



## Maths on your bioscience course

Maths plays an important role in the biosciences, from calculating the concentrations of solutions to validating the results of your research using a variety of statistical tests. Some people love maths, others don't! This guide aims to give you an overview of the benefits and uses of maths on your bioscience course and is full of hints and tips from bioscience students on how to approach and get the most out of the maths on your bioscience course.

“Forget your pipettes, pH meters and Bunsen burners - MATHEMATICS is one of the most important tools in science... and the sooner you get to grips with it the sooner you can make the most of your science!”  
*Caroline Beckett, University of Leeds*

“I found practicals to be the best moments to learn, because you are doing the experiments so you can directly process your results and see how good they are.”  
*Daimona Koudé, Cardiff University*

“Come to your interdisciplinary work in the right frame of mind - open to learning, rather than suspicious of change.”  
*Sophie Kershaw, University of Oxford*

“Maths consolidates what I'm learning in my course. I think that this is key to ensuring that theory that is learnt passively in lectures or through extra reading is embedded into my mind.”  
*Rachel Bell, University of Leicester*

“Unfortunately, instead of taking the time to understand how these equations work, most of us will choose to copy others or ask a demonstrator to do it for us.”  
*Kimberly Stirk, University of Exeter*

“What may not be fully apparent before you go to university is that maths is the lynchpin of the biosciences.”  
*Hannah Grist, University of Aberdeen*

“Working with my colleagues in discussing, thinking about and applying the knowledge of what we had learned in class to using appropriate statistical tests greatly helped me...”  
*Declan McLaughlin, Queen's University Belfast*

“Being methodical is essential; include all the steps needed and the answer will arise. However, rush or complicate steps and confusion quickly arises.”  
*Bethany Griffin, University of Leeds.*



## Maths... but I'm a biologist!

Just because you're doing a biology degree doesn't mean you won't have to use skills and knowledge you've developed in other disciplines or courses and maths is no exception. Maths is an essential part of the biosciences, from using statistical analysis to quantify results, to calculating the concentration of a solution or plotting the growth rate of bacteria.

Understanding the maths and statistics used in research will also give you skills you need to interpret other people's work. So, for example, when you're reading a scientific paper can you make sense of all the tables and diagrams? Can you understand why they have used the statistical test they have? Are their results really significant?

If you do find maths a struggle, you won't be the only one. While some students may have done A-level maths and statistics, some won't have been near an equation for years.

## To borrow an expression, there are lies, damn lies and statistics

Statistics plays a big part in the biosciences, validating research and experimental results. But they can be confusing – which test do you use? How do you carry it out? How do you interpret the results?

If you are designing an experiment think about how you will want to evaluate and analyse the results. If there is a specific test you need to undertake this may help you plan and design how you collect your data. You also need to think about how big a sample size, or how many replicates of a treatment, you need to make your experiment worth doing.

Don't just randomly apply statistical tests to your data until one gives you a significant result. Look at the data you have and think about how they need to be analysed. For example, are you comparing two sets of a measurement collected under different conditions? If so you might use a paired sample t-test. Are you comparing several groups of data? Then you might want to use ANOVA (analysis of variance). Some useful statistics websites are listed on the back page of this guide.

Learn how to use the analysis packages you have available, such as Minitab, and SPSS. You need to know how to use them to get useful and accurate results. Understanding how the test you are using 'works' will help you to interpret the results. And will mean you're not just blindly plugging numbers into a spreadsheet.

Once you've done any tests, think about what your results actually mean. A significant difference is all well and good, but if you can't relate it back to the biology then what was the point in calculating it in the first place?

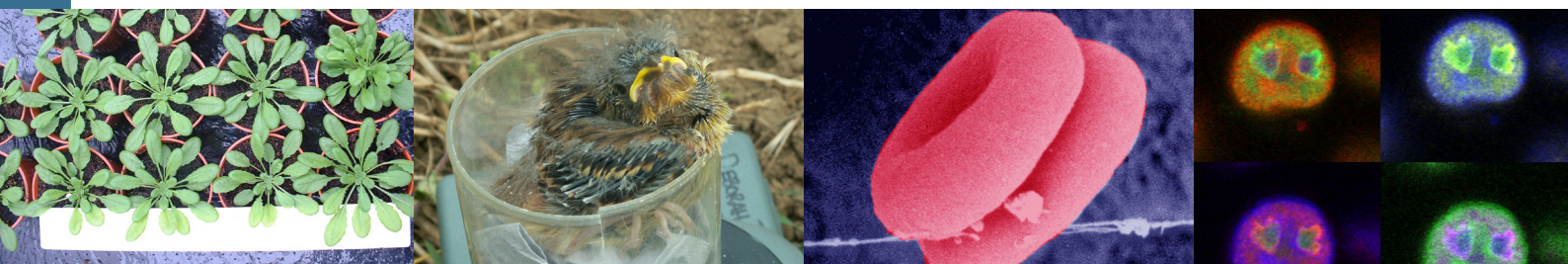
## But it's not all about statistics

It won't just be statistics that form an important part of the maths you use.

