Welcome to Unit five of Writing in the sciences.,This week, I'm going to walk you through how to write a scientific,manuscript before we jump into the scientific manuscript.,However, I do want to briefly continue our discussion from last week on the writing process.,I want to give you one more tip on avoiding procrastination in easing anxiety around writing.,1st of all, writing is hard for everyone.,I get intimidated and anxious when I have a big story to write, especially when I haven't gotten started yet.,One thing I do to ease my anxiety is to break the writing up and set very reasonable goals for each day.,As I'm driving into work, I might tell myself, my goal today is just to write 400 words.,If I can make 400 words, I will have had a successful day.,I choose a goal that I know is easy.,It's so reasonable and doable that it doesn't seem daunting.,It doesn't make me feel like crawling under my desk and curling up in a ball.,This makes it easier to get started on the writing that day.,And what usually happens is I reach my goal in a few hours, and by then I'm on a roll.,I feel on track because I've met my goal, and I'm able to keep going and get a lot more done that day.,But it's comforting for me to know in the back of my mind that if, for some reason, the writing ends up being really tough that day, and I can only get to 400 words, I can still call that a success.,If you set goals too high, like forcing yourself to try to whip out the entire manuscript in one day, this can be so daunting and unrealistic that it makes it hard to even get started, and you'll end up procrastinating and getting nothing done.,So set small doable goals. Now on to scientific manuscripts.,I recommend that you write them in this order.,I believe that you need to nail your tables and figures down.,1st. Don't just put together some shell tables or something rough, but come up with a beautiful, polished set of tables and figures.,The tables and figures contain the story of your paper.,Each table and figure should have a clear point, and together they should tell the story of your manuscript. So the 1st thing that you need to do is to figure out that story that your tables and figures are going to tell, and finalize those tables and figures make them look professional.,Once you have a complete set of tables and figures, the result section falls right out of these, so you should write the results next.,The result section just gives a high level summary of each table and figure, so it's easy to write results if you've done the tables and figures.,Well, next, I suggest writing the methods.,You could actually write this at any time, because it's just a play by play of what you did, but I think it makes move sense to to write it.,3rd, then you should write the introduction section.,I think it's important to nail down the story of your manuscript in the tables, figures and results.,1st before you write the introduction, because that helps you to know how to frame the introduction.,Next, you should write the discussion section.,That's of course, the hardest to write, because it involves the most writing.,It's the most complex. But having written the rest of the manuscript at this point, it makes it easier to know what to put in the discussion.,Finally, always do your abstract. Last abstract means to pull out, you are pulling out bits and pieces of the other sections, ,so it's much easier to write after you've already done the other sections.,So this is the order I recommend writing manuscripts in, and I'm going to go over the sections in this order in my lectures for this week.,If you want to do some further reading, I've given you two references on the page, and I'm going to be citing these two sources throughout the modules this week.,1st, there's a great series in clinical chemistry.,It goes through all the parts of the scientific manuscript.,And it's you don't need to be a chemist to benefit from these that really, these articles apply to any scientific discipline.,It's very well done in easy to read series.,If you want a longer, more comprehensive reference, I recommend Mimi zeiger's textbook, the Essentials of Writing Biomedical Research Papers. That's a comprehensive textbook with lots of practice exercises.,It's especially useful for those in biomedison.,In the 1st module for this unit, we're going to talk about tables and figures.,In a lot of ways, the tables and figures are the most important part of the manuscript.,One big mistake that scientists make if they do the tables and figures kind of haphazardly.,They just kind of throw the data into the tables without much thought.,You need to think through those tables and figures,very carefully, because they form the foundation of your story.,Editors, reviewers and readers may look at the tables and figures.,1st When I get a paper to review, I skim the abstract just to get a sense of what the papers about, and then I jump right to the tables and figures.,I want to look at the data for myself before I read the authors take on their data.,This means that the tables and figures have to be able to stand alone.,They have to be self contained.,The reader should not need to refer back to the text to make sense of them.,Acronyms have to be defined. Experimental details need to be defined also.,Each figure in table has to tell a clear story, and they should progress in that story from one to the next.,Each table and figure should make a clear point, and as you're creating the tables and figures, ,you should know what that point is, and you should try to stick to that point as