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Contents

Preface to the second edition ix
Preface to the first edition x
Acknowledgements xi

1 Starting out 1

1.1 The transition to university life 2
1.2 How degrees are awarded 3
  1.2.1 Modules 4
  1.2.2 Semesters 4
  1.2.3 Credits 4
  1.2.4 Degree classification 5
  1.2.5 University standards 5

2 Your degree – preparation for a career 7

2.1 Skills for success 7
  2.1.1 Planning your study and leisure time 8
  2.1.2 How much work should I do? 10
  2.1.3 Effective private study is an essential part of your course because ... 10
  2.1.4 Golden rule 1 – plan your time 10
  2.1.5 Golden rule 2 – use the time effectively 11
  2.1.6 And finally... the responsibility for learning rests on you 11

2.2 Help! 11
  2.2.1 Where else can you ask for help? 12

2.3 Personal Development Portfolios 13
  2.3.1 Why should you keep a PDP? 13
  2.3.2 How to keep a PDP 14

3 How to learn in a university setting 17

3.1 The learning process: “deep” and “surface” learning 17
3.2 Individual study – how do students learn? 18
  3.2.1 Where to study? 18
  3.2.2 When to study? 18
  3.2.3 For how long should you study? 18
  3.2.4 Should you study by topic or by time? 19

3.3 Effective reading 20
3.4 When the good times go bad 21
4 Making the most of teaching

4.1 Blended learning and virtual learning environments

4.2 Learning from lectures
   4.2.1 How do you get the most out of lectures?
   4.2.2 Before the lecture
   4.2.3 Active listening

4.3 Learning from tutorials

4.4 Learning from laboratory practical classes

4.5 Field trips

4.6 Teamwork
   4.6.1 Large teams

4.7 Books
   4.7.1 Buying books

4.8 Using libraries
   4.8.1 Making the most of the library facilities
   4.8.2 Journal papers and how to understand them
   4.8.3 How scientific papers are published
   4.8.4 How should you read a scientific paper?

4.9 Using the internet as a source of information
   4.9.1 Finding reliable internet resources

5 Presenting your work

5.1 Plagiarism

5.2 Good writing and writing style
   5.2.1 Third person, passive voice and the past tense
   5.2.2 Sentences
   5.2.3 Clarity
   5.2.4 Accepted usage and jargon
   5.2.5 Over-use of adjectives
   5.2.6 Legibility and quality of presentation
   5.2.7 Waffle and irrelevant material
   5.2.8 Check your writing style
   5.2.9 Some common errors of English usage
   5.2.10 Some general points of style and punctuation in electronic documents

5.3 Illustrations and tables of data

5.4 Referencing your work
   5.4.1 What information is included in a reference?
   5.4.2 Styles of referencing
   5.4.3 A (fictitious) reference list
   5.4.4 Compiling a reference list
   5.4.5 Citing references in your text
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.5 How to write a good essay</td>
<td>60</td>
</tr>
<tr>
<td>5.5.1 General considerations</td>
<td>60</td>
</tr>
<tr>
<td>5.5.2 What is found in a good essay</td>
<td>62</td>
</tr>
<tr>
<td>5.5.3 Assessing essays</td>
<td>62</td>
</tr>
<tr>
<td>5.5.4 Planning your essay</td>
<td>64</td>
</tr>
<tr>
<td>5.6 How to write a practical report</td>
<td>68</td>
</tr>
<tr>
<td>5.6.1 The title page</td>
<td>69</td>
</tr>
<tr>
<td>5.6.2 The introduction</td>
<td>69</td>
</tr>
<tr>
<td>5.6.3 The methods section</td>
<td>69</td>
</tr>
<tr>
<td>5.6.4 The results section</td>
<td>69</td>
</tr>
<tr>
<td>5.6.5 The discussion section</td>
<td>75</td>
</tr>
<tr>
<td>5.7 Posters</td>
<td>76</td>
</tr>
<tr>
<td>5.8 Oral presentations</td>
<td>77</td>
</tr>
<tr>
<td>5.8.1 Planning</td>
<td>77</td>
</tr>
<tr>
<td>5.8.2 Resources for delivery</td>
<td>77</td>
</tr>
<tr>
<td>5.8.3 Tips on using <em>Microsoft PowerPoint</em></td>
<td>78</td>
</tr>
<tr>
<td>5.8.4 Content and organization</td>
<td>78</td>
</tr>
<tr>
<td>5.8.5 Practice</td>
<td>79</td>
</tr>
<tr>
<td>5.8.6 Your final presentation</td>
<td>79</td>
</tr>
<tr>
<td>5.8.7 Dealing with questions</td>
<td>80</td>
</tr>
<tr>
<td>5.8.8 Improving your presentation technique</td>
<td>81</td>
</tr>
<tr>
<td>5.9 Summative and formative assessment</td>
<td>81</td>
</tr>
<tr>
<td>6 Using computers and information technology</td>
<td>83</td>
</tr>
<tr>
<td>6.1 Interactive online learning</td>
<td>84</td>
</tr>
<tr>
<td>6.2 Being organized – file storage and management</td>
<td>84</td>
</tr>
<tr>
<td>6.3 Keep file sizes small</td>
<td>85</td>
</tr>
<tr>
<td>6.4 Back-ups and passwords</td>
<td>85</td>
</tr>
<tr>
<td>6.5 Email and etiquette</td>
<td>86</td>
</tr>
<tr>
<td>6.5.1 Sending emails</td>
<td>87</td>
</tr>
<tr>
<td>6.5.2 Etiquette</td>
<td>88</td>
</tr>
<tr>
<td>6.5.3 Replying to messages</td>
<td>89</td>
</tr>
<tr>
<td>6.5.4 Organizing your emails</td>
<td>89</td>
</tr>
<tr>
<td>6.6 University printing facilities</td>
<td>89</td>
</tr>
<tr>
<td>6.7 “What to buy or not to buy; that is the question…”</td>
<td>90</td>
</tr>
<tr>
<td>7 Revision and examinations</td>
<td>91</td>
</tr>
<tr>
<td>7.1 Effective revision</td>
<td>91</td>
</tr>
<tr>
<td>7.1.1 Plan a realistic revision schedule</td>
<td>91</td>
</tr>
<tr>
<td>7.1.2 Revise little and often</td>
<td>92</td>
</tr>
<tr>
<td>7.1.3 Plan your method of revision</td>
<td>92</td>
</tr>
</tbody>
</table>
Chapter 4  Making the most of teaching

4.1 Blended learning and virtual learning environments

Imagine that your timetables show that you are about to have a lecture on “mycobacterial infections”. A few years ago, the only way to get a real grip on this topic would be to wade through textbooks, some of which may not even have any relevant pictures. Today you will be able to log into a virtual learning environment (VLE) or portal, where the lecture course will be backed up with a variety of other resources.