- Graphs and charts – histograms, pie charts and scatter diagrams (for example) are an ideal way to display data clearly and concisely and give a visual impression of data that is much easier to take in than a table of numbers. You might also have to plot things such as population growth or enzyme activity.
- Concentrations, weights and measures – being able to calculate the molarity of a solution and being sure that the solution you make up is of the correct concentration is vital if your experiments are to work. See the "practical session" resources on the back page of this guide for websites with guidance on calculating concentrations and dilutions.
- Units and unit conversion – do you know the difference between a  $\mu\text{l}$  and a  $\text{ml}$ ? Could you convert  $\text{g/L}$  to  $\text{mM}$  and vice versa?
- Depending on which area of the biosciences your course is in you might have to: use geometry to look at the shape and structure of proteins, calculate enzyme kinetics or drug metabolism rates, model predator-prey cycles, look at immigration and emigration in populations, calculate photosynthetic rates, osmotic potentials or nerve action potentials.

## Maths and practicals

Practicals are an ideal way of learning about and practicing maths. You can apply the maths you might have learnt in a lecture or tutorial to real data and you get to interpret and analyse the data you generate.



Most of the maths you need to do in practical sessions is fairly straightforward. And once you have worked out the hows and whys of a calculation, test or equation you can use it time and time again.

You may need to be able to calculate molarities and concentrations, set up a dilution series or calibrate a standard curve. When you're collecting experimental data you also need to think about the basics: Why am I measuring this? How do I measure it accurately? Am I collecting all the data I need?

Your practical write-ups also give you more opportunities to practice your maths skills, for example undertaking statistical analysis of your data and drawing charts or graphs.

### Where can I go for maths advice?

Don't struggle away on your own with calculations or a statistical test or equation you really can't get your head round, seek help. You might try:

- Your friends – going through a few problems in a small group might help you straighten things out. You could even form a study group.
- Demonstrators in practical sessions – could give you a different slant on how you can calculate the dilution or concentration of the reagent or solution you need for your experiment.
- Your tutor or lecturers – might be able to go over a particular calculation or equation with you. Or perhaps you could cover some of the maths concepts that everyone in your tutor group is struggling with during a tutorial
- Maths and statistics books and guides – see what your library has to offer. You might find maths and statistics for biologist guides that give you examples of things specific to your course. Or you might want an A-level maths textbook to give you a bit more grounding in the basics.
- Online maths guides - have a search on the web for online study guides and interactive materials to support you. A few are listed at the end of this guide.
- Skills courses at your university or college – you might find you can do a course on maths basics, or more advanced maths or statistics,

which could help build your confidence.

- Doing those additional optional questions – just to give yourself some extra practice and boost your confidence.

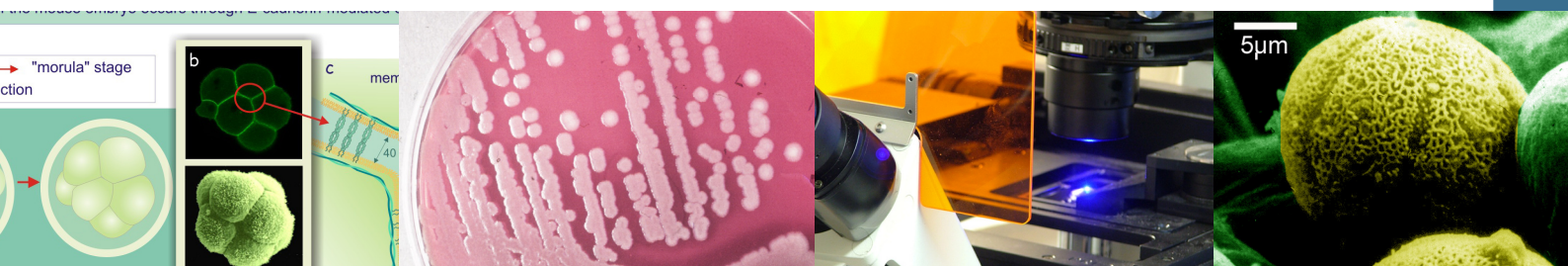
Give it a go and don't leave asking for help until the last minute.

### I'm stuck!

- Don't panic! Often what you need to do is to break down your calculation, test, or analysis into a series of short and simple steps and work through the exercise step-by-step.
- Seek help, but give it a go yourself first.
- You may find it helpful to break down a big data set into smaller more manageable chunks. You could use data management programmes, such as Microsoft Excel, to help you organise and manipulate your data.
- Show your working! This can help you to see how a calculation or equation works and where you might have gone wrong.
- Find a logical sequence that helps YOU to understand how an equation or calculation works. The steps that someone else takes might not make sense to you.
- Just being given the answer won't help you in the future when you need to do something similar. You need to understand what you're doing and why.