much as possible.,Some people would go so far as to say that the tables and figures are the crooks of the manuscript, and the writing around him is just window dressing.,I picked out a quote here that's specifically about computational science, but just substitute the word data for the word software.,Here he says, an article about computational science in a scientific publication isn't the scholarship itself.,It's merely advertising of the scholarship.,The actual scholarship is the complete software development environment and the complete set of instructions which generated the figure.,In the same vein you could say that the data in your tables and figures is the scholarship is the story, and the writing around the tables and figures is just advertising for them. A couple of tips on tables and figures.,1st of all, you want to use the fewest figures and tables needed to tell the story.,Just as in writing prose, you want to be concise and to the point.,Plus, scientific journals may have limits on the numbers of tables and figures that you're allowed to submit.,2nd, don't repeat the same data in both a tablet and a figure.,Choose to present that data as one or the other.,One of these, the decisions are going to have to make is which data belong in a table and which data belong in a figure.,What's the difference? Figures should have a visual impact.,So if you have data that lends itself to a nice, visually appealing graphic, think about putting it in a figure.,Figures are used to show trends and patterns.,Figures also tell a quick story, so if there's a single, big point that you want to get across to your readers, that's another thing to put in a figure.,I like figures because they can give more information about the data.,So if you want to show all of your data points rather than just giving summary statistics, E.G., or if you want to show the distribution or range of the data, a figure works well for that.,People also use figures to highlight the most important result of their paper, because, again, figures are visually appealing and they can grab the reader's attention.,So if there's a specific result you want to emphasize, consider putting that in a figure.,Tables are used to give precise values in a figure, you don't usually convey the precise value down to the decimal place.,So if you think those precise values are important, you need to put them in a table.,And of course, if you have many values with many variables that you need to display, a table is better for displaying a lot of information.,Now, let's talk about the format of tables.,Every table has a title, which should identify the specific topic or point of the table.,Remember, every table tells a story, and the title should give a quick synopsis of that story.,Be sure to repeat the same keywork key terms in the table title, the column headings of the table and in the main text of the paper. Be consistent so that you don't confuse your reader.,Remember, it's OK to repeat key words.,You want to repeat them so that your reader doesn't get confused.,You also want to keep the table title concise.,An example title would be descriptive characteristics of the two treatment groups, and then means plus or minus standard deviation, or in percent.,This tells the reader the point of the table to describe the two groups, and lets them know what statistics to expect.,Tables also have footnotes. In different journals have different rules for what symbols to use for footnotes.,Some journals might use stars, whereas others might use letters.,ABC don't try to guess. When you are starting to build your tables and figures, identify the journal that you plan to submit the paper to, ,and then pick up a published article from that journal and copy the footnote symbols used in the example.,Each journal has its own set of guidelines, ,and the best way to figure out those guidelines is either to read the author's instructions that the journal puts out, ,or even easier, just pull a paper from that journal and copy the format in their published papers.,If you're using footnotes to indicate statistically significant differences, ,make sure to be clear about exactly what comparisons were made, which groups were compared, and what statistical test was used.,Also use the footnotes to explain experimental details or acronyms.,Again, the table has to stand on its own, so any acronyms or definitions or measurement content conventions have to be defined within the table.,The reader should not have to go back to the text to look those up.,In formatting tables, there are a ton of little decision points you have to make, like, do I capitalize the variable names on the table?,Do I flush them left or center?,Do I use a talics? Where do I put the footnotes?,What are the footnotes? Symbols? Don't guess.,Don't try to reinvent the wheel and make all this up from scratch.,Just go pull a publish paper from the journal you are targeting and copy what you see there. Every journal has its own set of style guidelines.,You might as well make your tables look like other published papers in the journal.,Your targeting reviewers and editors are impressed when they see professional looking tables in that journals style.,Another thing to keep in mind is that the convention for most journals is that tables contain just three horizontal lines, ,one above the column headings, one below the column headings and one below the data.,A lot of people are unaware of this, so they put in many more lines than this, and it ends up looking unprofessional.,Here's an example table with some made up