Practical LaTeX for the Health Sciences

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Contents

1 Background

The purpose of this tutorial is to introduce health scientists, analysts, and writers to LaTeX for preparing scientific documents. LaTeX is a document preparation system for creating professionally typeset scientific documents. LaTeX is freely available and widely used by data scientists, mathematicians, physicists, statisticians, engineers, demographers, and many other disciplines. Specifically, we will learn how to prepare a scientific article or report. Additionally, we introduce selected software solutions that enhance the publication process.

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The purpose of scientific writing is to communicate, persuade, educate, inform, or alert readers using content that is well-organized and clear. Scientific and technical documents can be divided into the following components (in order of importance!):

1. Content
2. Structure
3. Appearance

The document *content* is the main reason for writing anything: we want to effectively communicate, and perhaps persuade, our audience with our narrative and supporting tables and figures. As writers, we want to spend our time and intellectual energy producing excellent content. Next in importance is document *structure*: that is, how our document is organized for logic and flow: title, section headings, subheadings, bibliography, tables, figures, etc. Good document structure optimizes the logic and flow of our content. Last in importance is document *appearance*. We do not want to waste our time worrying about how the content will appear—this can be accomplished efficiently later if the document is well-structured to begin with.

Therefore, as we write, we should spend most of our time on content production, spend time on determining organization to optimize the order and flow of our content, and spend minimal time on formatting appearance. All too often writers spend an extensive amount of time formatting the appearance of their document to give it a desired structure and appearance. This is problematic for documents that are long or that require frequent updating. Additionally, most writers are not trained in typography:[1] the time wasted on formatting is much better spent on improving content.

Preparing scientific documents is not writing a fiction novel. In many ways preparing a scientific document is easier. First, the organization has an expected structure. For example, a scientific article generally has the following sections: introduction, methods, results, and discussion. Second, scientific writing should be factual, concise, and clear. And third, displays are generally limited to tables and figures.

Preparing scientific documents present the following challenges:

- Organization is structured (introduction, methods, results, etc.)
- Document length may be long
- Document may require periodic updating
- Use of mathematical notation and equations
- Management of references
- Creation of bibliographies
- Cross-references to equations, tables, and figures

[1] Typography is the art and technique of setting written subject matter in type using a combination of typefaces, point size, line length, leading (line spacing) and letter spacing. Source: http://en.wikipedia.org/wiki/Typography

- Re-number equations, tables, and figures
- Generation of table of contents, tables, and figures

Because article manuscripts are relatively short (about 20 pages double-spaced), these issues are less problematic. For a doctoral thesis (or long report), these issues are either addressed efficiently and save time, addressed poorly and wastes someone's time (possibly an administrative assistant—or worse, the author—spending hours reformatting), or not addressed at all—resulting in a lower quality, less user-friendly document.

In general, document preparation systems can be classified as either visual design or logical design. Microsoft (MS) Word is a familiar example of a *visual design* system; it is also known as "what you see is what you get" (WYSIWYG). What you see on the computer screen is almost identical to what you get when you print the document. In MS Word, basic word processing is easy to learn, user-friendly, and convenient for local formatting. Local formatting is achieved by highlighting a string a text and then formatting it: for example, italicizing, bolding, or changing font face, size or color. A major limitation of visual design is that local formatting of appearance is so easy that it becomes (unintentionally) the formatting method of choice for structuring long documents. Extensive local formatting of long documents become onerous and impractical; WYSIWYG comes to mean "what you see is what you got." *visual design*

In contrast, *logical design* separates the process of content production from the processes of formatting structure and formatting appearance. LaTeX is a logical design system: it provides a "markup language" to mark up content to have structural and conceptual meaning. This facilitates global formatting of structure and appearance using established typographical standards for scientific documents. Once the content is marked up, the content is compiled into a professionally typeset document using well established formats for scientific publication. The writer spends little time worrying about formatting structure and appearance, and more time on preparing high quality narrative content. The best way to understand this is to experience it firsthand. *logical design*

2 Getting started with LaTeX

A complete LaTeX system consists of the following components:

- LaTeX package (required; must install or use online)
- Text editor (required; available on all operating systems)
- Reference manager (optional, but recommended)
- Graphics/image editor (recommended)

For this tutorial, we will set up a LaTeX system for the MS Windows, Macintosh, or Linux operating system.

2.1 LaTeX system

For MS Windows, we recommend installing the MikTeX distribution.[2] For Mac OS, we recommend installing the MacTeX distribution.[3] For Linux, we recommend installing the TexLive distribution.[4] These distributions are large, so we need a high-speed Internet connection to download them.

Alternatively, we can go online and compile LaTeX documents for free from the following sites:

- ShareLaTeX (https://www.sharelatex.com/)
- Overleaf (https://www.overleaf.com/)
- Authorea (https://www.authorea.com/)

In fact, this might be the best way to get started. Both sites have free individual accounts and subscription fee for collaborating, co-editing, and track changes. Great! We are are ready to start LaTeXing!

2.2 Text editor

To create LaTeX documents we need a text editor. A text editor is a program for, you guessed it, editing text. MS Windows comes with Notepad (found in the Accessories folder). Mac OS comes with TextEdit (found in the Applications folder). In the text editor, type the following and save the file with a `.tex` extension; for example, `mydoc.tex`:

```
\documentclass{article}
\begin{document}
This is my first article.
\end{document}
```

We recommend saving `mydoc.tex` to it's own directory. When LaTeX compiles our `.tex` source file, it creates several auxilary files (`.aux`, `.log`, `.out`, `.tex~`, etc.). For this reason, we prefer a dedicated directory folder: we create a folder named `mydoc` and a subfolder named `tex` where `mydoc.tex` resides. For example, here is the full path to our `mydoc.tex` file (in a Mac):

```
/Users/<user>/Documents/mydoc/tex/mydoc.tex
```

where `<user>` is the user HOME directory in the Mac. All auxilary files (`mydoc.*`) will be in the `tex` folder. One can put related, but non-LaTeX files can go in the `mydoc` folder.

To compile this document we run commands from the Command Prompt (Windows) or the Terminal (Mac or Linux). From the command line, move to the `./mydoc/tex/` directory. Type and submit the following:

[2] http://www.miktex.org/
[3] http://tug.org/mactex/
[4] http://www.tug.org/texlive

```
pdflatex mydoc
```

We do not need to specify the `.tex` extension. This will produce a PDF file (`mydoc.pdf`). To view this document, use the default PDF viewer (e.g., Adobe Acrobat Reader). Wow, that was easy!

Now, edit and save `mydoc.tex` to create a complete article:

```
\documentclass{article}

\begin{document}
\title{My first article}
\author{Tomas J. Aragon}
\date{\today}
\maketitle

\section{Introduction}
The purpose of this article is to teach public health and medical
scientists how to create professionally typeset documents.

\section{Methods}
This document was created using a text editor.

\section{Results}
Use the PDF viewer to open and view your document after you have
compiled it.

\section{Discussion}
That's it. Wasn't that fun and easy.
\end{document}
```

Recompile `mydoc.tex` and view `mydoc.pdf` in a PDF viewer. It should look like the document that follows:

My first article

Tomas J. Aragon

July 30, 2016

1 Introduction

The purpose of this article is to teach public health and medical scientists how to create professionally typeset documents.

2 Methods

This document was created using a text editor.

3 Results

Use the PDF viewer to open and view your document after you have compiled it.

4 Discussion

That's it. Wasn't that fun and easy.