As well as a full set of notes, your tutor may have provided links to a range of additional, complementary resources. These could lead you to a very diverse range of related topics, with one link taking you to Dirk Bouts’ painting of Christ in the House of Simon the Leper (circa 1445) to illustrate how lepers have been and, maybe, still are regarded as outcasts by most people. The next link may be to a Shakespeare folio for Hamlet; his father’s ghost said this of his murder:

‘... Upon my secure hour thy uncle stole
   With juice of cursed hebona in a vial,
   And in the porches of my ears did pour
   the leperous distilment...’

Other links may take you to the World Health Organization’s data on global trends in the incidence of leprosy, scrofula, the Science Museum’s etching showing King Charles II dispensing the “King's Cure” and then on to Regency dandies with high collars, intended to hide their scrofulous necks.

A different direction could focus initially on Henry Purcell, whose early death is thought by many to be due to tuberculosis. Further links via Purcell’s music for the funeral of Queen Mary, may lead you to a video clip from Stanley Kubrick’s “A Clockwork Orange”, with its adaptation of Purcell’s music played on a synthesizer. An alternative explanation for Purcell’s untimely death, that he was poisoned after eating a bad batch of chocolate, may trigger a link to another lecture in the current module devoted to food poisoning. Further links from TB-related deaths could lead you to: the last act of Verdi’s “La Traviata” in which the heroine, Violetta Valerie, dies of the illness, and also to information on George Orwell, who may have contracted the illness when living as a down and out and subsequently on to an e-book of his semi-autobiographical novel “Down and Out in Paris and London”. Finally, you may
be offered a link to the Public Health England website showing the inexorable rise in cases of tuberculosis in recent years.

Learning about mycobacterial infections in the past could have been an isolated experience. These days, it opens up the opportunity for interested students to explore fine art, theatre, fashion, baroque and contemporary music, opera and literature, as well as providing easy access to primary research data. Learning has become a rich experience full of an astonishing array of opportunities to explore the wider world that lies beyond the ivory towers of Academe.

If you are lucky, in addition to lecture notes and links to internet resources, you may get access to an illustrated set of notes, with images taken from the resources listed above. You may also have access, after the lecture, to a podcast to download so that you can listen again to the lecture; this is a particularly useful feature when planning your revision. Increasingly, lectures are being videoed and the videos are becoming available.

Periodically during your modules, you will be tested on what you have learned. Often, particularly during the early part of your course, tests will be in a multiple response format. You may be offered access to online question banks, similar to those used in the real tests, but which can be used as many times as you wish. After providing you with your score, the best question banks will also give access to explanations so that you can learn from your mistakes.

Numerous resources may also be provided to help you with your practical classes. In addition to electronic copies of the experimental protocols, there may be videos illustrating what you should be doing in your lab classes, animations illustrating concepts that are otherwise difficult to understand and links to software that will help you analyse and interpret your observations. Data generated by your classmates may be shared electronically. For experiments that are too complex or too dangerous for students to perform in person, simulations are available. In teaching infectious diseases, there are programs where clinical scenarios are presented. Make the right decisions and your patient survives: if you get it wrong, you could be summoned to a virtual inquest.

Virtual learning environments have more features. As well as sharing data, there are discussion areas, where students can post ideas and engage with discussion threads. Alternatively, collaborative work may be facilitated by “wikis” (named after the Hawaiian word “wikiwiki” meaning “very quickly”). These have the advantage that the editing history can be easily seen and the relative contributions of various group members may be assessed.

In contrast to journals, VLEs have tools for staff that permit monitoring of how, and when, resources are used and by whom. The scores of interactive tests available via the VLE are also stored, making the end-of-module assessment of student performance a relatively easy matter.

The resources described above are frequently referred to as contributing to blended learning, where face-to-face teaching is augmented by an array of online resources.
These undoubtedly enrich the student experience but they will probably never replace entirely teaching in lectures, tutorials and practical classes. The rest of this chapter is devoted to an exploration of traditional teaching methods and their associated resources.

4.2 Learning from lectures

The one-hour lecture still dominates the teaching of many courses; especially those taught to large numbers of students. If you think a lecture is the process whereby a lecturer's notes are transferred to a student notebook without the need for mental effort on anybody's part, think again. If you approach lectures in the proper manner, you will find that you will learn a great deal from them. The benefits that you can derive from lectures include:

• providing an overview or summary of an area of interest
• highlighting and discussing difficult areas
• covering and linking subject matter that is not well covered in standard textbooks
• introducing relevant research topics, which may include recent discoveries and other advances in your subject

4.2.1 How do you get the most out of lectures?

Lectures may be given in stuffy lecture theatres, possibly in semi-darkness. This, together with the time that they occupy, can lead to them making you feel very drowsy. Large lecture classes in particular limit the opportunities for discussion, making the flow of information seem to be only one-way, from lecturer to student. However, these will not be major drawbacks if you follow the advice below and learn how to listen. Listening in lectures should be an active process.