data.,When my daughter was two, uh, the Wizard of Oz was her favorite movie.,And, uh, there's a line in that movie where the good witch asks Dorothy, are you a bad witch or a good witch?,So they have bad witches and good witches in OZ.,So I made up some pretend data on bad witches and good witches.,In my hypothetical study, I have 13 bad witches and twelve good witches.,I've measured their descriptive characteristics and put it into a descriptive table, which is your typical table one for a medical study.,This is what a typical table looks like.,Notice the three horizontal lines. One um above the column headings, one below the column headings, and one below the data before the footnotes.,That's how most journals form at their tables.,Notice that this table has a simple, clear point to compare the two groups of which, and we can quickly glean what's different about the two groups.,Bad witches are older, less healthy and somewhat less employed.,Some journals will also gray out every other row to help readers distinguish one row from the next.,Notice there are still just those three horizontal lines, but the shading helps guide the reader's eyes.,This also looks very professional. Now, I'm going to show you some things that you should avoid doing in your tables.,OK? 1st of all, I mentioned earlier the importance of getting grid lines correct.,You should have just those three horizontal lines. Here's a table in which they have included all of the grid lines.,And it might seem like a minor point, but the problem is that the table looks unprofessional.,This is not how tables appear in journals.,I make a big point of this with my students at Stanford,, because I've reviewed many, many papers over the years, ,and at some point I noticed that papers with tables like this with all the grid lines tend to have lots of problems elsewhere in the paper.,Maybe using all the grid lines like this is more common among new authors who don't have much paper writing experience.,Or maybe it's just a mark of general sloppiness.,But I notice this correlation between the presence of the grid lines and problems elsewhere in the paper.,So when I flip the tables to the tables and I see all those grid lines, there's a red flag that goes off in my head.,I automatically expect that the paper is going to have other problems.,I suspect that other reviewers and editors have formed the same association in their heads, either consciously or unconsciously.,And I've actually had several students come back to me after taking my course and say that they started noting,, noticing this association between the presence of all the gridlines and poor quality papers.,So you don't want to make this mistake, because it's a red flag for reviewers and editors.,It might seem like a trivial thing, but it signals to reviewers and editors that your paper is sloppy and unprofessional.,Always take the time to get those grid lines right.,Figure out in your word processing program how to get rid of the extra grid lines make your tables look professional.,Another thing that doesn't look professional is if your columns and data are misaligned.,You can see here that items and the columns are not lined up nicely.,They don't usually look as bad as this.,I've exaggerated for effect here, but you'll often see numbers that aren't perfectly lined up, especially when decimal places are involved.,I also have some words here, beginning with capitals and others beginning with lower case. I mixed it up. This inconsistency also looks unprofessional.,This kind of sloppiness makes a big negative impression on reviewers and editors.,So take the time to make your tables look professional.,Another problem I see with a lot of tables is people love to go out to a ridiculous number of significant figures.,I think that's because if you put something like age into your statistical analysis program,, your computer will spit out values like the average age or the average BMI to several decimal places,, and then people just cut and paste the value into their tables without thinking about it.,But we don't need to know BMI to the 3rd decimal place, and it just cutters the table.,Plus, we may not have measured BMI this precisely.,You should only go out as to as many decimal places as you can claim as significant figures.,So if you only measured BMI to one decimal place, your summary statistics for BMI should not have more than one decimal place.,I generally recommend going out to know more than one decimal place for clinical variables like age, BMI and exercise.,So watch that number of significant figures.,Also, always give units for the variables in your table.,A lot of my students forget to include units when listing variables like this.,I think it's easy to forget the units when, again, you're just cutting and pasting output from your statistical analysis program, but the units are often ambiguous.,E.g., what does exercise mean? Here?,Is that 30 min a day? Is that 30 min a week?,Is that 60 min a year? Is that 60 h a year?,There's no way to tell without having the units.,Even age may seem obvious. You may assume that 45 and 30 sixes referring to years here, but we don't know for sure.,It could be months if we are talking about toddlers.,So units are essential. Another mistake people make on tables is to include too many columns.,I had a nice, crisp table to begin with.,It was easy to see that the goal of the table was to compare bad witches and good witches.,It was easy to gleam that bad witches seemed to be older and less healthy than good witches. Adding extra columns just attracts