To summarize, just follow this sequence:

- Edit `mydoc.tex` and save
- Recompile `mydoc.tex`
- View `mydoc.pdf` in PDF viewer

LaTeXing is that easy! However, typing all that LaTeX mark up can get tedious and result in errors. To be more efficient and accurate, we should use a better text editor. A good text editor will make your LaTeXing easier, efficient, and accurate. Because we also need a text editor for data processing, data management, and statistical programming, the functionality we look for in a text editor includes the following:

- Toggle between wrapped and unwrapped text
- Rectangle cutting and pasting (also called block editing)
- Easy macro programming
- Search and replace using regular expressions
- Ability to import datasets for editing

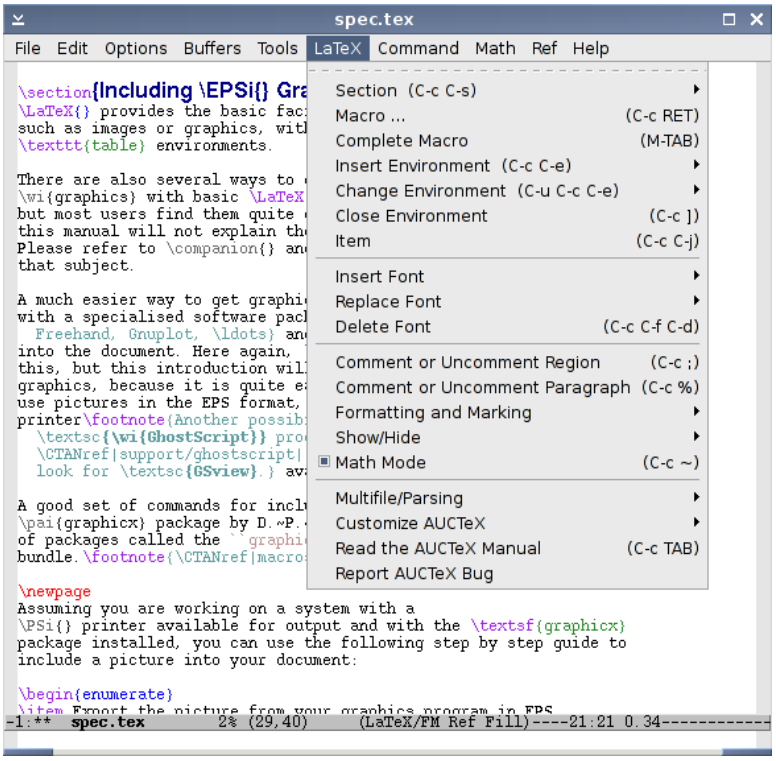

Figure 1: Text editor: GNU Emacs with AUCTeX

When we are programming we want text to wrap so we can read all of our code. When we import a data set that is wider than the screen, we do not want the data set to wrap: we want it to appear in its tabular format. Rectangle editing allows us to cut and paste columns of text at will. A macro is just a way for the text editor to learn a set of keystrokes (including search and replace) that can be executed as needed. Searching using regular expressions means searching for text based on relative attributes. For example, suppose we want to find all words that begin with "b," end with "g," have any number of letters in between but not "r" and "f." Regular expression searching makes this a trivial task. All these are powerful features that once we use regularly, we wonder how we ever got along without them.

Table 1: Recommended user-friendly text editors for LaTeX

Operating system	Recommended	Alternatives
MS Windows	TeXMaker	TeXStudio, WinEdt ($), GNU Emacs
Mac OS X	TeXShop	TeXMaker, TeXStudio, GNU Emacs
Linux	GNU Emacs	TeXMaker, TeXStudio TeXWorks

My personal favorite text editor is GNU Emacs (Figure 1). For Windows, we recommend the Emacs/ AUCTeX bundle.[5] For Mac OS, we recommend Emacs for Mac OS X[6] (includes AUCTeX). AUCTeX is the Emacs package for editing LaTeX documents. The only limitation with Emacs is its Unix-like feel: Mac and Windows users may not feel comfortable starting with Emacs. Therefore, user-friendly text editors are listed in Table 1. Again, if text editors are completely foreign, start with the online providers.

2.3 Reference manager (recommended)

Retrieving and managing reference citations is an important part of scientific writing. For this we will need a reference manager. The capabilities we look for in a reference manager include the following:

- Search and retrieve citations from PubMed's MEDLINE;
- Automatic viewing of key fields and abstract without opening citation;
- Automatic indicator of duplicate references in our database;
- Manage multiple reference databases;
- Create subject groupings across databases;
- Import and export various formats (e.g., EndNote, etc.);
- Database for generating LaTeX bibliographies;

[5] http://www.gnu.org/software/auctex/download-for-windows.html
[6] https://emacsformacosx.com/

- Manage links to supportive PDF documents, web pages, or other files;
- Run on multiple platforms (Mac, Windows, Linux, etc.)

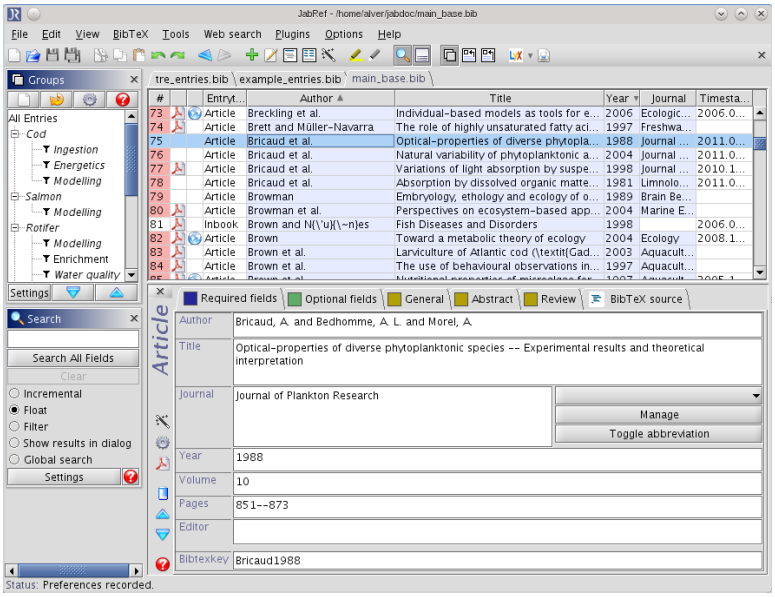

Figure 2: JabRef BibTEX Reference Manager main window is more powerful than EndNote

BibTEX is a database and tool for formatting bibliographies for LATEX documents. For managing BibTEX references, we recommend JabRef,[7] an open source bibliography reference manager (Figure 2). JabRef has all the capabilities listed above (and more). As a reference manager alone, it is much more powerful than EndNote. For now, download, install, and become familiar with JabRef.

2.4 Graphics/image editor (optional)

For software similar to Adobe Photoshop for creating, editing, or converting images (JPG, BMP, TIFF, PNG, GIF, EPS, etc.), we recommend the open source GNU Image Manipulation Program or GIMP (Figure 3).[8] For software similar to Adobe Illustrator for editing vector graphics we recommend open source Inkscape.[9] For software similar to Visio for drawing diagrams and flowcharts we recommend the open source Dia[10] (Figure 4).

3 Creating LATEX Documents

For the sections that follow please print Winston Chang's LATEX Cheat Sheet, available at https://wch.github.io/latexsheet/. Keep this Cheat Sheet readily available when working through

[7] https://www.jabref.org/
[8] http://www.gimp.org
[9] https://inkscape.org/en/
[10] https://wiki.gnome.org/Apps/Dia/

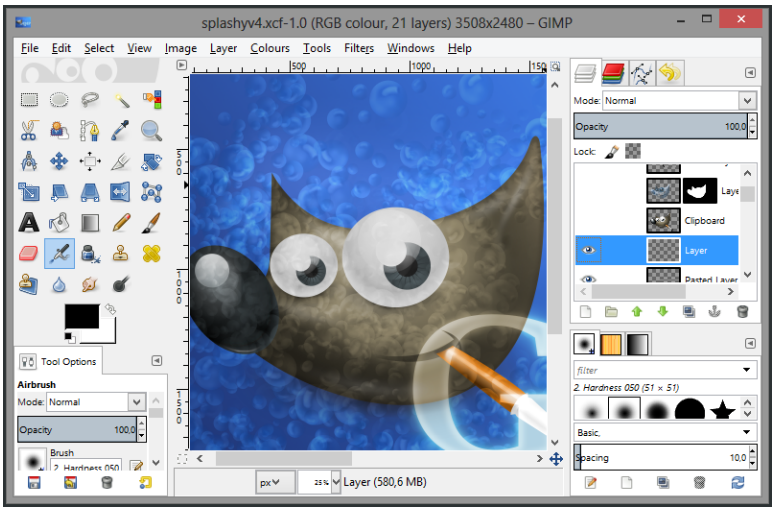

Figure 3: The GNU Image Manipulation Program (GIMP)

this tutorial.