4.2.2 Before the lecture

To prepare for each lecture, you should:

• read about the general area of the lecture topic beforehand
• spend a few minutes before the lecture trying to recall what you already know about the subject – this will help greatly with a deep learning approach to your studies
• TURN YOUR MOBILE PHONE OFF BEFORE YOU ENTER A LECTURE THEATRE
• try not to arrive late. You will almost certainly miss a very important part of the lecture – its outline. Lecturers often spend the first few minutes of a lecture introducing the subject, and placing it in the context of other lectures. In any case, being late, unless for a good reason, is impolite
• sit near to the front of the lecture theatre if possible – you should be able to see and hear more easily
• do not chat, even in a whisper, during lectures. It is very rude, and it is highly distracting for others. Some lecturers may ask you to leave if you continue to talk during their lectures. More embarrassingly, they may want to join in your conversation...
• if you can, sit with a group of students with whom you feel at ease. If your lecturer breaks up the lecture into small group discussions, then this will be much more productive, and fun, if you get along with your neighbours

4.2.3 Active listening

Many lecturers use a standard format for their lectures; they will have a beginning (the outline of the lecture), a middle (the body of the lecture) and an end (a summary of the points that have been covered). Recognizing this form will enable you to organize your thoughts and structure your lecture notes.

A good lecture always starts with a **preamble**, such as … “*Hello, my name is Dr Frank N Stein*”, and this preamble is followed in a good lecture by the **orientation**. This is where the lecturer tells you what will be covered in the lecture, and, possibly, how this material relates to other subjects given in the lecture course. Your notes can then reflect this structure as below:

Lecture on SUBJECT

  Orientation

  This lecture will consider the following key points:

  Topic A, Topic B, Topic C

  Topic A …

  Description …

  Extension 1 to Topic A

  First example (+ aside)

  Second example (+ aside)

  Topic B …

  Description …

And so on …until …

The summary

Taking notes in a lecture is a very personal matter, but the following basic guidelines might help you structure the material more clearly.

**Key points** are the major topics around which the lecture is structured (Topics A, B and C). You should note key points carefully, along with their **extensions**. These are the secondary areas covered in the lecture.

**Examples** provide useful illustrations related to particular points in a lecture, and **asides** are less important points. These provide light relief in a lecture, and may be humorous in nature.

**Summaries** are used to bring together different sections of the lecture. These may often begin with a phrase like… “*what this goes to show is…*”, or something like it.

Most lecturers provide opportunities for **questions** either during the lecture, or on an individual basis at the end. Don't be afraid to ask about things that you do not
4.2 Learning from lectures

understand. Lecturers are there to help you to learn. Many students do not feel confident enough to ask a question in front of others during the lecture so, if you feel this way, you are not alone! However, if you are confused by part(s) of the lecture or want to know more, do go and meet the lecturer at the end and ask your questions then. Lecturers are usually very enthusiastic about their subject and welcome such student queries.

If you find that you have particular difficulties understanding an individual lecturer, because of the way the material is presented, it is a good idea to discuss these problems, if not with the lecturer concerned then with your personal tutor. Good lecturers will want to act on constructive criticism where there are positive suggestions about how to clarify the lecture material or improve the lecturing style. Do remember, however, that lecturers are human too and don’t like negative criticism any more than you do, which is why constructive comments are far more likely to bring about the changes that you want.

**Tips that can help you with active listening**

Some lecturers provide a full set of notes, made available before their lectures; others may only provide brief outlines. Even if you do get given full notes, it is important that you listen actively to what is being said because it is extremely unlikely that a good lecturer will simply read out the notes verbatim. Annotate the notes during the lecture, taking down the “nice to know” material that may help you to remember the subject matter more easily and highlight key points. If you have access only to outlines, the following advice will help you to make the most of any lecture.

**Be selective:** you will not be able to take down everything in a lecture, unless you are very proficient at shorthand. If you are not selective in your note-taking, then you will miss important points, and may well end up misunderstanding the material being taught.

**Take legible notes:** it is more than likely that you will not have time to make “fair” copies of all of your notes, however much you promise yourself that you will. So, try to make legible notes from the outset. Don’t forget to file any handouts with the relevant lecture notes after the lecture.

**Reinforce your note taking:** educational research has shown that when you leave a lecture theatre you will remember less than half of the content of the lecture. One week later, you will remember only half of this half. A few minutes spent in the evening of the lecture going over your notes can help to prevent the secondary loss, and this will save you much trouble later. Get into the habit of reading through your notes. To reinforce your reading, write an outline of the lecture, sketching out the main points, sub-headings and principal examples from the lecture. After you have done this, you should review your notes again, and amend your revision notes. List the points that you do not understand. If you find that textbooks do not help to clarify the problem, then ask your friends, or your personal tutor or the person who gave the lecture.
Link the material in each lecture: it is rare that lectures stand entirely alone. More often they occur within a module or course with common themes. It will greatly assist your deep learning if you search for and describe the links between various individual lectures, and then go on to develop links across the whole of a module or course.

Tips for making the most of your notes

Highlight essential points as you take notes, for example by underlining words or using CAPITALS or **asterisks**. If you carry a range of coloured pens, you may also wish to change the colour of your text in your notes. When you re-read your notes you can use coloured highlight pens, but don’t overdo it since you can very easily overwhelm your text with fluorescent colours.

Compare notes with your friends. Everybody will bring a slightly different perspective to a lecture, and so it is likely that you will gain insights into the material that may have been important to your friends but that you considered of lesser importance. By sharing notes, you will expand your experience of the lecture material. You will also reinforce your learning through discussion with others, and this will be of great benefit when you want to revise.

If you make use of the advice above, you should enjoy your lectures, and you will be able to make the most of them.

Checklist for getting the most out of your lectures

- Arrive promptly or you might miss important introductory points.
- Do not try to write down everything the lecturer says.
- Listen to what the lecturer is saying and try to follow the thread.
- Make short notes to supplement the information in your handouts, when available.
- Note down any references to resources so you can look them up later.
- Do not chat your to neighbour – you will miss information and disturb others, including the person giving the lecture.
- As soon as possible after the lecture, look over your notes to remind yourself of the contents and look up any extra information you feel you need.
- Before the next lecture, make sure you have understood the information in the previous one. If you don’t, you will find it more difficult to grasp new information.