from this nice, simple message.,Here we have an overall column.,That overall column is extra information that doesn't have to do with the comparison.,And if a reader really wanted to know the overall value for some reason, they could calculate it from the other data in the table, so it just adds clutter.,Similarly, statistical significance can be neatly indicated using subscripts and footnotes, as I did in the original table.,The point of the p values here is just a flag statistically significant differences, which can be done with a star in a footnote.,There may be instances when it's important to show the exact key values for all the different variables, but I don't think that's the case here here.,Readers just need to be able to quickly glean which variables differ significantly.,Extra columns make the table hard to read and detract from the main focus and take home message of the table.,So get rid of them. All right.,Now, moving on to figures. There are three types of figures that we're going to talk about.,1st, there's what we call primary evidence.,That would be things like gels, photographs, x rays, micrographs, pathology slides.,They're in there to show the quality of the data, and also because there's a seeing is believing element to these.,If readers can see the lines on the gel for themselves, they're more confident in the results.,Primary evidence is usually pretty straightforward to create, because it's just pictures or movies.,2nd, there's graphs. These are graphical ways of displaying your data, things like line graphs, bar graphs and scatter plots.,I'll talk more about these in a minute.,Finally, there are drawings and diagrams.,I don't think, uh, people use these enough.,Actually. Drawings and diagrams are a bit underused in the scientific literature.,They have really nice uses you can do.,Use them to do things like illustrate an experimental setup or a workflow, or to indicate the flow of participants in your study, or to illustrate cause and effect relationships or cycles. Drawings and diagrams can convey key information to the reader that might be quite tedious and convoluted when written in prose um.,And sometimes it's nice you can give a hypothetical model, or it's nice to represent things that you can't see, like microscopic particles or or microorganisms.,Sometimes it's helpful to represent those as,cartoons. That can be nice for the re the reader, to have a visual of something that they couldn't otherwise see.,So I'm going to go through each of these types of figures.,Now, in turn, of course, all your figures will have a legend.,You need the legend so that the figure can stand alone.,It should have a brief, informative title that conveys the main point of the figure.,It should contain essential experimental details so that the reader doesn't have to go back and read the main text.,You'll also have a legend to define symbols, lines or patterns, or to explain what's in different panels.,If you have, like an A-B-C-D and E panel.,Or if you want to get you're gonna need also to give statistical details, such as what tests were used and what the P values, where did those P values come from?,What the P values were. Here's an example of a figure legend.,This is from a study that found that tomato and a rabbitopsis plants kind of eat microbes such as equal eye bacteria.,I'm not going to read through the legend, but you can see that it has an informative title in sufficient experimental detail details that the figure can stand on its own.,This is the figure that goes with the legend I just showed you.,You'll notice there's a lot of different panels in this figure.,They also have some letters and arrows in the panels.,You'll notice all the little white arrows, and there are some letters like E-M and R, all of this has to be explained in the legend.,This was the paper where they were showing that plants actually eat microbes like e coli.,So that's a cool paper with some very cool images.,Those green parts are the e coli being taken up by the plant roots.,The plants are actually eating the microbes. So this is primary evidence. It's showing you.,Hey, here it is. Here is the equal eye in the plant roots.,Seeing is believing. Here's another example of primary evidence a gel.,You need to see those bands in the gel to believe the results.,So that's primary evidence. Next, I'm going to jump to graphs.,I could teach a whole course on graphs.,You really need a whole course on data visualization to do justice to this topic.,And it's such an important topic that I'd actually recommend that you do take a course in data visualization in the future.,But I'm going to give you the five minute version just to let you know the kinds of graphs that are out there.,Among the most common types of graphs are line graphs, scatter pots, bar graphs, individual value bar graphs, histograms, box pots and survival curves.,I'm going to go through each of these.,So line graphs show trends over time, or something trends over something that's increasing or decreasing, like age or dose.,Typically, we um just graph the mean values for each group at each time point, but if the study is very small,, you could even show the trend lines for individual people or individual animals.,Just to give you an example, here is a line graph that compares two groups, a treatment group, which is in green, in a control group, which is in red.,They are tracking what happens to the number of positive cells as you increase the dose of DPI.,This graph tells a quick story.,Increasing dpi, that your X variable access, your XX is