A LaTeX document is compiled from a LaTeX source file. The source file is just an ASCII text file ending in `.tex` that we prepare using our text editor. The source file contains a *preamble* and a *body*. Comments are preceded by `%`.

Here is an example of a minimal source file:

```
\documentclass{article} % Preamble starts here
\begin{document}        % Body start here
My content goes here.
\end{document}
```

3.1 Preamble

The preamble is that first part of our LaTeX source file that contains the following global declarations:

- Document class (required)
- Packages (optional)
- Miscellaneous (optional)
- User-defined commands (optional)

3.1.1 The `documentclass` command

The `\documentclass` command has the following syntax:

```
\documentclass[<options>]{<class>}
```

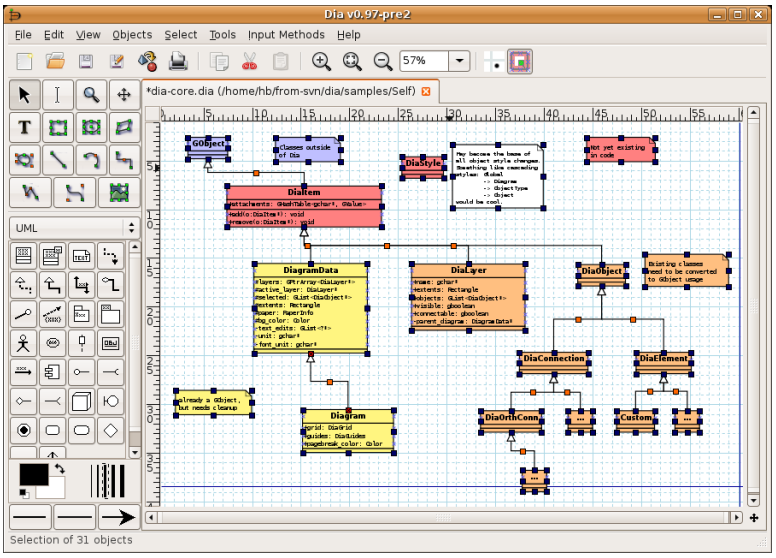

Figure 4: The Dia program for drawing diagrams (main window) is similar to Visio

We will only consider these document classes: `article`, `report`, and `book`. Common options include font size: `10pt`, `11pt`, and `12pt`; and paper size: `letterpaper` (default), and `a4paper`. Here is the `\documentclass` command for typical manuscript:

```
\documentclass[12pt,letterpaper]{article}
```

Table 2 on the following page summarizes the default document class options for standard classes (article, report, book). For example,

```
\documentclass{article}
```

has the default options of `letterpaper`, `10pt`, `onecolumn`, `oneside`, `notitlepage`, `portrait`, and `final`. To change defaults just add options:

```
\documentclass[11pt,landscape,twocolumn]{article}
```

3.1.2 The usepackage command

After `\documentclass`, we use `\usepackage` commands to declare what additional packages we want for this document. Most of these packages are installed with our LaTeX distribution. For example, a typical preamble might include the following packages:

```
\documentclass[11pt]{article}       % Preamble starts
\usepackage[margin=1.5in]{geometry} % Change  margins
\usepackage{graphicx}               % Enable graphics
\usepackage{setspace}               % Enable double-spacing
```

Table 2: Default document class option for standard classes

	Class			Optional
Option	article	report	book	values
Paper size	letterpaper	letterpaper	letterpaper	legalpaper
Font size	10pt	10pt	10pt	11pt, 12pt
No. columns	onecolumn	onecolumn	onecolumn	twocolumn
Margins	oneside	oneside	twoside	n/a
Titlepage	notitlepage	titlepage	titlepage	n/a
Chapter start page	n/a	openany	openright	n/a
Orientation	portrait	portrait	portrait	landscape
Draft or final	final	final	final	draft

```
\usepackage{booktabs}                % Improved tables
\usepackage{cite}                    % Citations like [2-8]
\usepackage{hyperref}                % Enables hyperlinks
```

3.1.3 Miscellaneous commands

After the \usepackage commands, we can add miscellaneous commands. For example, the \pagestyle command changes the default headline, footline, and page numbering. Here is the syntax:

```
\pagestyle{<style>}
```

where <style> can be plain, empty, or headings. The plain style is the default for the article and report classes: the page head is empty, and the page foot contains the centered page number. The headings style is the default for the book class: the page head contains both the page number and title information (chapter and section headings), and the page foot is empty. The empty style makes the page head and foot empty. For practice, update and recompile the mydoc.tex source file after setting pagestyle to empty:

```
\pagestyle{empty}
```

3.1.4 User-defined commands

Finally, after the miscellaneous commands, we can include user-defined commands. For example, suppose we need to write "Centers for Disease Control and Prevention" several times in our article but we do not want to type this each time. Instead, we can create a command that will insert this text into our document:

```
\newcommand{\cdc}{Centers for Disease Control and Prevention}
```

In the body of the source file, this text:

```
The \cdc director reported that the outbreaks were caused
by the same strain of \textit{E. coli}.
```

compiles to the following:

> The Centers for Disease Control and Preventiondirector reported that the outbreaks were caused by the same strain of *E. coli*.

Notice that the words "Prevention" and "director" are not separated by a space, as they should be. To ensure the appropriate space we put a \ (backslash) or {} (brackets) after the \cdc:

```
The \cdc\ director reported that the outbreaks were caused
by the same strain of \textit{E. coli}.
```

compiles to the following:

> The Centers for Disease Control and Prevention director reported that the outbreaks were caused by the same strain of *E. coli*.

3.2 The document environment

3.2.1 Title

In the LaTeX source file, the body begins after the preamble, and is contained by the `document` environment. Everything between `\begin{document}` and `\end{document}` is the body.

We start the document body by specifying the title, author, and date, and then running the `\maketitle` command.

```
\title{My title goes here}
\author{Tomas Aragon}
\date{\today}
\maketitle
```

Here is a realistic title example:

```
\title{Practical \LaTeX\ for the Health Sciences}
\author{Tom\'{a}s J. Arag\'{o}n, MD, DrPH\thanks{aragon@berkeley.edu
    }\\
University of California, Berkeley\\
School of Public Health}
\date{\today}
\maketitle
```

`\LaTeX` becomes LaTeX; `\'{a}` and `\'{o}` become á and ó, respectively; `\\` inserts a linebreak; and `\today` inserts the current date. The `\` after `\LaTeX` adds normal inter-word spacing; the default is to have no spacing. To add multiple authors, separate the authors with `\and`. For example,

```
\author{Tomas Aragon \and Wayne Enanoria}
```

3.3 Structuring document

Our next task is to structure our document using section headings. These section headings (and the subheadings) become an outline for the paper. Doing this is a good idea when preparing to write any paper. For example, a health sciences research paper will likely have the following section headings:

- Introduction
- Methods
- Results
  - Study design
  - Subject selection
  - Measurements
  - Statistical issues
- Discussion

And the LaTeX source file might be the following:

```
\documentclass[letterpaper,12pt]{article}

\begin{document}
\title{My first \LaTeX\ document}
\author{Tomas Aragon}
\date{\today}
\maketitle

\section{Introduction}
Write the introduction here.

\section{Methods}
\subsection{Study design}
Describe the study design here.

\subsection{Subject selection}
```

```
Describe the subject selection here.

\subsection{Measurements}
Describe the measurement issues here.

\subsection{Statistical issues}
Describe the statistical issues here.

\section{Results}
Describe the results here.

\section{Discussion}
Write the discussion here.

\end{document}
```

LaTeX uses the following section commands:

`\part` is the highest level for books only.