4.3 Learning from tutorials

Tutorials offer a very special opportunity for learning, since they involve small groups of students working together. In this section, tutorials refer to groups of up to about ten students talking through a topic with a tutor. Typically, tutorial sessions last for about an hour.
Providing that the participants prepare properly for a tutorial, they can be amongst the most stimulating of learning sessions. At their best, tutorials promote discussion, clarify difficult topics and permit study of a subject at a greater depth than is possible in a lecture. They give you the opportunity to express your views and give your knowledge an airing. You can also practise your listening skills when others are making their contribution. Furthermore, they provide social occasions when you can get to know fellow students and your tutor better.

Successful tutorials require the three Ps – Planning, Preparation and Participation. You, the student, must take an equal share with your tutor in being responsible for the three Ps.

Planning involves finding out what is to be discussed well in advance of the tutorial session. You should discuss this both with your tutor and with fellow students. Tutorials are generally flexible and, with advanced planning, they can be adapted to reflect your needs and interests. Without planning, preparation becomes impossible.

Preparation for a given tutorial will vary depending on the work to be covered in that tutorial. It may require reading up on your lecture notes, or using textbooks and the internet to investigate a topic. You may need to interpret data that have been given to you before the session. Alternatively, it may require you to consider your own views on a given subject, and be ready to discuss them. It may just involve deciding the questions on which you particularly want to seek clarification.

Participation, by all of the students in the group, is the third pre-requisite for a successful tutorial. You must be prepared to make a personal input into tutorials otherwise sessions will either become a mini lecture or will develop into a dialogue between the tutor and the most vociferous member of the tutorial group.

Speaking up in a tutorial may seem difficult at first, but tutors do appreciate this problem, and you will have the support of your fellow tutees. After all, they are in the same boat, too. Never think that your opinions are worth less than those of anybody else. The best discussions build up in small steps, not as a series of brilliant flashes of inspiration. It is also a good idea to address your remarks to the whole group, rather than just to the tutor. In this way, everybody in the tutorial will become involved.

Remember

All participants share responsibility for the successful running of a tutorial. You, as a member of the tutorial group, must be prepared to play your part in making tutorials exciting and effective learning processes.

4.4 Learning from laboratory practical classes

Most science subjects are rooted in practical work, and much of our scientific knowledge has been built upon the deductions that scientists have made after analysis of experimental data. Therefore one of the primary objectives of practical classes
is to develop a critical awareness of experimental method. Practicals have much more to offer, however. They teach: good laboratory practice, the necessity of paying attention to detail, and an awareness of using technical equipment appropriately. For example, microbiology students learn to handle microbial cultures safely using aseptic technique which, initially, is much more about protecting the cultures from their handlers than it is about protecting students from their cultures! Practicals are also used to demonstrate theories that you will have heard about in lectures. They may provide you with opportunities to exercise your problem-solving skills.

In many practical classes you will be working with a laboratory partner, and in some classes, you may need to form part of a team to tackle problems that are more complex. Acquisition of practical and team-working skills will benefit you enormously in your future career. Above all, safely run practicals are fun.

For each practical class you will almost certainly be given a handout or a workbook that describes the practical work that you will be undertaking and you should make it a golden rule that you read and understand the introductory material that is provided BEFORE you arrive for a particular class.

Highlight or underline any important points and make a note of anything you don’t understand so that you can ask before you start the experiment. If you make this a habit, you will appreciate why things are done in a particular way and what is going on during the actual class. When recording measurements for representation as a chart, prepare a table and graph paper beforehand so you can easily and neatly note down your data as they are collected, and quickly plot them on a graph. This will enable you to identify anomalous points so that you can repeat them within the practical time allocation. **Note:** it is very good practice to keep a notebook specifically for laboratory work and to enter your data directly into it. For some types of class, books need to be retained in the laboratory. For example, when working with live cultures, it is necessary to minimize the risk of disseminating microorganisms. Maintaining a lab book helps you to learn the importance of recording your observations at the time they are made, and is excellent practice for when you are conducting independent investigations. By preparing for the practical in this manner, you will greatly add to your understanding and enjoyment of the practical session.

It may seem odd that we are advocating the use of old-fashioned lab books; why don’t we suggest using your tablet device or smartphone? Undoubtedly these (or similar devices) will become the data collectors of the future but until they become cheap enough to be kept permanently in the lab, their universal use is probably a little way off.

The most challenging part of an experiment is obtaining a useful set of results. There are several steps to increase the likelihood that your experiment will be successful and these are outlined below.
4.5 Field trips

Field trips allow you to make observations and to collect data in a manner that usually cannot be done in a laboratory. Because they are scientific investigations, all the information in the previous section is relevant; the laboratory notebook is, however, usually called the field notebook.

Results collected on a field trip will be influenced by a variety of external factors that you cannot control and are therefore likely to be more complex than those collected from laboratory-based practical experiments. Dealing with these uncertainties will give you more of an understanding of the issues that can affect scientific investigations. The effects of a host of external factors might require you to think about a topic in a wider context, encouraging you to make connections between different areas of a subject. You will then gain a broader overview of the topic.

On a field trip you are likely to be working as part of a team with each group member making different observations. This means that you can assemble a much more comprehensive set of results than each person collecting results individually. Moreover, when teams work well together, the whole experience can be great fun.

Actively collecting data outdoors can be a much more memorable experience than collecting data in your usual practical laboratory so you are likely to remember more of what you actually did and the reasons why. Often, however, the most memorable parts of a field trip are the events that have nothing to do with your investigation, such as your best mate falling into a stream and getting soaked through, and these remain with you the longest!