variable, doesn't seem to affect the control group much.,The red lines pretty flat, but you can see it causes the treatment group to dip and then rebound.,Um. So it tells a quick visual story.,The one thing that's a bit confusing in this graph is I don't like the stars on top.,These probably have to do with statistical significance, but it's not immediately obvious what they mean.,OK, bar graphs. Bargraphs are used to compare groups at one time point or one dose.,Everybody loves bargraphs because they are easy to understand. They tell a quick visual story, and your reader doesn't have to do too much work to understand a bargraph.,So here are some examples. This was from that study looking at tomato plants eating e coli.,They have two controls and a treatment.,And the treatment group clearly takes up more equally, they incorporate more of the microbes.,Now, that's easy to gleam from the graph.,There are a few things I'm going to point out on this graph that I would improve.,Uh, E.G. it's not immediately clear to me what the A-B and C mean.,If possible, it's best to not make the reader have to go to the legend to figure that out.,Make it something more obvious. It's not also not terribly, um, beautiful visually, because they've left the bars with white spaces um.,Usually shading those bars makes it look a little bit,nicer. So here's another example. This one's a little bit more visually appealing.,Notice they've shaded the bars in grey.,This,graph also appears to be at higher resolution.,It's sharper and crispr than the graph I just showed you.,I also love the fact that they've put the ends the sample sizes on each bar to indicate how many are in each group.,Normally people leave this information off, but it's so important for the reader to have that information at their fingertips that I love to see it put on the graph like this.,So this is a nice bar graph that has a clear take on point the outcome, average degree is increasing over increasing concentration.,Next scatter plots. Scatter plots are used to show relationships between two variables, usually to continuous or to numeric variables.,I love scatterpots because they show all the data.,Most graphs and tables just show summary statistics, but you don't get to see all the individual data points.,The scatter plot is great because it shows everything about the data.,It shows all the individual data points.,So it gives you more information.,It really gives the reader a sense of what's going on in the data.,Instead of just giving one perspective on the data.,In a way, it shows all the dirty laundry. So I like, uh, scatterplus, because you can see those individual data points.,Let me give you some examples.,This scattered plot is from a study that was looking at high grade and low grade brain tumors.,The high grade tumors are in red, the low grade tumors are in blue.,And the graph shows the correlation between expression levels of a particular gene, that's on the X axis, and levels of the biomarker CD that's on the Y axis.,You can see that you're getting a lot more information from a pot like this.,The high grade tumors in red have a higher level of both the gene expression and the CD four four biomarker than the low grade tumors.,You can see the red is more in the upper right hand corner than the blue is.,But what you can see here that you wouldn't be able to gleam from summary statistics, is that there's a lot of variation in that red group.,Some of the people in the red or the tumors in the red group have very high levels of both, but we also have tumors that have low levels of both.,So there's high variation here. You'll also notice that the relationship between the gene expression and the biomarker, it's not a straight line relationship.,It's a bit curved, um. So you can see that the shape here is not exactly a total linear relationship.,So I love scattered plots because they give you so much information.,Again, you're kind of airing your dirty laundry, but that allows the reader to get a really good feel for what's going on in your data.,One caution on scatter plots, though, if you are going to superimpose either straight lines or curved lines, like they have here, just be aware that these lines can fool the eye.,In the plot I'm showing here, there is a clear straight line relationship between x and y, so it's perfectly appropriate to superimpose a straight line, a regression line, on that plot.,But be careful, because sometimes lines can fool the eye.,So I'm going to show you that now.,So here's a scatterpot that I made.,I just made up some data, an X variable and A-Y variable, and then I superimposed a line on that. If you just glance at this quickly, it looks like there's a nice inverse relationship between x and y, right?,It's actually an illusion, though, x and y are completely unrelated, ,but I superimposed a line slanting down degrees, and it draws your eye in such a way that it makes you see a inverse relationship between x and y.,It makes it appear that there is to have a an inverse relationship.,And just to show you that this is really just a visual trick, I also superimposed a 90 degree line in the positive direction.,And notice that this is the exact same scatter plot, but when I put the um the line in the other direction, all of a sudden, ,your eye starts to think that there is a positive correlation between x and y.,But of course, both of these are just your eye being fooled, because if I take the lines off of this graph, you can see that there is actually no relationship whatsoever between x and y.,So it's easy to to fool your eye.,Be