`\chapter` is used in books and reports only.

`\section` is used for all document classes.

`\subsection` is used for all document classes.

`\subsubsection` is used for all document classes.

`\paragraph` is used for all document classes.

`\subparagraph` is used for all document classes.

By default, sections are numbered in a nested fashion: 1, 1.1, 1.1.1, 1.1.2, 1.2, 2, 2.1, 2.2, etc. Use `*` to prevent automatic numbering:

```
\section*{<section heading>}
```

3.4 Paragraphs and sentences

Paragraphs are created by writing sentences, and are separated by a blank line. Therefore, blank lines separate paragraphs. The first sentence of the first paragraph following section headings are not indented. Subsequent paragraphs have their first sentence indented.

LaTeX attempts to determine the end of sentences in order to insert a small amount of extra space between sentences. LaTeX interprets a period and space following a lower case letter as the end of a sentence. Sometimes this is incorrect. For example, compare these two sentences:

Aragon et al. published their findings. (correct)

Aragon et al. published their findings. (incorrect)

In the second sentence, LaTeX added extra space after the "al." in et al. To correct this, study how the first sentence was prepared:

```
Aragon et al.\ published their findings.
```

The `\` in `et al.\` inserts the correct inter-word spacing.

Likewise, LaTeX interprets a period after an upper case letter to be occurring in the middle of sentence and does not add inter-sentence spacing. This works fine except when a sentence ends like this: "Specimens were sent to the CDC. Afterwards, ..." Use `\@.` to ensure correct inter-sentence spacing. Compare these sentences:

Specimens were sent to the CDC. Afterwards, ... (correct)

Specimens were sent to the CDC. Afterwards, ... (incorrect)

To correct this, study how the first sentence was prepared:

```
Specimens were sent to the CDC\@. Afterwards, ...
```

The `\@.` in `CDC\@.` ensured the correct inter-sentence spacing. Here is a summary: when in doubt,

- use `\` between words to ensure appropriate interword spacing; and
- use `\@` before the end-of-sentence period (`\@.`) to ensure appropriate inter-sentence spacing.

Fortunately, if we ignore the above details, we will probably never notice the difference. With practice, we'll come to appreciate the complete control LaTeX gives us in preparing scientific documents.

3.5 Creating lists

To generate unordered or ordered lists we use the following environments:

- `itemize`
- `enumerate`
- `description`

Using `itemize` in the source file:

```
\begin{itemize}
\item First item
\item Second item
\item Third item
\end{itemize}
```

produces this in the document:

- First item
- Second item
- Third item

Using `enumerate` in the source file:

```
\begin{enumerate}
\item First item
\item Second item
\item Third item
\end{enumerate}
```

produces this in the document:

1. First item
2. Second item
3. Third item

Using `description` in the source file:

```
\begin{description}
\item [itemize:] is used for unordered lists
\item [enumerate:] is used for ordered lists
\item [description:] is used for categorical lists
\end{description}
```

produces this in the document:

itemize: is used for unordered lists

enumerate: is used for ordered lists

description: is used for categorical lists

And of course, lists can be nested, but not beyond three levels:

1. First item
    - First item
        (a) First item
        (b) Second item
    - Second item
2. Second item

(a) First item

- First item
- Second item

(b) Second item

3. Third item

To see more list examples visit https://en.wikibooks.org/wiki/LaTeX/List_Structures.

3.6 Displaying mathematics

In scientific documents, mathematical notation and formulas appear inline or displayed. For example, in epidemiology, the risk formula derived from a constant hazard assumption is $R(t) = 1 - \exp(\lambda t)$, where R is risk, t is obervation time, and λ is the constant rate. These expressions are inline mathematical notation; they were created by placing the notation between $ symbols:

```
For example, in epidemiology, the risk formula derived from a
constant hazard assumption is $R(t)=1-\exp(\lambda t)$, where $R$ is
risk, $t$ is obervation time, and $\lambda$ is the constant rate.
```

To display a formula, use the `equation` environment. For example, the exponential risk formula,

$$R(t) = 1 - \exp(\lambda t) \tag{1}$$

was created using the following in the source file:

```
\begin{equation}
  R(t)=1-\exp(\lambda t)
\end{equation}
```

Notice that the `equation` environment automatically numbers the formula on the righthand side. To display an unnumbered formula use `equation*` instead. For example,

$$R(t) = 1 - \exp(\lambda t)$$

was created using the following in the source file:

```
\begin{equation*}
  R(t)=1-\exp(\lambda t)
\end{equation*}
```

To display aligned multiple equations we use the `eqnarray` environment. For example, here

is a general formula for the odds ratio for a cohort study:

$$\begin{aligned} OR &= \frac{R_1/(1-R_1)}{R_0/(1-R_0)} \\ &= \frac{R_1(1-R_0)}{R_0(1-R_1)} \end{aligned} \tag{2}$$

was created using the following in the source file:

```
\begin{eqnarray}
  OR &=& \frac{R_1/(1-R_1)}{R_0/(1-R_0)} \nonumber\\
     &=& \frac{R_1(1-R_0)}{R_0(1-R_1)}
\end{eqnarray}
```

This demonstrates several features. The `&` in `&=&` aligned the equations. To create the subscript in R_1 we used `R_1`. Although not shown, to create superscripts like x^y we would use `x^y`. The `eqnarray` environment automatically numbers each equation. To suppress equation numbering for an equation we used `\nonumber`. To suppress all numbering use `eqnarray*`, similar to `equation*`. We inserted `\\` for line breaks. Finally to create fractions, we used the following syntax:

```
\frac{<numerator>}{<denominator>}
```

Summation symbols are very common in the quantitative sciences. For example, the exponential risk formula (Equation 1, p. 18) can be changed to handle time intervals where the interval rates can differ but are constant within each interval. For example, this exponential formula for interval-specific rates:

$$R(0,t) = 1 - \exp\left(-\sum_{j=1}^{J} \lambda_j h_j\right) \tag{3}$$

where J is the number of time intervals, λ is the interval-specific rate, h_j is the length of the time interval, and $\sum h_j = t$. Equation 3 was create by using the following in the source file:

```
\begin{equation}
  R(0,t) = 1 - \exp \left( - \sum_{j=1}^J \lambda_j h_j \right)
\end{equation}
```

We recommend loading the `amsmath`, `amsfonts`, and `amssymb` packages in the preamble.[11] These packages from the American Mathematical Society include additional fonts, symbols, and features. For example, to include plain text in your equation, we use `\text`. This displayed equation,

$$\text{Incidence rate} = \frac{\text{Number of new cases}}{\text{Person-time at risk}}$$

was created using the following in the source file:

[11] To learn more download their guide: ftp://ftp.ams.org/pub/tex/doc/amsmath/short-math-guide.pdf

```
\begin{equation*}
  \text{Incidence rate} = \frac{\text{Number of new cases}}
  {\text{Person-time at risk}}
\end{equation*}
```

There is much more to learn about creating mathematical formulas using LaTeX, but we have covered enough to get us started. There are plenty of online LaTeX tutorials to learn more; just google "latex mathematics tutorial."

For more mathematics examples visit https://en.wikibooks.org/wiki/LaTeX/Mathematics. For advanced mathematics examples visit https://en.wikibooks.org/wiki/LaTeX/Advanced_Mathematics#align_and_align.2A.