Field trips are, by their very nature, organized outside the safe confines of a university building, and so all participants must be aware of potential hazards, how to avoid their dangers, and know what to do if things go wrong. So, in order to make a field trip a success, you should make sure that you are properly equipped with the recommended kit, follow any instructions you are given and ALWAYS do as your field trip supervisor(s) instructs. When assembling your kit remember to include:

• appropriate clothing, including long-sleeved shirts and long trousers which offer protection against the sun, stinging and prickly plants and biting and stinging

---

Checklist for recording data

• Set any equipment appropriately and then make sure you use it correctly throughout the experiment.
• Take accurate and careful readings.
• When taking timed readings – take readings at the exact time required.
• Pre-prepare a results table, preferably in a dedicated laboratory notebook, so that the data can be jotted straight into it. When appropriate, plot results on a graph as you go along – so that you can spot any anomalies and repeat measurements if necessary.
animals. Remember, also, that several thinner layers are better than one or two thick ones.

- appropriate footwear; flip flops and high heels are unsuitable for walking far – Wellington boots are not designed for many country terrains
- relevant equipment, including pens and pencils, paper, field notebook, etc.
- communication equipment, although mobile phones may not work in remote places
- medication for any allergies that you may have
- sunscreen/insect repellent
- backpack and full water bottle

Do not be tempted to take prized possessions that could easily become damaged, such as an expensive camera or your favourite pair of trousers; their ruin could spoil your impression of the trip.

Other items such as specialized scientific equipment, first aid kits, compasses and survival gear should be provided by your university department or the field station.

Finally, remember that while you are on your trip you must take only the samples necessary for your work; you should cause minimal disruption that could harm any animals or plants and you must not leave any litter that could damage the environment. As the old saying goes: “Leave only footprints: take only memories”.

**Checklist for a successful field trip**

- Be aware of potential hazards and how to react in an emergency.
- Take appropriate items of clothing, equipment and medication.
- Comply with any departmental instructions.
- Follow instructions from your trip leader.
- Do not take prized or expensive personal items.
- Respect the environment you visit.

### 4.6 Teamwork

Much of this guide is about independent learning, but there are times when you will need to work as part of a team. At its simplest, teamwork involves learning to work effectively with a lab partner, as many practical exercises require that you work in pairs to complete the tasks on time. To be effective, both of you should understand the aim of the experiment and be prepared to contribute equally to the outcome of the practical. It is not unusual to see pairs of students conducting experiments in the lab, where one of the pair is relatively passive and doing very little, while the other is carrying out all the thinking required, as well as performing the bulk of the practical work. Although the passive member of the team appears superficially to benefit from this arrangement, the most benefit is derived by the active partner, who has learnt the skills of preparation, organization, time management, use
of equipment, and so on. Maximum benefit will, of course, be obtained by both students if both play an active role in preparing for, and participating in, the practical session. The added bonus of following this advice is that you are also likely to find that your practical sessions will tend to go more smoothly and will be completed sooner.

4.6.1 Large teams

As well as working in pairs in practical classes, teamwork may also involve larger team exercises. Working as a group, you will typically achieve more than the sum of the individual efforts and so will be able to tackle bigger topics. By drawing on the different strengths of group members, individuals within the team can learn from one another.

All this sounds great but successful groups don’t just happen. There are active steps that you can take to ensure the success of any group of which you are a part. Understanding the dynamics of the group is fundamental to this process and there is no magic formula that will work in every situation. This is because each group will comprise individuals each with different skills and personal strengths and weaknesses.

In every group, individual members will have individual responsibilities. Each person will have:

• specific tasks to accomplish on their own which need to be brought back to the group
• a contribution to make to the work done by other members of the group; most often, this is done by constructive criticism of the efforts of other team members
• a responsibility to ensure that the team works effectively together

And, within the team, there are three interrelated areas of activity:

• task-related activities, directed to achieving the objective set for the group
• group-related activities, directed to ensuring that the group works together effectively
• individual tasks for group members

Effective groups allow individuals the freedom to achieve their own objectives, thus allowing the group to achieve the overall objective. In the most effective teams, all members are aware of their individual responsibilities, the responsibilities of other members, and the responsibility they owe to the group. Any individual may take on more than one role.

To be effective, every group needs:

• a team leader, or at least someone to co-ordinate the activities of the group. This person is responsible for allocation of tasks and for ensuring that good communications are maintained with all team members. If the final product of the team exercise is written communication, the team leader might, for example, take on the role of editor to ensure a uniformity of written style is imposed.
• good communication with all team members. Every member of the team should be present at team meetings, so these need to be arranged for times when everyone can be present and at a venue that is accessible to all members of the group. Any job inevitably takes longer than envisaged at the outset and deadlines have a nasty habit of creeping up rapidly. So, to avoid unpleasant shocks, don’t leave everything to the last minute.

• shared responsibility between all team members for all of the output from the team effort. Just because you are not primarily responsible for a task, this does not mean that you should not help to improve it if it has not been done well, and don’t just blame the individual whose primary responsibility it was. Ultimately, who is going to look bad for inferior work produced by your team?

• allocation of tasks according to the specialist talents of its various members, although it is important to be flexible in the roles that you take on when engaged in teamwork

• good group dynamics, where team members are supportive towards the others on the team, are unselfish, and do not form cliques within the group

Consider the following example: a team has three members who make an average effort and is led by a member who is outstandingly productive. Despite this, however, there is one member of the group who never answers emails, does not turn up for group meetings and has not produced a single piece of work. Clearly it would be unfair for that individual to benefit from the hard work of the others. It is particularly hard on the group leader who is otherwise dynamic and effective.

Sadly, instances like this do occur. Where appropriate assessment is in place, group members would be given the opportunity to penalize team members who do not contribute fully to the work.

### Checklist for effective teamwork

- Good communication – this underpins every successful team.
- Understanding group dynamics – this will help you to make the most of any teamwork in which you engage.
- Recognition and utilization of the different strengths of individual members of the team.
- Team members who fully engage with the task and take their responsibilities seriously.