careful when you're super imposing lines, because it can make relationships look stronger than they really are, and this can be misleading.,Few tips for graphs. Again, graphs are supposed to tell a quick visual story, so you want to keep it simple.,You want to make it easy on your reader.,Instead of representing different groups with arbitrary symbols, such as filled in circles or unfiled circles or squares or triangles,,try to be a bit more clever than this, e.g.,if you have a treatment group in a control group, label the graph with teas for treatment and seas for control.,This is much easier on the reader, because they don't have to keep referring back to the legend.,Also use different colors for different groups.,When I learned to make graphics, we used to have to use dash lines or in solid lines to distinguish groups, because you had to assume that your paper was going to be read in black and white.,People would copy papers out of journals, and the copies would always be black and white.,Well, now we're in an era when you can use color.,Most everyone is reading papers on an electronic device, so you can go ahead and use colors to distinguish different groups. That's much easier on the reader.,Keep in mind that if your figure turns out too complex, maybe you should consider putting that data in a table instead.,So let me give you some examples.,Here's an example. The line graphs on the left side of the slide are quite nice.,I like those line graphs. You can see that there are four groups, and the proportion of cooperation that you're why variable is going down over time in all the groups except one.,That group in red seems to be different than the other three groups in terms of the trajectory.,So that line graph tells a nice story.,But then the authors also added a bargraph to the figure on the right hand side, and this is summarizing the same data that are in the line graph.,What they did is they averaged sessions five through ten so that they could show that the red group was, on average, in those five sessions, statistically higher than the other three groups.,The stars are supposed to be indicating statistically significant differences here, but it's very confusing those stars is not clear where that what comparisons they're referring to.,Plus, seeing the data points from the individual sessions is much more informative than just seeing an average of an arbitrary number of sessions.,So I don't think you gain anything by adding the bargraph to this figure.,It just serves to clutter the graph and confuse the reader.,The authors could have just added a star somewhere on the line graph to indicate that the red group differed from the other three, ,based on a statistical test that compares the trajectories over time.,Um One other tip here. Noticed that the line graph uses squares, triangles, diamonds and circles to differentiate the different groups.,It's a little hard on the reader, because the reader has to keep looking back to the legend to figure out which group is which.,Maybe the authors could have labeled the groups, uh, the group names on the graph somewhere, or used more informative plotting symbols.,Here's another example where the graph has too much going on. It's not telling a clear and simple story.,The bar graphs are too cluttered.,There's too much data. There are nuclear patterns, so it's not obvious what the take on point is supposed to be.,If the data are this complicated, you may be better off presenting them in a table rather than a figure.,A figure is supposed to tell a simple visual story, and I don't think this one accomplishes that.,This figures from the same paper.,Same problem, has the same problems.,Finally, I'm going to jump now into diagrams and drawings.,You have diagrams and drawings at your disposal, and these are underused, I think, in the scientific literature.,They can be very powerful, e.g.,many things don't lend themselves well to text, such as explaining the flow of participants in a study or the details of an experimental setup.,Often a picture is better for conveying this information.,Also, if you have some kind of hypothetical cause and effect model that you're trying to propose, ,diagram is great for indicating how you think those variables interact, especially if the relationships are complex.,This may all be better put in a picture than trying to explain it in some complicated text.,Also, if you are talking about something people can't see, like viruses or proteins or antibodies, a cartoon can help you read or visualize what you're talking about.,So think about in your paper, if there's places where you could use a diagram or drawing to your advantage.,I'll give you some examples. So here's a figure from a paper that was looking at drug company advertisements and journals.,This drawing sums up the typical layout of an advertisement.,So you see that at the beginning, at the top of the the advertisement page, you get the picture of the happy physician or happy patient.,And then you get at the bottom right hand corner, you always have your Caplin.,Myer survival curve. A picture is worth a thousand words here.,If you tried to describe this set up in prose, it would be uninteresting to the r to read.,It would be boring to read, and it would be much harder to convey that information. This is visual information, so might as well put it in a drawing.,I love this diagram. This was in a paper describing dog bites and cat bites in human patients.,Rather than just sticking the data into a boring table, the authors were clever enough to put,it in a picture. The