3.7 Displaying characters and text

3.7.1 Special characters

For technical documents, we need to regularly mark up words or characters to change how they are displayed. First, we need to understand that LaTeX reserves selected characters for special purposes; typing the single character in a source file will not be rendered as normal text in the document. Table 3 summarizes these special characters, and how to display them as normal text.

Table 3: Special characters, their usual uses, and how to display them as normal text

Special character	Usual use	Example use	Display	To display as normal text use
%	Comment source	`%comment`	`%comment`	`\%`
#	Command variable[a]	n/a	n/a	`\#`
{ }	Left and right braces	`\textit{italics}`	*italics*	`\{ \}`
\	Commands	`\'{a}`	á	`\textbackslash`
&	Tabular environment	`a & b`	a b	`\&`
~	Linked space	`Table~\ref{tab:one}`	Table 1	`\~{}`
∼	Web address	`nd.edu/$\sim$tja`	nd.edu/∼tja	`$\sim$`
$	Math mode	`$\frac{a}{a+b}$`	$\frac{a}{a+b}$	`\$`
_	Subscript (math)	`$_{n}M_x$`	${}_nM_x$	`\_`
^	Superscript (math)	`$^{n}M^x$`	${}^nM^x$	`\^{}`
<	Less than (math)	`$y < x$`	$x < y$	`\textless`
>	Greater than (math)	`$y > x$`	$x > y$	`\textgreater`

[a] Beyond the scope of this tutorial; n/a = not applicable

3.7.2 Quotation marks

In a word processor, we use a double quotation mark (") to start and end a quotation (e.g., "start and end"). This approach does not work in LaTeX. Instead, in the source text, the opening quotation mark is created by using the grave accent[12] twice (``), and the closing quotation mark is

[12] http://en.wikipedia.org/wiki/Grave_accent

created by using the apostrophe[13] (`''`) twice.

For example, `` ``start and end'' `` produces "start and end".

3.7.3 Changing the font face

LaTeX is more than a markup language; it's a programming language that uses *commands*, *environments*, and *declarations*. Commands have the following syntax:

```
\command{<argument>}
```

For example, `\usepackage` and `\section` are commands.

Environments create an enclosure in which a formatting structure or style applies, and have the following syntax:

```
\begin{<environment>}
The environment is enclosed here.
\end{<environment>}
```

For example, the document body is contained within the `document` environment.

Finally, a declaration applies a command to all text that follows it until a different declaration changes it or until the environment ends. A declaration has the following syntax:

```
\declaration
```

For example, the `\centering` declaration in the `table` environment causes all its components to be center aligned (see Section 3.11).

To limit the effect of a declaration to selected text we add braces like this:

```
{\declaration This text will be affected,} this text will not be
    affected.
```

To change the text font face we can use either the commands or declarations displayed in Table 4. These are example of physical markup. The font face consists of the font *family* (style), font *series* (thickness), or font *shape*. To change the font face for a single word use a command; for more than one word, use a declaration. For example,

"I have yet to see any problem, however complicated, which, when you look at it in the right way, did not become still more complicated."

Poul Anderson (Science fiction writer)

was created by this source text:

```
{\itshape ``I have yet to see any problem, however complicated, which,
  when you look at it in the right way, did not become still more
  complicated.''
```

[13] http://en.wikipedia.org/wiki/Apostrophe

Table 4: Change the font face using commands or declarations

Command	Declaration	Effect
`\textrm{`*text*`}`	`{\rmfamily` *text words*`}`	Roman family
`\textsf{`*text*`}`	`{\sffamily` *text words*`}`	Sans serif family
`\texttt{`*text*`}`	`{\ttfamily` *text words*`}`	`Teletype family`
`\textmd{`*text*`}`	`{\mdseries` *text words*`}`	Medium thickness series
`\textbf{`*text*`}`	`{\bfseries` *text words*`}`	**Bold thickness series**
`\textup{`*text*`}`	`{\upshape` *text words*`}`	Upright shapte
`\textit{` *text*`}`	`{\itshape` *text words*`}`	*Italic shape*
`\textsl{`*text*`}`	`{\slshape` *text words*`}`	*Slanted shape*
`\textsc{`*text*`}`	`{\scshape` *text words*`}`	SMALL CAPS SHAPE
`\textnormal{`*text*`}`	`{\normalfont` *text words*`}`	Document font
`\emph{`*text*`}`	`{\em` *text words*`}`	*Emphasized text*

```
  \hfill Poul Anderson (Science fiction writer)}
```

We used the `\itshape` declaration to italicize the quote. A better approach would be to combine the `quote` environment and `\itshape` declaration. For example, this quote

> *"I have yet to see any problem, however complicated, which, when you look at it in the right way, did not become still more complicated."*
>
> *Poul Anderson (Science fiction writer)*

was created by this source text:

```
\begin{quote}
  \itshape ``I have yet to see any problem, however complicated,
  which, when you look at it in the right way, did not become still
  more complicated.''

  \hfill Poul Anderson (Science fiction writer)
\end{quote}
```

In the previous quotes, the `\hfill` command is equivalent to `\hspace\fill` which horizontally fills space pushing text to the right, in this case the author's name.

To emphasize text use the `\emph` command or the `\em` declaration. `\emph` and `\em` are examples of logical markup: they emphasize text contrasting it to the surrounding text. For example, this source text

```
This text: {\em has emphasis, but so does {\em this text}}.
```

creates this document text:

> This text: *has emphasis, but so does* this text.

Underlining a word does not change the font face. To underline a word use the `\underline` command. Unfortunately, this command has limitations. For better underlining commands check out the `ulem` and `soul` packages.

3.7.4 Changing the font size

To globally change the default font size for the document, use the `\documentclass` option; for example,

```
\documentclass[11pt]{article}
```

To change the font size locally, use the declarations listed in Table 5.

Table 5: Declarations to change the font size

Declaration	Example	Effect
`\tiny`	`{\tiny Public Health}`	Public Health
`\scriptsize`	`{\scriptsize Public Health}`	Public Health
`\footnotesize`	`{\footnotesize Public Health}`	Public Health
`\small`	`{\small Public Health}`	Public Health
`\normalsize`	`{\normalsize Public Health}`	Public Health
`\large`	`{\large Public Health}`	Public Health
`\Large`	`{\Large Public Health}`	Public Health
`\LARGE`	`{\LARGE Public Health}`	Public Health
`\huge`	`{\huge Public Health}`	Public Health
`\Huge`	`{\Huge Public Health}`	Public Health

3.7.5 Dashes

In documents, dashes are used for several purposes.[14] Hyphens (-) are used to hyphenate words; en-dashes (–) are used to indicate a closed range or a connection between two people, places, or things; em-dashes (—) are used for parenthetical comments or an open-ended range; and minus signs (−) are used in math mode. In the source file, hyphens are created using a single dash (`-`), en-dashes using 2 dashes (`--`), em-dashes using 3 dashes (`---`), and minus signs using math mode (`$-$`). See Table 6 for a summary.

3.8 Displaying blocks of text

On occasion, we need to display quotes, quotations, or monospace text (e.g., to display computer programming code). The `quote` and `quotation` environments are very similar. Here is the `quote` environment:

[14] http://en.wikipedia.org/wiki/Dash

Table 6: Dashes in documents

Type	Purpose	Example	Effect
Hyphen	Hyphenation of words	`mother-in-law`	mother-in-law
En-dash	Expression of closed range	`pages 34--56`	pages 34–56
	Expression of connection	`SFO--LAX flight`	SFO–LAX flight
Em-dash	Parenthetical comment	`yes---or no?`	yes—or no?
	Expression of open range	`J. Doe, 1989---`	J. Doe, 1989—
Minus sign	Substraction or unary minus	`$a-b$` or `$-x$`	$a - b$ or $-x$

> To protect and promote individual and community health we all need access to relevant and timely biomedical and public health research. The communities that have a higher need for this information, often lack the financial resources to purchase access to this wealth of published research studies.
>
> However, the vast majority of this research is funded by public dollars, yet are controlled by for-profit companies that restrict or limit access to only those who can afford to pay.