### Maths skills...

- Can help you develop your critical analysis skills. For example if you're reading a scientific paper and you understand the test used you can confidently decide if the conclusions drawn are valid. You will also be able to see clearly why, for example, a trial with 500 participants might be more robust than one with 50.
- Are often wanted by potential employers. Employers want numerate graduates and the skills you develop in manipulating and presenting data could stand you in very good stead.
- Are very useful when dealing with science in the media. They can help you understand the "headline figures" and understand how the outcomes of studies could be misrepresented.



## Resources



The advice and tips in this Short Guide are based on entries to the 2011 UK Centre for Bioscience Award which asked students to tell us about “**The pluses and minuses of maths on my bioscience course**”. The

winning, runner-up and shortlisted entries are all available to view and download from our website at [www.bioscience.heacademy.ac.uk/funding/essay/award11.aspx](http://www.bioscience.heacademy.ac.uk/funding/essay/award11.aspx)

### Online maths resources

The **SUMS project** has information on a variety of topics from accuracy and precision to plotting and interpreting graphs and charts. [www.stepup-to-science.com/sumsv3/](http://www.stepup-to-science.com/sumsv3/)

**OpenLearn** (from the Open University) has online modules on a range of maths topics. <http://openlearn.open.ac.uk/course/category.php?id=8>

A number of universities produce **online study guides** with sections on maths, for example

- University of Hull - [www2.hull.ac.uk/student/studyadvice/mathematicsresources.aspx](http://www2.hull.ac.uk/student/studyadvice/mathematicsresources.aspx)
- University of Leeds - [http://skills.library.leeds.ac.uk/topic\\_improving\\_your\\_maths.php](http://skills.library.leeds.ac.uk/topic_improving_your_maths.php)
- Cardiff University - [www.cardiff.ac.uk/mathssupport/learningresources/mathsforbiosi/](http://www.cardiff.ac.uk/mathssupport/learningresources/mathsforbiosi/)
- University of Leicester - [www2.le.ac.uk/offices/ssds/sd/ld/resources/numeracy](http://www2.le.ac.uk/offices/ssds/sd/ld/resources/numeracy)

**MathCentre** have quick-reference leaflets, teach-yourself booklets, revision exercises and online exercises on a range of maths skills. [www.mathcentre.ac.uk/](http://www.mathcentre.ac.uk/)

**Numeracy, Maths and Statistics** resources from LearnHigher. <http://learnhigher.ac.uk/Students/Numeracy-maths-and-statistics.html>

**Essential Mathematics and Statistics for Science** is a website to accompany a book of the same name. The site has study guides and interactive multiple choice questions. [www.blackwellpublishing.com/currellmaths2/](http://www.blackwellpublishing.com/currellmaths2/)

From the Reusable Learning Objects CETL, a collection of interactive online tutorials on **Essential maths for Medics, Vets and Biologists**. [www.rlo-cetl.ac.uk/whatwedo/rlos/completedrlos.php#essen](http://www.rlo-cetl.ac.uk/whatwedo/rlos/completedrlos.php#essen)

## Statistics and data analysis

**Statistics Hell**, information sheets, podcasts and worked examples on a wide range of statistical tests. Be aware the theme and examples used won't be to everyone's taste... [www.statisticshell.com/](http://www.statisticshell.com/)

**Engage in Research** step-by-step guidance on undertaking a research project, including statistical analysis. [www.engageinresearch.ac.uk/](http://www.engageinresearch.ac.uk/)

**Analyse This!!!** An online tutorial that aims to help you develop your quantitative and qualitative data analysis skills. [www.learnhigher.ac.uk/analysethis/](http://www.learnhigher.ac.uk/analysethis/)

### For practical sessions

**Amount and Concentration: Making and Diluting Solutions** (from the University of Cambridge) covers making solutions and dilutions. <http://tinyurl.com/5djzn7>

**Numeracy Tutorial** from the University of Liverpool covers: units and unit abbreviations; concentrations; moles; molarity; and dilutions. [www.liv.ac.uk/~agmclen/Medpracs/numeracy/Tutorial.html](http://www.liv.ac.uk/~agmclen/Medpracs/numeracy/Tutorial.html)

### Resources from the UK Centre for Bioscience

This Student Short Guide is one of a series from the Centre, other Guides include:

- Feedback - Make it work for you!
- Making the most out of practical work
- Assessment

All the Short Guides can be downloaded from: [www.bioscience.heacademy.ac.uk/resources/studentguides.aspx](http://www.bioscience.heacademy.ac.uk/resources/studentguides.aspx)

Our **student pages** have a wide range of resources for bioscience students. [www.bioscience.heacademy.ac.uk/network/students/](http://www.bioscience.heacademy.ac.uk/network/students/)

Need to illustrate your posters, lab reports or presentations? **ImageBank** brings together thousands of copyright-cleared bioscience images. [www.bioscience.heacademy.ac.uk/imagebank](http://www.bioscience.heacademy.ac.uk/imagebank)

All the images in this Short Guide are available in ImageBank.



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