### 4.7 Books

#### 4.7.1 Buying books

If your personal study is to be effective, you will require a number of textbooks. School courses tend to work from defined set books but for most university courses you will have greater freedom of choice. Which books should you buy, should you then pick an e-book or a paper copy and from where should you buy them?
Choosing a book

You will probably be recommended to consider buying a variety of books. One of the first steps that you can take to help you make the decision on what to buy is to talk to last year’s students about different texts. Was the coverage insufficient, or was it over-the-top? Was it up-to-date? Was the course designed with that book in mind, or another book, or none at all? Talk to the people who teach on your course, and check that the book you propose to buy is suitable. It is also important to check that you will not be required to work from a particular set text if you decide that you do not want to buy it.

You should also visit the library and spend a little time looking at the array of books that they have on related subjects. Scan through them to get a “feel” for the book. You need not attempt to understand the whole content of these books at first. Do you find the text style readable? Are the illustrations clear? Is the text properly sub-divided into sections with appropriate sub-headings, or are you faced with a monotonous sea of print? Does each section have an introduction and a summary of the material it contains? Dip into random paragraphs to see if they are too long. What do you feel about sentence length? It can be very difficult to read long, complex sentences that contain several ideas, but when people are writing texts they may get so caught up in their ideas, which are, of course, so fascinating to them that they forget the poor reader! See what I mean? Ask yourself: “...would I enjoy working from this book?”

When it comes to the question of ‘real' books made from paper or e-books, the choice is largely one of personal preference. If you opt for an e-book, you will be constrained to using a particular reader, although this will store all of your textbooks in a single location. You will also not be able to sell your book on once you have finished with it. Physical books take up a lot of space and can be very heavy when you move. However, you can easily lend your copy to your mates.

Actually purchasing your books

You can either buy new or second-hand books. Many university towns and cities are fortunate in having a number of bookshops, but there is little point in shopping around as the price of books hardly varies between them. Alternatively, it is sometimes possible to purchase books from internet sites at discounted prices. At this point, however, a word of caution is necessary. Some bookshops stock expensive hardback books when cheaper paperback versions are available. The difference in price between a paperback and a hardback book can be significant and so you may end up paying quite a lot extra for a couple of bits of board! It is also a good idea to check that a new edition of the book that you want is not just about to be published.

Students in higher years frequently sell textbooks that they used earlier in their studies, often through advertisements placed on notice boards. Buying books in this way can save considerably on the cost of a brand new textbook. Before buying, however, remember to use the guidelines above to judge whether the text would really suit your purposes. Ask yourself why the book is being sold. You should expect second-hand textbooks to show signs of wear and tear, but if it is sold “as
new”, was it really useful for the course for which it was recommended? Don’t buy a second-hand book solely on the recommendation of the seller.

**Before you buy**
Check the edition of the book being sold. Some subjects like molecular biology advance at an alarming rate, and at higher levels, a three-year-old text may be hopelessly out of date. By contrast, anatomy books, for example, would not be expected to change at the same rate. If the textbook on offer does not appear to be the latest edition, then be very cautious about buying it. If you have any queries about buying a book, you should consult the person running the course.

### 4.8 Using libraries
Libraries contain tens of thousands of books and journals, and their very size can be daunting when you first visit them. Even students who are used to libraries at school or in their home towns can feel intimidated. Fear not, help is at hand. University libraries are organized to assist you with your studies, and there will be a range of resources to help you with searching, evaluating, managing and referencing information, as well as advising how to keep up to date with new information. They will also be able to advise on copyright and plagiarism issues.

#### 4.8.1 Making the most of the library facilities
There are three main reasons why you will use the library: quiet study, consulting or borrowing textbooks, and looking up reference material in journals. Within the libraries are desks and tables that help you study in peace and quiet.

Broadly speaking, there are three types of reading material to be found in academic libraries; textbooks, advanced books on specific academic topics, and journals. In general, textbooks are collected together in different sections of the library by subject and “classmark”, and are stored separately from journals.

Many universities make a point of introducing new students to the relevant libraries, showing them where material is kept, how to access it and the various rules of the library. This introductory visit will certainly cover how to find what you are looking for – so pay attention since this advice will prove invaluable later on in your studies!

**Borrowing books – and fines!**
Most textbooks and sometimes bound volumes of journals may be borrowed from the university libraries. Most books can be borrowed for extended periods but there are some that are in high demand and may only be borrowed for a limited time to allow others fair access to the material. Books in really high demand are loaned out for just a few hours. This is usually because a book is required for a particular course and so, for a limited period, a large number of students will need access to it. In these situations, the book is transferred to the “counter collection”, which means
that it is only available on request from the librarian on the counter. This allows all students the opportunity to refer to the book, rather than the lucky individual who happens to borrow it first.

Overdue books and journals attract fines that can quickly build up to significant and alarming sums of money. As well as being potentially expensive, it is bad manners to keep a book longer than necessary, since others may require access to the same text.

If a library book is not available when you first want it, it is sensible to ask for it to be reserved. As well as ensuring that you eventually have access to the book, it also alerts library staff to the demands for that book. This may mean that the library buys additional copies for future use.

**Ask for help**

A library can be a daunting place when you first start to use it. When starting out, use the library catalogue (it will be available online) when searching for specific books and journals.

Will you make mistakes?

Will you fail to find references?

Will you need advice on the best way of tackling a particular search?

Yes, Yes, and Yes. Do not despair. The library staff are highly trained and are expert in such matters. They are there to help you, so don’t waste hours getting nowhere – ask them for help! They will be pleased to point you in the right direction, and to show you where you have gone wrong. This will help you to avoid those pitfalls next time you need to search for information.

### 4.8.2 Journal papers and how to understand them

*There was once a pathologist who would come into his laboratory every Friday morning, hand over the latest copy of a famous medical journal and say to his staff: “Well, here are this week’s fairy stories”. Although the pathologist was making a joke there is an element of truth about what he said.*

At school or college, textbooks will provide you with all the information that you need to excel in your subject. At university, while you may get an excellent grounding in the subject from textbooks in your first year, you will soon need to start reading, and understanding, scientific papers.

Scientific papers are written in a highly structured, conventional manner. It is important that you appreciate how the conventions work if you are to get the most from the papers, so we need to start by considering how papers are written and published.