And, here is the `quotation` environment:

> To protect and promote individual and community health we all need access to relevant and timely biomedical and public health research. The communities that have a higher need for this information, often lack the financial resources to purchase access to this wealth of published research studies.
>
> However, the vast majority of this research is funded by public dollars, yet are controlled by for-profit companies that restrict or limit access to only those who can afford to pay.

The `quote` environment does not indent the first sentence of paragraphs and separates paragraphs by an empty line. The `quotation` environment indents the first sentence of paragraphs and separates paragraphs with a linebreak only.

Here is the source code for `quotation` paragraphs:

```
\begin{quotation}
  To protect and promote individual and community health we all need
  access to relevant and timely biomedical and public health
  research. The communities that have a higher need for this
  information, often lack the financial resources to purchase access
  to this wealth of published research studies.

  However, the vast majority of this research is funded by public
  dollars, yet are controlled by for-profit companies that restrict or
  limit access to only those who can afford to pay.
\end{quotation}
```

In this tutorial, we used the `listings` package and its `lstlisting` environment to display the LaTeX source code. The `lstlisting` environment does not process LaTeX commands and displays the text using monospace, teletype font. This environment is also used to display programming code, including statistical programming code such as R.[15]

```
> lam <- 0.025
> tim <- 4
> risk <- 1 - exp(-lam*tim)
> risk
[1] 0.09516258
```

Here is the source code:

```
\begin{lstlisting}{language=R}}
> lam <- 0.025
> tim <- 4
> risk <- 1 - exp(-lam*tim)
> risk
[1] 0.09516258
\end{lstlisting}
```

Finally, we can combine environments. The following indented display was created by combining the `quote` and `lstlisting` environments.

```
    > lam <- 0.025
    > tim <- 4
    > risk <- 1 - exp(-lam*tim)
    > risk
    [1] 0.09516258
```

And it was produced by this source code:

```
\begin{quote}
\begin{lstlisting}
> lam <- 0.025
> tim <- 4
> risk <- 1 - exp(-lam*tim)
> risk
[1] 0.09516258
\end{lstlisting}
\end{quote}
```

[15] http://www.r-project.org

3.9 Text alignment

By default, LaTeX documents are justified. For left alignment, use the `flushleft` environment or the `\raggedright` declaration. For right alignment, use the `flushright` environment or the `raggedleft` declaration. For center alignment, use the `center` environment or the `\centering` declaration. For example, this quote display,

> Statistical models are sometimes misunderstood in epidemiology. Statistical models for data are *never true*. The question of whether a model is true is irrelevant. A more appropriate question is whether we obtain the correct scientific conclusion if we pretend that that process under study behaves according to a particular statistical model.
>
> Scott L. Zeger
> Amer J Epi 1991;134(10):1062

was creating by combining the `quote` and `flushleft` environments like this:

```
\begin{quote}
  \begin{flushleft}
    Statistical models are sometimes misunderstood in
    epidemiology. Statistical models for data are \emph{never
      true}. The question of whether a model is true is irrelevant. A
    more appropriate question is whether we obtain the correct
    scientific conclusion if we pretend that that process under study
    behaves according to a particular statistical model.

    Scott L. Zeger\\
    Amer J Epi 1991;134(10):1062
  \end{flushleft}
\end{quote}
```

Alternatively, this quote display,

> Statistical models are sometimes misunderstood in epidemiology. Statistical models for data are *never true*. The question of whether a model is true is irrelevant. A more appropriate question is whether we obtain the correct scientific conclusion if we pretend that that process under study behaves according to a particular statistical model.
>
> Scott L. Zeger
> Amer J Epi 1991;134(10):1062

was created by combining the `quote` evironment and the `\raggedleft` declaration.

```
\begin{quote}
```

```
  \raggedleft
  Statistical models are sometimes misunderstood in
  epidemiology. Statistical models for data are \emph{never
    true}. The question of whether a model is true is irrelevant. A
  more appropriate question is whether we obtain the correct
  scientific conclusion if we pretend that that process under study
  behaves according to a particular statistical model.

  Scott L. Zeger\\
  Amer J Epi 1991;134(10):1062
\end{quote}
```

Generally, it makes more sense to use a declaration inside an environment. For example, we commonly use the `\centering` declaration inside the `table` environment (see Table 7) and the `figure` environment (see Figure 5) to center align tables and figures.

3.10 Creating footnotes

Creating footnotes is very easy.[16] For example, the footnote in the previous sentence was created using the following in the source file:

```
Creating footnotes is very easy.\footnote{This is a footnote}
For example, ...
```

The footnotes will be inserted at the bottom of the current page and will be number consecutively.

3.11 Inserting tables

In general, the most difficult aspect of LaTeXing is creating tables. Powerful word processors make the creation of complex tables very easy. Unfortunately, creating table using source code in any programming language can be cumbersome. However, with practice comes confidence. Hopefully, this tutorial will have most, if not all, of the templates we will need for public health and biomedical publications.

3.11.1 The table and tabular environments:

First, using the `tabular` environment, we create a simple table with 2 rows and columns, and all borders shown.

row 1, column 1	row 1, column 2
row 2, column 1	row 2, column 2

This table was table was created using the following in the source file:

```
First, using the \texttt{tabular} environment, we create a simple
```

[16] This is a footnote

```
table with 2 rows and columns, and all borders.
\begin{tabular}{|c|c|}
  \hline
  row 1, column 1& row 1, column 2\\
  \hline
  row 2, column 1& row 2, column 2\\
  \hline
\end{tabular}
```

However, the `tablular` environment creates the table and puts it inline like any text. We actually want the table displayed, not inline. To display a table we wrap the `tabular` environment in the `table` environment. The following examples illustrate this.

Here we create the familiar 2 by 2 table. For this we need to create a table with 3 rows and 3 columns. To create a proper table we must use the `table` and `tabular` environments together. Here is a 2 by 2 table with all borders:

Table 7: A 2 by 2 table with no borders

	Disease	Nondisease
Exposed	a	b
Nonexposed	c	d

This table was table was created using the following in the source file:

```
\begin{table}[!h]
  \centering
  \caption{A 2 by 2 table with no borders}
  \begin{tabular}{|l|c|c|}
    \hline
    &Disease&Nondisease\\
    \hline
    Exposed   &  $a$  &   $b$\\
    \hline
    Nonexposed&  $c$  &   $d$\\
    \hline
  \end{tabular}
  \label{tab:2by2none}
\end{table}
```

The `tabular` environments is for creating the actual table. The `table` environment wraps around the `tabular` environment and enables the following:

- Creates a floating table
- Specifies floating position

- Inserts caption above or below the table (optional)
- Contains label for cross-referencing (optional)

LaTeX places the floating table in the optimal position, taking into account our preference. The syntax for specifying floating position preference is

```
\begin{table}[<preferences>]
```

where [<preferences>] can be either

`[h]` Place here.

`[t]` Place at top of page.

`[b]` Place at bottom of page.

`[p]` Place on page of floats.

Preceding with an exclamation mark (`!`) indicates a very strong preference; for example, `[!h]`. Floating position preferences can also be combined. For example, `[tbp]` indicates "place at top of page, otherwise place at bottom of page, otherwise place on page of floats."

By default, the `table` environment places the table to the left. To center the table add the `\centering` declaration. Everything that follows will be centered. Therefore, it makes sense to insert the caption next, which will be above the table and centered.

