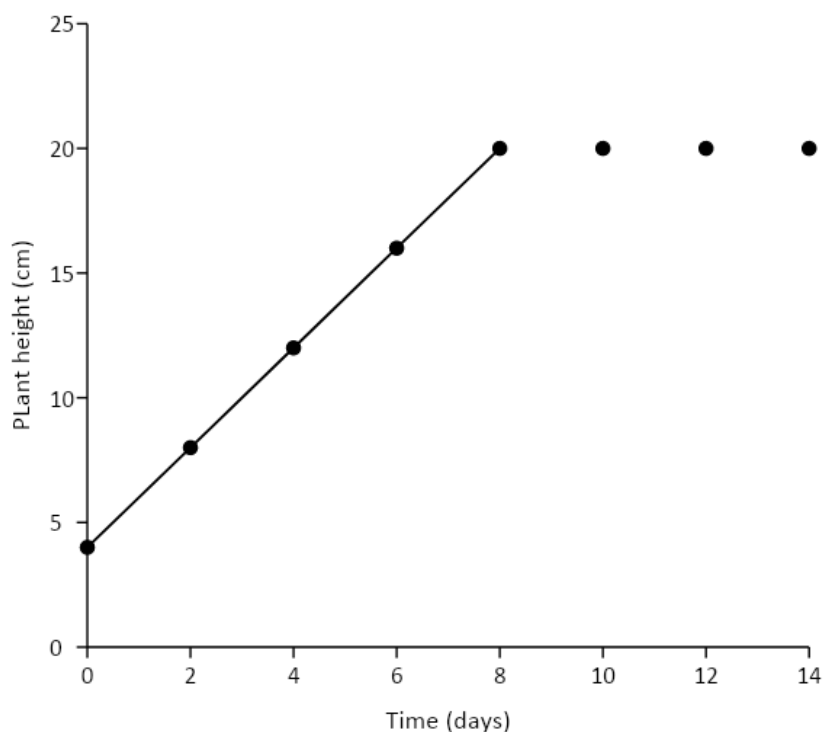
Figure 7 – Plant Growth Curve for Plant C.

Therefore, you have to treat the data (Table 1) as two different data sets and plot them differently (using the steps above). Firstly, plot days 0-8 and generate a curve and then plot the rest of the data (days 10-14). Alternatively, if Day 4 had an unusually low/high height you can 'omit' it from the trendline, by plotting it as a separate data set, and only plotting Day 0, 2, 6 and 8 to generate the linear curve (Fig. 8). The take home message is to be cautious with your data, you want to generate curves that are logical and make sense depending on the data and interpretations.
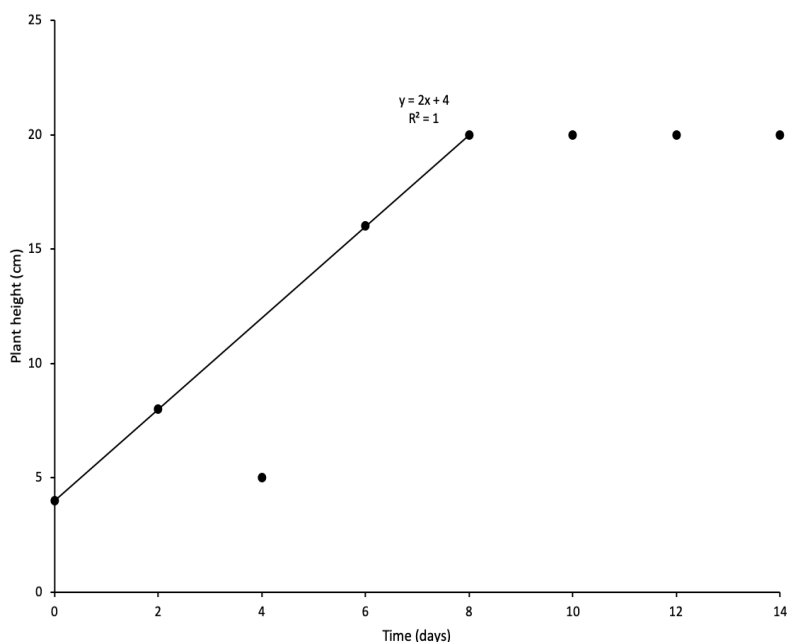

Figure 8 – Plant Growth Curve for Plant C. Note that in this data set, Day 4 is exceptionally lower than the trend, so has been omitted from the curve.

Key Tips / Hints

- Where appropriate, you may want to include the line of the equation and R^2 value (Coefficient of determination) if plotting a linear curve. For some graphs (e.g. a Decay Curve) a line of an equation could provide valuable insight into the data (i.e. the rate constant etc)
- Ideally, graphs should be in a square dimension, so that it is easier to manipulate when our team is ready to publish your manuscript! Remember to keep all graphs at a high resolution.
- Not all graphs need to be constructed on Microsoft Excel - there are other great tools that can be used (e.g. SPSS), however sometimes simplicity is best!
- Ensure figure legends are detailed - the reader should be able to understand what the figure is without having the figure in front of them. Be sure not to include any interpretations in the figure legend - these should go in the main body.
- Figure legends go **below** the figure, but table legends go **above** the table.
- When referring to a Figure in text it is professional to refer to it as "Fig. X" rather than "Figure X"

Scatter graphs are typically used in STEM research, though sometimes it might be appropriate to display data as a Histogram/Bar Chart. Do not worry - the 'basic rules' still apply here, but to provide a visual illustration of what these may look like, see Fig 9.
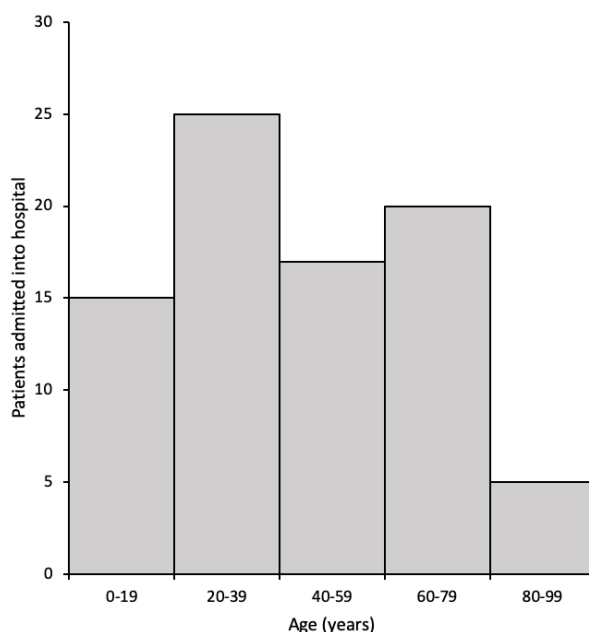

Figure 9 - Number of patients admitted into hospital on Wednesday in Coventry per age group.

Conclusion

Hopefully this guide has given you a good idea of how to construct graphs to a professional journal standard. Whilst it does seem like a lot, over time this becomes easier and it will become second-nature to you! If there are any questions feel free to contact the Editor in Chief (editor@youthstem2030.org) or a member of the editorial team.