A journal is a regular publication (perhaps weekly or monthly) in which academics and researchers will publish their research findings. Each published research study is called a “paper” (in science, it is called a “scientific paper”) and is extremely
detailed so that the reader can repeat the work if necessary. We will talk more about research papers below. These days, journals are nearly always also available in electronic format and so academics and students can read journals from their computer rather than having to visit the library to do so.

University libraries subscribe to a large number of journals devoted to a staggering array of subjects. Current issues of the journals (i.e. recent issues produced that week or month) will be found on the “current journals” shelves of the library until a volume (usually a complete year’s worth of individual issues) is completed. Shortly after the volume has been completed, it will be sent away to be bound as a hardback volume. The “bound journal” is then returned to the library, and is stored alongside earlier volumes of the same journal. The various bound journals are arranged alphabetically by journal title and are also placed in date order as you would expect.

As well as journals being listed in the relevant library catalogue, at the end of each bay are notices saying which journals it contains (e.g. Nature or The Lancet). It goes without saying that electronic journals don’t disappear for binding!

4.8.3 How scientific papers are published

Scientific researchers aim to publish the results of their work in high quality journals with a large readership. The work is written up in the form of a “paper” and then submitted for consideration by their preferred journal. These papers are usually sent to two or more referees for “peer review” before they are published. Peer review means that the submitted paper will be reviewed by several other academic experts (“peers”) who will be able to comment on the quality of the paper and spot any issues that need to be addressed. Their job is to take a critical view of the material that has been submitted for publication and then to write a report to the editor of the journal, pointing out any matters of concern.

The sorts of questions asked during the peer review process include:

• are the research findings of the author(s) really original?
• do the experimental results described fully support the conclusions drawn by the author(s)?
• is the paper clearly written so as to be unambiguous?
• is the paper comprehensive so that the experiments can be repeated by the reader to test their validity?

...and so on...

Only if a paper meets these criteria will it be published in a peer-reviewed journal.

This thorough approach generally works well, but the system is not perfect and mistakes do creep into the literature.

There are three major types of paper: full original research papers (often collectively called the “primary literature”), short “research letters”, and review articles. These are now considered in turn.
**Primary literature**

Most of the papers that you will come across are full descriptions of original experiments made directly by researchers. Although the details differ between journals, a typical scientific paper includes:

- **abstract** – a very brief summary of the work, the major results, and the author’s conclusions
- **introduction** – a short overview of that specific field of research and where this new research fits in
- **materials and methods** – a concise description of the methods used to undertake the research
- **results** – a detailed presentation of the original experimental results; depending on the experiments, this section may also include statistical analysis (see *Catch Up Maths & Stats* for details on why authors use particular statistical tests to analyse their data)
- **discussion** – a description as to what the author concludes that these data show
- **references** – a list of the other research papers that the author refers to in his work (allowing a reader to look further into particular aspects of the topic)

**Research letters**

When results, sometimes only from single experiments, are too important to wait for the whole body of work to be completed before publication, then these smaller sets of results may be released as research letters.

Alternatively, a research letter may be a critique of work that has already been published, perhaps including data to refute the previous paper. In such cases, the author(s) of the original work are often invited to publish a reply, most often appearing next to the first research letter.

**Review articles**

Given the very high volume of research papers published, it would be a huge task for a student to read all the relevant papers in a subject area. This is when review articles can be helpful, particularly when finding your way around an unfamiliar area. Therefore, although we have described reviews last in the discussion of the three types of journal, they should often be the first place you start when learning about a new subject area.

Reviews are typically written by experts in their field and give either an in-depth view of a particular topic or present a broad overview of their field of interest. Reviews cite many primary publications (papers describing original research) in support of their arguments, and interested readers can use these to explore the literature further, often with the benefit of critical comments made in the review.

A variant of the review article is the short “news and views” type article, often devoted to a critical review of a specific paper published in the same edition of the journal. “News and views” articles tend to be commissioned by the journal from leading experts in the field.
4.8.4 How should you read a scientific paper?

How you read a scientific paper (i.e. a paper from the primary literature – see above) depends on what you want to do with the information. Early in your undergraduate career, you should aim to get a feel for what is being published in an area. However, by the time you undertake a research project in your final year, particularly if it involves experimental work, you will need to pay much more attention to the way the science was done.

A good approach to take when faced with reading a scientific paper is to go through it in the order of the steps listed below.

Step 1
Look at the title which is a crucial part of any paper. As many papers may be published on a topic, authors often try to make their titles interesting, to encourage the reader to explore further: “GM foods – a case of resistance” is an allusion both to the antibiotic resistance markers left in first-generation insect-resistant plants and to the public opposition in the UK to the introduction of GM plants into commercial agriculture. If you come to write papers, you will need to remember that the title may be the only part of the paper that many people will read.

Step 2
Read the abstract or summary. This is a short description of the principal findings of the paper, and, together with the title, gives the reader a feel for the subject. For many, reading the abstract will be sufficient, but if this is all you read you may miss out on important details that lie hidden in the body of the text. It is not always wise to rely absolutely on the authors of a paper to highlight in the abstract what is important and “hidden gems” may be found by those who are prepared to explore deeper into papers.

Step 3
What you read next depends on why you are reading the paper and what you want to do with the information. For someone who is relatively unfamiliar with the research in that area it may be invaluable to read the introduction section next since this sets out the background against which the research was carried out and introduces the topic in context. People already familiar with similar work may not find the introduction of much interest and might skip this step.

Step 4
The next step is to read the results that are reported in the paper and the interpretation placed on them by the authors in the discussion section. Typically, “Results” and “Discussion” sections are written separately, but when complex sets of experiments are being reported, particularly if the implications of one set of results need to be explained before the next set can be understood, a combined “Results and discussion” section may be provided.

Step 5
The papers to which the author(s) refer are described in the reference list and you might want to follow up the information in the paper by reading some of these,
especially if you are preparing a dissertation or literature review. Finally, the acknowledgements section of the paper is typically very short and often need not be read by the students. However, it contains important information, particularly concerning the way that the work was funded.