key messages are instantly clear.,Most bites happen on the hands, and there's some difference in the location of cat bites versus dog bites.,That's a much more interesting and, uh, nice way to present the data than just putting it at a boring table.,Diagrams are great for drawing causal diagrams like this.,You can see how this is much simpler to present in a diagram than to try to explain all those relationships in prose.,And finally, here's a cartoon illustration of the creation of some novel antibodies.,Again, the picture is really helpful to the reader in understanding how these antibodies are built.,And the final thing I want to mention is that nowadays, you're not just limited to tables and figures.,Your papers. Can have videos. This is back to the paper on plants, eating microbes for nutrients.,Seeing is believing applies even more for movies than for still pictures.,So we can play this little video and actually see the uh microbes being taken up by the plant.

欢迎来到《科学写作》第5单元。本周，我将带你了解如何撰写科学手稿。但是，在我们进入科学手稿之前，我确实想简短地继续我们上周关于写作过程的讨论。我想再给你一个关于避免拖延和缓解写作焦虑的小贴士。首先，写作对每个人来说都很难。当我有大故事要写时，尤其是当我还没有开始的时候，我会感到恐惧和焦虑。为了缓解焦虑，我所做的一件事就是分解写作，为每天设定非常合理的目标。当我开车上班时，我可能会告诉自己，我今天的目标就是写400个字。如果我能写出400个字，我就会度过一个成功的一天。我选择了一个我知道很简单、非常合理和可行的目标，以至于看起来并不令人望而生畏。这不会让我觉得自己像爬到办公桌底下然后蜷缩在球里。这使得当天开始写作变得更加容易，通常发生的情况是，我会在几个小时内达到目标，到那时，我已经开始工作了。我之所以感觉步入正轨，是因为我已经实现了目标，而且那天我能够继续前进，完成更多工作。但是，令我感到欣慰的是，如果出于某种原因，那天写作真的很艰难，而我只能写到400个字，我仍然可以称之为成功。如果你设定的目标太高，比如强迫自己尝试在一天之内完成整篇手稿。这可能非常艰巨和不现实，甚至很难入门，而且你最终会拖延而什么也没做，所以设定一个小而可行的目标。现在来看科学手稿，我建议你按这个顺序写它们。我相信你需要先把表格和数字弄清楚。不要只拼凑一些贝壳桌或粗糙的东西，还要想出一套漂亮、抛光的桌子和人物。表格和数字包含您论文的故事。每个表格和图形都应该有一个明确的观点，它们应该共同讲述你的手稿的故事。因此，你需要做的第一件事就是弄清楚你的表格和数字将要讲述的故事。并最终确定这些表格和数字，让它们看起来很专业。一旦你有了完整的表格和图表，结果部分就会从中脱颖而出，所以接下来你应该写下结果。结果部分只是对每个表格和数字进行了高级摘要，因此，如果你把表格和数字做得很好，就可以很容易地写出结果。接下来，我建议写这些方法，你实际上可以随时写这个，因为它只是你所做的事情的逐个玩法，但我认为把它写在第三个最有意义。然后，你应该写介绍部分。我认为，在写导言之前，必须先在表格、图表和结果中确定手稿的故事，因为这可以帮助你知道如何构思导言。接下来，你应该写讨论部分，这当然是最难写的，因为它涉及的写作最多，最复杂。但是，在撰写完手稿的其余部分之后，可以更轻松地知道要在讨论中放些什么。最后，一定要把你的抽象写在最后，抽象的意思是抽象出来。你正在提取其他部分的点点滴滴，所以在完成其他部分之后写起来要容易得多。所以这是我推荐写手稿的顺序，我将在本周的讲座中按这个顺序仔细阅读各个部分。如果你想进一步阅读，我在这里的页面上给了你两个参考文献，我将在本周的整个模块中引用这两个来源。首先，《临床化学》中有一个很棒的系列文章。它涵盖了科学手稿的所有部分，你不需要成为化学家就能从中受益，实际上，这些文章适用于任何科学学科。这是一个做得很好而且很容易阅读的系列。如果你想获得更长、更全面的参考资料，我推荐咪咪·齐格的教科书《生物医学研究论文写作要点》。这是一本全面的教科书，里面有很多练习题，对生物医学领域的人特别有用。在本单元的第一个模块中，我们将讨论表格和数字。在很多方面，表格和数字是手稿中最重要的部分。科学家犯的一个大错误是他们随意绘制表格和数字。他们只是不加思索地把数据扔到表格里。你需要非常仔细地思考这些表格和数字，因为它们构成了你故事的基础。编辑、审稿人和读者可以先查看表格和数字。当我有一篇论文要评论时，我会浏览摘要只是为了了解这篇论文的内容，然后我直接跳到表格和数字上。在阅读作者对数据的看法之前，我想亲自看看这些数据。这意味着表格和数字必须能够独立，它们必须是独立的。读者不必回过头来参考文本就能理解它们。必须定义首字母缩略词，需要定义实验细节。此外，每个人物和桌子都必须讲述一个清晰的故事，他们应该在故事中从一个走向另一个故事。每个表格和图形都应该明确观点，在创建表格和图形时，你应该知道那点是什么，你应该尽可能地坚持这一点。有些人甚至会说，表格和数字是手稿的症结所在，而它们周围的文字只是橱窗装饰。我在这里挑选了一句专门关于计算科学的名言，但只需用数据一词代替这里的软件一词即可。他说，科学出版物中关于计算科学的文章不是奖学金本身，而只是奖学金的广告。实际的奖学金是完整的软件开发环境和生成该数字的完整说明集。同样，你可以说表格和数字中的数据是奖学金，是故事，而围绕表格和数字的写作只是为它们做广告。关于表格和数字的几个小贴士，首先，你想使用讲故事所需的最少的数字和表格。就像写散文一样，你要简洁明了。另外，科学期刊可能对允许你提交的表格和数字的数量有限制。其次，不要在表格和图中重复相同的数据，而是选择将这些数据作为一个或另一个呈现。你必须做出的决定之一是，哪些数据属于表格，哪些数据属于图表。有什么区别？人物应该具有视觉冲击力。因此，如果你有适合制作漂亮、视觉上吸引人的图形的数据，可以考虑把它放在一个人物中。数字用于显示趋势和模式，数字也可以讲述一个简短的故事。因此，如果你想向读者传达一个重要观点，那是另一回事。我喜欢数字，因为它们可以提供有关数据的更多信息。因此，如果您想显示所有数据点，而不仅仅是提供摘要统计信息。或者，如果你想显示数据的分布或范围，一个数字可以很好地解决这个问题。人们还使用数字来突出论文中最重要的结果，因为同样，人物具有视觉吸引力，并且可以吸引读者的注意力。因此，如果你想强调一个具体的结果，可以考虑把它放在一个数字中。表格用于给出精确的值。在图中，您通常不会将精确的值传达到小数位。因此，如果您认为这些精确的值很重要，则需要将它们放在表格中。当然，如果你有许多值和许多变量需要显示，那么表格更适合显示大量信息。现在让我们来谈谈表格的格式。每个表格都有一个标题，标题应标识表格的特定主题或要点。请记住，每张桌子都讲述了一个故事，标题应该简要介绍这个故事。请务必在表格标题、表格列标题和论文正文中重复相同的关键术语。保持一致，这样你就不会让读者感到困惑。请记住，重复你想重复的关键字是可以的，这样你的读者就不会感到困惑。您还需要保持表格标题的简洁性，示例标题将是两个治疗组的描述性特征，然后是正负标准差或N百分比。这告诉读者描述这两个群体的表格要点，并让他们知道预期会有哪些统计数据。表格也有脚注，不同的期刊对脚注使用什么符号有不同的规则。有些期刊可能使用星星，而另一些期刊可能使用字母A、B、C。不要试图猜测。当你开始制作表格和数字时，请确定你计划向哪个期刊提交论文。然后从该期刊中挑选一篇已发表的文章，并复制示例中使用的脚注符号。每本期刊都有自己的一套指导方针，弄清楚这些指导方针的最佳方法要么是阅读该期刊发布的作者说明，要么更简单的方法是从该期刊中提取一篇论文，然后将格式复制到他们发表的论文中。如果你使用脚注来表示统计学上的显著差异，请务必清楚到底进行了哪些比较、比较了哪些组以及使用了什么统计检验。也可以使用脚注来解释实验细节或首字母缩略词。再说一遍，这张桌子必须独立存在。因此，任何首字母缩略词、定义或测量惯例都必须在表格中定义。读者不必回到正文中去查看。在格式化表格时，你必须做出很多小决定要点，比如，我是否将表格中的变量名大写？我是向左冲还是向中冲洗？我用斜体吗？我该把脚注放在哪里？脚注符号是什么？别猜，不要试图重新发明轮子然后从头开始编造所有这些。只需从你定位的期刊中提取一篇已发表的论文，然后复制你在那里看到的内容即可。每本期刊都有自己的一套风格指南。你不妨让你的表格看起来像你目标期刊上其他已发表的论文。当审稿人和编辑看到期刊风格的专业表格时，他们会留下深刻的印象。要记住的另一件事是，大多数期刊的惯例是表格只包含三条水平线。一个在列标题上方，一个在列标题下方，一个在数据下方。很多人没有意识到这一点，所以他们写的台词比这多得多，结果看起来不专业。这是包含一些虚构数据的示例表。当我女儿两岁的时候，《绿野仙踪》是她最喜欢的电影。那部电影中有一句话是好女巫问多萝西，你是坏女巫还是好女巫？所以他们在绿野仙踪里有BadWitches和GoodWitches。所以我编造了一些关于BadWitches和GoodWitches的假装数据。在我的假设研究中，我有13个坏女巫和12个好女巫。我已经测量了它们的描述性特征，并将其放入描述性表中，这是医学研究的典型表一。这就是典型的桌子的样子。注意三条水平线。一个在列标题上方，一个在列标题下方，一个在脚注前面的数据下方。大多数期刊都是这样格式化表格的。请注意，此表有一个简单明了的要点，可以比较两组女巫。我们可以快速了解这两个群体的不同之处。坏女巫年龄较大，健康状况较差，就业率也较低。有些期刊还会将每隔一行变灰，以帮助读者将一行与下一行区分开来。请注意，仍然只有那三条水平线，但是阴影有助于引导读者的视线。这看起来也很专业。现在，我将向你展示一些你应该避免在桌子上做的事情。好吧，首先，我之前提到了正确调整网格线的重要性。你应该只有那三条水平线。这是一张包含所有网格线的表格。这可能看起来像是一个小问题，但问题在于这张桌子看起来不专业。这不是表格在日记账中的显示方式。我对斯坦福大学的学生非常重视这一点，因为这些年来我已经审阅了很多论文。在某个时候，我注意到带有这样的表格、所有网格线的纸张在论文的其他地方往往会有很多问题。也许使用所有的网格线在没有太多论文写作经验的新作者中更为常见，或者这只是普遍草率的标志。但我注意到网格线的存在与论文其他地方的问题之间存在这种关联。因此，当我把桌子翻到桌子上然后看到所有这些网格线时，我的脑海里会响起一面红旗。我自动预计这篇论文还会有其他问题。我怀疑其他审稿人和编辑有意识或无意识地在脑海中形成了同样的联想。实际上，我有几个学生在上完我的课程后回来找我说，他们开始注意到所有网格线的存在和劣质论文之间的这种关联。所以你不想犯这个错误，因为这对审稿人和编辑来说是一个危险信号。这可能看起来像是一件微不足道的事情，但它向审稿人和编辑发出信号，表明你的论文草率且不专业。一定要花点时间把那些网格线弄好。在你的文字处理程序中弄清楚如何去除多余的网格线。让你的桌子看起来很专业。另一件看起来不专业的事情是，如果您的列和数据未对齐。你可以在这里看到，列中的项目排列得不好。它们通常看起来不像这个那么糟糕。我夸大了这里的效果。但是你经常会看到排列不完美的数字，尤其是在涉及小数位时。我这里还有一些以大写开头的单词，还有一些以小写开头的单词，我混淆了。这种矛盾之处，看起来也不专业。这种草率行为会给审稿人和编辑留下很大的负面印象，所以花点时间让你的表格看起来很专业。我在很多桌子上看到的另一个问题是，人们喜欢看到数量惊人的重要数字。我认为那是因为如果你在统计分析程序中加入年龄之类的东西，你的计算机就会把平均年龄或平均体重指数等值吐到小数点后几位。然后人们只是在不考虑的情况下将值剪切并粘贴到表中。但是我们不需要知道体重指数到小数点后三位，这简直太混乱了。另外，我们可能没有用这个来衡量BMI。确切地说，你应该只计算出尽可能多的小数位，就像你所说的显著数字一样。