Next comes the `tabular` environment. Here's where we construct our table. For example,

```
\begin{tabular}{lcr}
```

means create 3 columns: the 1st column is aligned left, the 2nd column is aligned center, and the 3rd column is aligned right. For vertical border lines, we insert `|` wherever we want a border. For example,

```
\begin{tabular}{l|c|r}
```

insert a border between the 2nd and 3rd column. To insert a double-line border use `||`.

Wherever, we want a horizontal line (across all columns) we insert `\hline`. Table 7 (p. 28) started with a horizontal line (using `\hline`). This was followed by the first row (which are the column headings) looked like this:

```
  & Disease & Nondisease\\
```

For this first row, each cell is separated by an `&` sign. The first cell is empty, the second cell contains "Disease", and the third cell contains "Nondiseaase". The end of the row contains a linebreak (`\\`). The subsequent rows follow the same syntax. Notice that we can use math mode (e.g., `$a$` gives a) inside the `tabular` environment. Finally, the `table` environment can contain a label for cross-referencing.

Table 8: A 2 by 2 table with better formatting

	Disease	
Exposure	Yes	No
Yes	*a*	*b*
No	*c*	*d*

Now, here is the same 2 by 2 table but with better formatting.
And, here is the source code that produced Table 8.

```
\begin{table}[!h]
  \centering
  \caption{A 2 by 2 table with better formatting}
  \begin{tabular}{lcc}
    \hline
    &\multicolumn{2}{c}{Disease}\\
    \cline{2-3}
    Exposure&  Yes  &  No\\
    \hline
    Yes     &  $a$  &  $b$\\
    No      &  $c$  &  $d$\\
    \hline
  \end{tabular}
  \label{tab:2by2better}
\end{table}
```

The \multicolumn command was used to create a cell that spanned more that one column. Here is the syntax:

```
\multicolumn{<number of columns to span>}{<alignment>}{<text>}
```

Now we present a more realistic table that might be submitted in a manuscript. Displayed in Table 9 on page 32 are selected rows from a table presented in a research manuscript that was accepted for publication.

Here is the source code that generated Table 9:

```
\begin{table}[bht]
  \centering
  \caption{Bivariable frequency-matched odds ratios (OR) for the
    occurrence of shigellosis according to selected sexual exposures
    and non-sexual risk factors}
  \begin{tabular}{lrrrrccr}
    \hline
```

```
    & \multicolumn{2}{c}{Cases} & \multicolumn{2}{c}{Controls} & & &
       \\
    Variable & No./$N$ & (\%) & No./$N$ & (\%) & OR & 95\% CI & $p$
       value\\
    \hline
    Men sex with men & 48/76 & (63.2) & 30/147 & (20.4) & 13.0 &
    5.82--28.8 &  $<0.001$\\
    STD history & 41/76 & (53.9) & 48/144 & (33.3) & 2.41 &
    1.35--4.30 & 0.003\\
    HIV positive & 28/76 & (36.8) & 7/147 & (4.8) & 13.9 &
    5.51--34.9 &  $<0.001$\\
    AIDS diagnosis & 11/74 & (14.9) & 5/144 & (3.5) & 5.08 &
    1.67--15.5 & 0.004\\
    Any sexual activity & 44/75 & (58.7) & 67/138 & (48.6) & 1.50 &
    0.85--2.66 & 0.160\\
    Sexual anal contact & & & & & & \\
    \hspace{15pt}No sex/No anal & 38/76 & (50.0) & 90/147 & (61.2) &
    1.00 & Reference& $\cdots$ \\
    \hspace{15pt}Sex/No anal & 9/76 & (11.8) & 40/147 & (27.2) & 0.60
       &
    0.25--1.41 &  0.241\\
    \hspace{15pt}Indirect anal & 14/76 & (18.4) & 13/147 & (8.8) &
       2.93 &
    1.19--7.23 &  0.020\\
    \hspace{15pt}Direct anal & 15/76 & (19.7) & 4/147 & (2.7) & 10.2 &
    3.04--34.2 &  $<0.001$\\
    \hline
  \end{tabular}
  \label{tab:sexrisk}
\end{table}
```

This source code illustrates a few addtional features. The `\vspace{5pt}` added 5 points of vertical space between the caption and the table. The

```
\setlength{\extrarowheight}{1pt}
```

added 1 point to the row height. Finally, we used `\hspace` to add 15 points of indentation to subcategories of a variable.

For specific scientific disciplines, there are a handful of tables that are commonly deployed. The trick is to have a small library of table templates that you can adapt for your work. In the appendix we have common table templates for public health, medicine, and epidemiology.[17]

[17] Please submit templates to mailto:medepi@gmail.com

Table 9: Bivariable frequency-matched odds ratios (OR) for the occurrence of shigellosis according to selected sexual exposures and non-sexual risk factors

	Cases		Controls				
Variable	No./N	(%)	No./N	(%)	OR	95% CI	p value
Men sex with men	48/76	(63.2)	30/147	(20.4)	13.0	5.82–28.8	< 0.001
STD history	41/76	(53.9)	48/144	(33.3)	2.41	1.35–4.30	0.003
HIV positive	28/76	(36.8)	7/147	(4.8)	13.9	5.51–34.9	< 0.001
AIDS diagnosis	11/74	(14.9)	5/144	(3.5)	5.08	1.67–15.5	0.004
Any sexual activity	44/75	(58.7)	67/138	(48.6)	1.50	0.85–2.66	0.160
Sexual anal contact							
No sex/No anal	38/76	(50.0)	90/147	(61.2)	1.00	Reference	⋯
Sex/No anal	9/76	(11.8)	40/147	(27.2)	0.60	0.25–1.41	0.241
Indirect anal	14/76	(18.4)	13/147	(8.8)	2.93	1.19–7.23	0.020
Direct anal	15/76	(19.7)	4/147	(2.7)	10.2	3.04–34.2	< 0.001

To learn more about tables visit https://en.wikibooks.org/wiki/LaTeX/Tables.

3.12 Inserting figures

Fortunately, inserting figures is not as cumbersome as creating tables. LaTeX can insert the following images

- PDF (portable document format)
- PNG (multipurpose)
- JPG (photographs)
- EPS (encapsulated postscript)

Here are some general rules to follow:

- Graphics display better in their native size; if possible, create graphics in the size you plan to display them
- For PDF, PNG, JPG images, `pdflatex` will create PDF file in one step
- Encapsulated PostScript (EPS) or PostScript (PS) provides the best quality
- For EPS or PS graphics, first create DVI file, then convert to PDF file

Remember that converting a DVI file to PDF is different in MS Windows compared to Mac OS. MS Windows required three steps:

```
latex mydoc
dvips mydoc
ps2pdf mydoc
```

And in Mac OS, only two steps are required:

```
latex mydoc
dvipdf mydoc
```

Our graphical displays are based on the graphicx package. Displayed in Figure 5 is a photograph of the Camp Funston emergency hospital during the 1918 influenza pandemic. Here is

Figure 5: Emergency hospital during 1918 influenza pandemic, Camp Funston, Kansas. Source: National Museum of Health and Medicine; Available at http://www.nmhm.washingtondc.museum/collections/archives/agalleries/1918flu/1918flu.html

the source code used to create Figure 5.

```
\begin{figure}[tbh]
  \centering
  \includegraphics[scale=0.4]{/home/tja/images/flu/fig_campfunston
     1918}
  \caption{Emergency hospital during 1918 influenza epidemic, Camp
     Funston,
    Kansas. Source: National Museum of Health and Medicine; Available
    at \url{http://www.nmhm.washingtondc.museum/collections/...}}
  \label{fig:flucamp}
\end{figure}
```

The figure environment is similar to the table environment: it is used to display the graphical image, including its alignment, caption, and label for cross-referencing. Without the figure environment, the includegraphics command would insert the graphic inline.