Step 6
If you wish to do similar work to that described in the paper, you will need to read the “Materials and methods” section. In places, the “Materials and methods” section may not describe a particular method used in any detail, but instead refer to other papers in which this is described.

4.9 Using the internet as a source of information

Although it now seems almost inconceivable, not many years ago, the only way to follow scientific progress was by reading the published journal papers in libraries. The advent of powerful and widely accessible computing and the existence of electronic journals has changed all that, for the better. Now, locating the journal articles you need to read and then reading them is fast and easy, if you know how!

When you need to search the primary scientific literature, a number of online tools can help. It is important that you learn to use them as they will undoubtedly make your information searches quicker and easier. Three particularly helpful tools are:

- Web of Science (http://isiwebofknowledge.com/) – the Web of Knowledge covers many thousand journals but allows users just to access the relevant scientific articles via Web of Science. Coverage does, however, get patchy, the further back in time you need to search
- PubMed (www.ncbi.nlm.nih.gov/pubmed/) – this is a service of the US National Library of Medicine that includes millions of citations from Medline and other life science journals for biomedical articles back to 1948. PubMed includes links to full text articles and other related resources
- Google Scholar (http://scholar.google.co.uk/) – provides users with the opportunity to use a range of search options across the scientific and medical literature

These three database “search engines” allow users to search for work published in journals using key words, authors, journal title, etc. In addition, most search engines like these now allow you to click on links in the reference sections of papers and you will be taken to the full text of that article too, allowing you to build a web around the original paper by following links forwards and backwards.

None of these tools is difficult to use, and they can prove invaluable, particularly during project work. When you first use these databases, it is easy to get overwhelmed by the number of citations that you find. All of these databases do, however, allow you to refine your search, narrowing down the list of papers, perhaps to just the one that you need. You may do this by combining different keywords,
Making the most of teaching

author names, journals, year of publication or any combination of these, providing, of course, that you have this information to hand.

Coverage of the literature is constantly being updated, so you will find new papers almost as soon as they are published. Indeed, with some journals, you may have access to the electronic version of an article before its paper version appears from the printing presses. The coverage of older papers is variable, depending on the database, but for most there is now reasonable coverage of journals published from the 1960s to the present day. Many of these databases are undergoing frequent redesigns so we have not provided detailed advice on their use – it is all fairly intuitive.

Assuming that your university library subscribes to the journal containing the article found by your search, then you will be able to have free access, from your computer, to the full article, so there is no need to go hunting through the library to find the paper copy. If your library does not subscribe to the journal (although most university libraries do subscribe to a huge number, there will be some to which it does not), then you will still be shown the title and abstract and offered the chance to buy an electronic copy. Before you buy, check the abstract to see if it really is a paper you need and then talk to the librarian to see if there is a cheaper way to gain access.

There are a number of other similar tools, which you are free to explore and your librarians will give you advice on how to get the most from them.

Remember

Databases are only as good as the data that they contain and they don’t all cover all of the journals. It is advisable to use more than one resource when researching topics.

4.9.1 Finding reliable internet resources

This brings up the whole question of how reliable the internet is as a source of information. It is essential to remember that it is very easy to post information on the web and many people do. The reasons people put up information are many and various; not all of them are for the greater good. Even apparently reputable websites may be designed to give a particular “spin” to a topic.

You need to be very very careful when evaluating information from the internet, particularly about the structure and content of the material and also what authority the website has. Except for web pages in academic journals (which includes papers identified by the Web of Science, Medline, PubMed, etc.) other web pages are rarely “peer-reviewed”. That means that it is down to you, the student, to evaluate which web pages to trust, and which to reject. The questions asked during the process of peer review (see above) may help you to make the right judgements. Here are some further questions to help decide:

• is the information relevant and pitched at the right level?
• are fact and fiction clearly differentiated?
• are references provided?
• are there links to independent sites in support of the content of the site in question?
• has the information been validated in any way?
• is the site up-to-date?

Sites that are not supported by valid references or external links or those that are not substantiated by peer review are more likely to be inaccurate and/or biased.

When it comes to considering the authority of a website, you may also like to bear the following in mind. A website produced by a corporation (with a web address ending in “.co” or “.com”) may give a view that favours that company. After all, companies exist to sell their products. In contrast, university sites in the UK contain “.ac.uk” and in the USA they end in “.edu”. UK government sites contain “.gov” or “.org”.

However, just because a website is not a company site does not guarantee reliability of the information. You should consider:
• who wrote the material?
• why was it written?
• are the credentials/qualifications of the author shown and relevant?
• is the site associated with a reputable institution (universities/research institutes/professional associations/government bodies)?
• can you see contact details for correspondence?

**Wikipedia**

In their early years at university, many students use Wikipedia as a source of information. This dynamic online encyclopaedia that anyone can edit contains many good pages which have external references and these are a useful resource. It claims to have a neutral viewpoint, its content is free and it has a code of conduct, part of which states that Wikipedia has no firm rules. You should, however, be **very careful** how you use Wikipedia. Although it is a good secondary source of information and as such will provide background information on a huge array of topics, it should not be quoted as a primary reference because it is not peer-reviewed and anyone can edit its pages, leaving open the possibility of unreliable information being posted on it.

Looking at the “discussion” tag may give some idea of how reliable the information is on any given page, particularly if it concerns a controversial topic. Furthermore, information may change after you have read a page so any reference you quote may change and others will not be able to access the information you cited. This means you need to take care to provide a **full** reference to the **actual page** you accessed. These may be traced using the “history” tag. Here is an example of how to do this:

Even if you can satisfy yourself that the website looks fine, remember that, just occasionally, science undergoes seismic changes.

In 1978 Peter Mitchell was awarded the Nobel Prize in Chemistry for expounding the chemiosmotic hypothesis to explain how mitochondria generate ATP. A few years previously he was not at all well regarded by some scientists in his field. Suppose he had had a website with the same content before and after he won his prize. How do you think that these would differ? How do you think your views would have changed on what you read?