因此，如果您只将BMI测量到小数点后一位，则您的BMI汇总统计数据不应超过小数点后一位。对于年龄、体重指数和运动等临床变量，我通常建议精确到小数点后一位。因此，请注意这些重要数字。此外，请务必为表中的变量指定单位。我的很多学生在列出这样的变量时都忘记了包括单位。我认为，当你只是剪切和粘贴统计分析程序的输出时，很容易忘记这些单位。但是单位往往含糊不清。例如，这里的运动是什么意思？那是一天30分钟吗？那是一周30分钟吗？那是一年60分钟吗？那是一年60个小时吗？没有单位就无法分辨出来。即使是年龄也可能显而易见。你可以假设这里的45和36指的是年份，但我们不确定。如果我们谈论的是幼儿，可能需要几个月的时间。因此，单位是必不可少的。人们在表格上犯的另一个错误是包含的列太多。一开始我有一张漂亮、清爽的桌子。不难看出，这张桌子的目标是比较坏女巫和好女巫。很容易得知，坏女巫似乎比好女巫年纪大了，健康状况不佳。添加额外的列只会减损这条漂亮的简单信息。这里有一个整体的专栏。整列是额外的信息，与比较无关。而且，如果读者出于某种原因真的想知道总体值，他们可以从表中的其他数据中计算出来。所以它只会增加混乱。同样，可以使用下标和脚注整齐地表示统计学意义，就像我在原始表格中所做的那样。这里p值的重点只是为了标记统计学上的显著差异，这可以用星号和脚注来完成。在某些情况下，显示所有不同变量的精确p值很重要。但我认为这里的情况并非如此。在这里，读者只需要能够快速收集哪些变量差异很大。额外的列会使表格难以阅读，也使表格偏离了表格的主要焦点和要传达的信息。所以把它们赶走。好吧，现在来看数字。我们要谈的是三种类型的数字。首先，我们称之为主要证据。那就是凝胶、照片、X光片、显微照片、病理幻灯片之类的东西。他们在里面是为了展示数据的质量。也是因为其中有眼见为实的元素。如果读者能亲眼看到凝胶上的线条，他们就会对结果更有信心。主要证据通常很容易创建，因为它只是照片或电影。其次，有图表。这些是显示数据的图形方式。诸如折线图、条形图和散点图之类的东西。我稍后再谈这些。最后，还有图纸和图表。实际上，我认为人们对这些的使用还不够。在科学文献中，绘图和图表有点未得到充分利用。它们有非常好的用途。你可以用它们来做一些事情，比如说明实验设置或工作流程。或者表明您的研究参与者的流向。或者用来说明因果关系或周期。绘图和图表可以向读者传达关键信息，当用散文写时，这些信息可能会非常乏味和错综复杂。有时候你可以给出一个假设的模型真是太好了。或者把你看不见的东西表现出来也很不错，比如微观颗粒或微生物。有时候，把它们描绘成动画片会很有帮助。对于读者来说，可以直观地看到原本看不到的东西，这可能很不错。因此，我现在要依次浏览每种类型的数字。当然，你所有的人物都会有一个传奇。你需要传说，这样人物才能独立存在。它应该有一个简短、内容丰富的标题，以传达图的要点。它应该包含基本的实验细节，这样读者就不必回去阅读正文了。如果你有A、B、C、D和E面板，你还将有一个图例来定义符号、线条或图案，或者解释不同面板中的内容。或者你还需要提供统计细节，例如使用了哪些检验，这些p值来自哪里，p值是什么。以下是人物图例的示例。这来自一项研究，该研究发现，番茄和拟南芥植物会吃大肠杆菌等微生物。我不会通读传说。但是你可以看到，它有一个内容丰富的标题和足够的实验细节，这个数字可以独立存在。这个数字与我刚才给你看的传说相吻合。你会注意到这个图中有很多不同的面板。它们的面板上还有一些字母和箭头。你会注意到所有的白色小箭头还有一些字母，比如E、M和R。所有这些都必须在传说中解释。在这篇论文中，他们显示植物实际上会吃微生物，比如大肠杆菌。所以这是一张很酷的论文，里面有一些非常酷的图片。这些绿色部分是植物根系吸收的大肠杆菌。这些植物实际上是在吃微生物。因此，这是主要证据。它在给你看，嘿，在这里。这是植物根系中的大肠杆菌。眼见为实。这是另一个主要证据的例子，凝胶。你需要在凝胶里看到那些条带才能相信结果。因此，这是主要证据。接下来我要跳转到图表。我可以教一整门关于图表的课程。你真的需要一门关于数据可视化的完整课程才能正确处理这个话题。这是一个非常重要的话题，我实际上建议你将来一定要上数据可视化课程。但我要给你讲五分钟的版本。只是为了让你知道那里有哪些图表。最常见的图形类型包括折线图、散点图、条形图、单值条形图、直方图、箱形图和生存曲线。我将逐一介绍。因此，折线图显示了随着时间的推移而出现的趋势或增加或减少的趋势，例如年龄或剂量。通常，我们只绘制每个组在每个时间点的平均值的图表。但是，如果研究规模很小，你甚至可以显示个人或个体动物的趋势线。举个例子，这里有一个比较两个组的折线图。绿色的治疗组和红色的对照组。他们正在追踪随着DPI剂量的增加，阳性细胞的数量会发生什么。这张图讲述了一个简短的故事。增加DPI（即你的x轴变量）似乎不会对控制组产生太大影响。红线很平坦。但是你可以看到它会导致治疗组下降然后反弹。因此，它讲述了一个简短的视觉故事。在这张图中有一点令人困惑的是，我不喜欢顶部的星星。这些可能与统计学意义有关。但目前尚不清楚它们的意思。好的，条形图。条形图用于比较一个时间点或一个剂量的组。每个人都喜欢条形图，因为它们很容易理解。它们讲述了一个简短的视觉故事，你的读者不必做太多工作就能理解条形图。因此，这里有一些例子。这来自那项研究，该研究着眼于吃大肠杆菌的番茄植物。他们有两种对照组和一种治疗方法。而且治疗组显然吸收了更多的大肠杆菌。它们含有更多的微生物。现在，这很容易从图表中得知。在这张图表上，我要指出一些需要改进的地方。例如，我不清楚a、b和c是什么意思。如果可能的话，最好不要让读者不得不去传说中去弄清楚这一点，让它变得更加明显。它在视觉上也不是很漂亮，因为它们在条形上留下了空白。通常，给这些条形加上阴影会让它更漂亮一点。所以这里再举一个例子，这个在视觉上有点吸引力。请注意，他们用灰色遮住了条形。该图表的分辨率似乎也更高。它比我刚才给你看的图表更清晰、更清晰。我也喜欢这样一个事实，那就是他们在每个条形上标出了末尾，即样本量，以表明每组中有多少样本。通常，人们会忽略这些信息。但是对于读者来说，让这些信息触手可及非常重要，我很乐意看到它像这样出现在图表上。因此，这是一个不错的条形图，有明确的观点。结果，平均程度会随着浓度的增加而增加。接下来是散点图。散点图用于显示两个变量之间的关系，通常是与连续变量或数字变量之间的关系。我喜欢散点图，因为它们显示了所有数据。大多数图表和表格只显示汇总统计数据。但是你无法看到所有的单个数据点。散点图很棒，因为它显示了有关数据的所有内容。它显示了所有单独的数据点，因此可以为您提供更多信息。它确实让读者了解了数据中正在发生的事情，而不仅仅是从一个角度看待数据。从某种意义上说，它显示了所有的脏衣服。所以我喜欢散点图，因为你可以看到那些单独的数据点。让我举几个例子。该散点图来自一项针对高等级和低度脑肿瘤的研究。高级别肿瘤为红色，低级肿瘤为蓝色。该图显示了x轴上特定基因的表达水平与y轴上的生物标志物CD44的表达水平之间的相关性。你可以看到，你从这样的情节中获得了更多的信息。红色的高级肿瘤的基因表达水平和CD44生物标志物均高于低等级肿瘤。你可以看到右上角的红色多于蓝色。但是你在这里可以看到，你无法从汇总统计数据中收集到，那就是那个红色组里有很多差异。一些红色或红色组的肿瘤中两者的水平都非常高，但我们的肿瘤两者的水平也都很低。因此，这里差异很大。你还会注意到，基因表达和生物标志物之间的关系，它不是直线关系，而是有点弯曲。因此，你可以看到这里的形状并不完全是完全的线性关系。所以我喜欢散点图，因为它们能为你提供很多信息。再说一遍，你有点像在放脏衣服，但这可以让读者对你的数据中发生的事情有很好的感觉。不过，在散点图上要注意一点。如果你要像这里那样叠加直线或曲线，请注意这些线可能会让人眼花缭乱。在我在这里展示的情节中，x和y之间存在明显的直线关系。因此，在该图上叠加一条直线，一条回归线是完全合适的。但是要小心，因为有时候线条会让人眼花缭乱。所以我现在要给你看。所以这是我制作的散点图。我刚刚编了一些数据，一个x变量和一个y变量。然后，我在上面叠加了一句话。如果你快速看一眼，看起来x和y之间有很好的反向关系，对吧？不过，这实际上是一种幻觉。X和y完全无关。但我叠加了一条向下倾斜90度的线。它吸引你的眼球，让你看到x和y之间的反向关系。它使这两者看起来存在反向关系。为了向你展示这实际上只是一个视觉技巧，我还向正方向叠加了一条90度线。请注意，这是完全相同的散点图。但是当我把线放在另一个方向时，突然间，你的眼睛开始认为x和y之间存在正相关性。但是，当然，这两个只是你的眼睛被愚弄了。因为如果我从这张图中删除线条，你可以看到x和y之间实际上没有任何关系。所以很容易做到。[咳嗽]欺骗你的眼睛。叠加线条时要小心，因为它会使人际关系看起来比实际情况更牢固，这可能会产生误导。图表的一些技巧，再说一遍，图表本应讲述一个简短的视觉故事。因此，你想让它变得简单，你想让读者更轻松。与其用任意符号（例如填充的圆圈、未填充的圆圈、正方形或三角形）来表示不同的组，不如尝试比这更聪明一点。例如，如果您有一个治疗组和一个对照组，则在图表上标记t表示治疗，用c表示对照。这对读者来说要容易得多，因为他们不必继续提及传说。另外，对不同的群组使用不同的颜色。当我学会制作图形时，我们过去必须使用虚线和实线来区分群组。因为你必须假设你的论文将以黑白相间的方式阅读。人们会从期刊中复印论文，而副本将永远是黑白相间的。好吧，现在我们正处在一个你可以使用色彩的时代。大多数人都在电子设备上阅读论文，因此你可以继续使用颜色来区分不同的群体。这对读者来说要容易得多。请记住，如果你的计算结果过于复杂，也许你应该考虑将这些数据放在表格中。所以，让我举几个例子。举个例子，幻灯片左侧的折线图非常漂亮。我喜欢那些折线图。你可以看到有四个组，除一个组外，所有组的合作比例，即你的y变量，都会随着时间的推移而下降。就轨迹而言，该组是红色的，似乎与其他三个组不同。所以那张折线图讲述了一个不错的故事。但是随后，作者还在右边的图中添加了一个条形图。这汇总了折线图中的相同数据。他们所做的就是平均每节课五到十次。这样他们就可以表明，从统计学上讲，在这五个会话中，红色组的平均水平高于其他三个组。这里的恒星应该表示统计学上的显著差异。但这非常令人困惑。那些明星，目前尚不清楚他们指的是什么比较。另外，查看各个会话中的数据点可以提供更多信息。不仅仅是查看任意数量的会话的平均值，而且内容丰富。因此，我认为将条形图添加到这个数字中不会带来任何好处。它只会使图表变得混乱，让读者感到困惑。根据比较一段时间内轨迹的统计检验，作者本可以在折线图的某处添加一颗星来表明红色组与其他三个组不同。这里还有一个小贴士，请注意折线图使用正方形、三角形、菱形和圆圈来区分不同的组。这对读者来说有点难，因为读者必须继续回顾传说才能弄清楚哪个群体是哪个群体。也许作者本可以在图表上的某个地方标记群体、组名，或者使用信息更丰富的绘图符号。这是另一个示例，其中图表上有太多内容。它讲的不是一个清晰而简单的故事。条形图太杂乱了，数据太多了。没有明确的模式，因此目前尚不清楚带回家点应该是什么。如果数据如此复杂，你最好用表格而不是数字来呈现。一个人物应该讲述一个简单的视觉故事，但我认为这个人物无法做到这一点。这个数字来自同一篇论文，有同样的问题。最后，我现在要跳到图表和绘图中。您可以随心所欲地使用图表和图纸。我认为，在科学文献中，这些都没有得到充分利用。它们可能非常强大。例如，很多东西不适合发短信。例如解释研究参与者的流程或实验设置的细节。通常，一张图片更适合传达这些信息。另外，如果你想提出某种假设的因果模型。图表非常适合说明您认为这些变量是如何相互作用的，尤其是在关系复杂的情况下。将这一切放在图片中可能比尝试用一些复杂的文字来解释要好。另外，如果你说的是人们看不到的东西，比如病毒、蛋白质或抗生素，那么动画片可以帮助你的读者直观地想象你在说什么。因此，在论文中想一想，是否有地方可以使用图表或绘图来发挥自己的优势。我给你举几个例子。因此，这是一篇研究制药公司广告和期刊的报纸中的一个数字。这幅画总结了广告的典型布局。所以你会看到，在广告页面的开头，你会看到快乐的医生或快乐的病人的照片。然后你到达右下角，你总是有Kaplan-Meier的生存曲线。这里有一张照片值1,000个字，如果你想用散文来描述这个设置，读起来就没意思了。读起来会很无聊，传达这些信息也要困难得多。这是视觉信息，所以不妨把它放在绘图中。我喜欢这张图。这是在一篇描述人类患者被狗咬伤和猫咬伤的论文中。作者们不只是把数据放在一张无聊的表格里，而是足够聪明，可以把它放在一张照片里。关键信息一目了然。大多数咬伤都发生在手上，猫咬伤和狗咬伤的位置有一些区别。与仅仅将数据放在无聊的表格中，这是一种更有趣、更不错的呈现方式。图表非常适合绘制这样的因果图。你可以看出，在图表中呈现这比尝试解释所有这些关系散文要简单得多。最后，这是一幅卡通插图，讲述了一些新型抗体的产生。再说一遍，这张照片对读者了解这些抗体是如何产生的，确实很有帮助。我想提的最后一件事是，如今，你不仅限于表格和数字。你的报纸上可以有视频，这又回到了关于植物吃微生物作为营养素的报纸？眼见为实，电影比静态照片更适用。因此，我们可以播放这个小视频，实际看到微生物被植物吸收。