The `\includegraphics` command has the following syntax:

```
\includegraphics[<options>]{<file path to graphic>}
```

For the size option, specify the `width`, `height`, or `scale`. We only need to specify width or height, not both. Remember to specify units (e.g., in, cm, etc.). A convenient option is to specific a relative width or height. Here are two examples:

```
\includegraphics[width=0.8\textwidth]{<file path to graphic>}

\includegraphics[height=0.8\textheight]{<file path to graphic>}
```

For the file name, we do not need to specify the file extension (e.g., .eps, .png, .jpg, etc.): it looks for the appropriate file. However, if one is uncertain include the file extension.

Suppose we wanted to plot the standard normal curve (Equation 4) and simulate the standard normal distribution. For a standard normal curve, $\mu = 0$ (mean) and $\sigma = 1$ (standard deviation).

$$f(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left\{\frac{-(x-\mu)^2}{2\sigma^2}\right\} \tag{4}$$

Using this information, we can plot the standard normal curve and simulate 500 standard normal variates (Figure 6)[18].

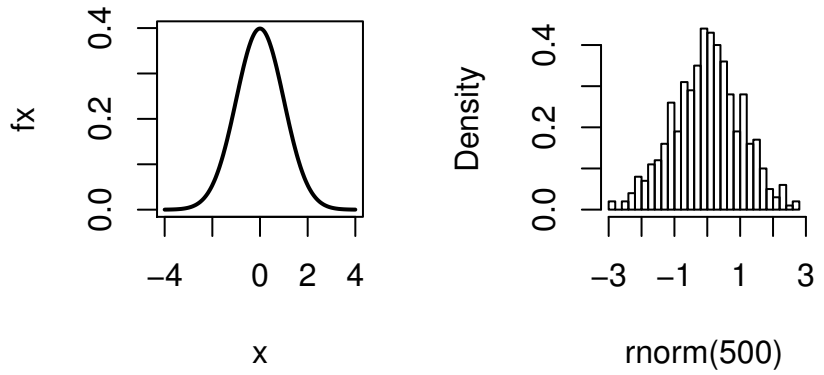

Figure 6: Standard normal curve from Equation 4 and simulatiing 500 standard normal variates

Here is the source code to create Equation 4:

```
\begin{equation}
  f(x) = \frac{1}{\sqrt{2 \pi \sigma^2}}
         \exp \left\{\frac{-(x - \mu)^2}{2 \sigma^2} \right\}
    \label{eq:norm}
\end{equation}
```

[18] Plots were created in R—an open source program for statistical computing and graphics. Available at http://www.r-project.org

And here is the source code to insert the postscript normal curve plot (Figure 6):

```
\begin{figure}[tb]
  \centering
  \includegraphics[angle=90,scale=1]{/home/tja/images/fig_norm-crop.
     pdf}
  \caption{Standard normal curve from Equation~\ref{eq:norm} and
    simulatiing 500 standard normal variates}
  \label{fig:normplot}
\end{figure}
```

Examples of graphics created in the LibreOffice Draw program are displayed in Figures 7, 8, and 9. These graphics were created in the same size they were intended to be displayed in the final documents. To export as an Encapsulated PostScript (EPS) file, from the main menu select Edit > Select All; then from the main menu select File > Export...; from the dialog menu select EPS-Encapsulated PostScript (.eps), and click on Export. This assures that only the image is exported to EPS, and not the whole page. Notice that the graphics are all high-quality and high-resolution.

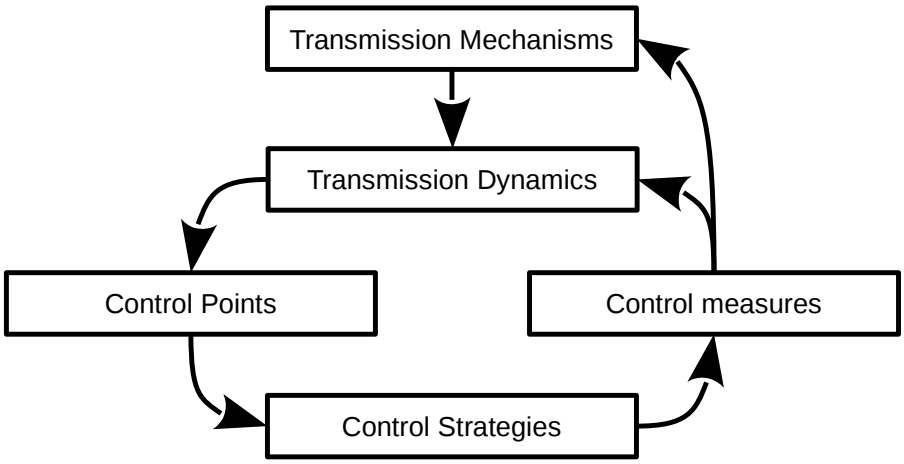

Figure 7: Example 1 of graphic created in LibreOffice Draw program and exported as an Encapsulated PostScript (EPS) file: Summary of the concepts for controlling microbial threats

3.13 Cross referencing

In LaTeX, anything can be labeled for cross referencing. In general, the following objects are commonly labeled:

- Tables
- Figures

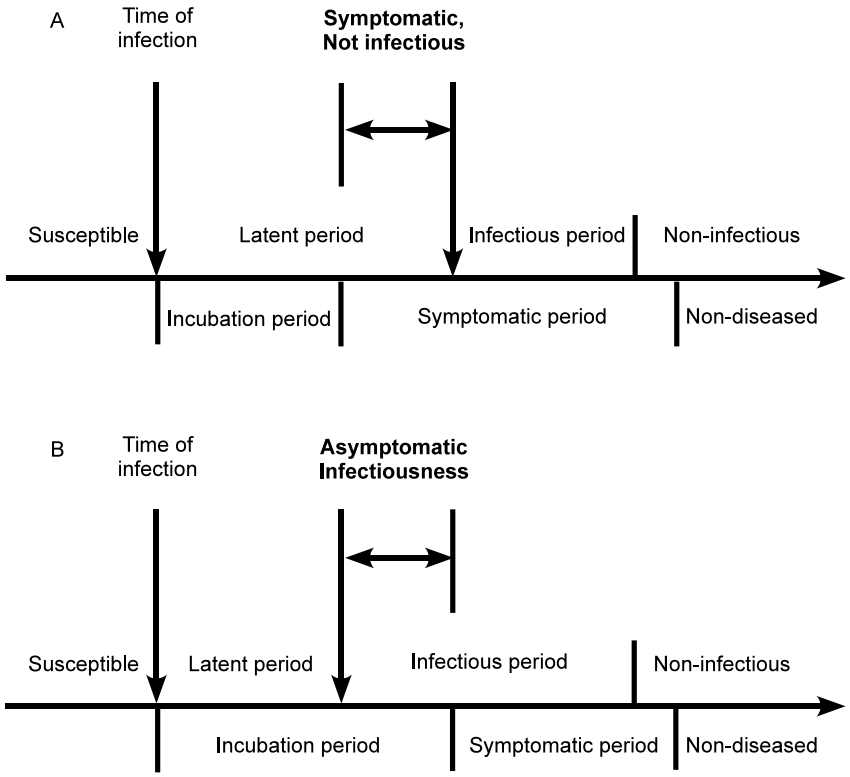

Figure 8: Example 2 of graphic created in OpenOffice.org Draw program and exported as an Encapsulated PostScript (EPS) file: The natural history of infection and infectiousness

- Equations
- Section headings

The following commands are used:

- `\label`
- `\ref`
- `\pageref`

We have already seen the `\label` command used in the `table`, `figure`, and `equation` environments.

For example, the source code for cross-referencing Figure 6 (p. 34), Equation 4 (p. 34), and Table 9 (p. 32) are provided below:

```
For example, the source code for cross-referencing
Figure~\ref{fig:normplot} (p.~\pageref{fig:normplot}),
Equation~\ref{eq:norm} (p.~\pageref{eq:norm}), and
Table~\ref{tab:sexrisk} (p.~\pageref{tab:sexrisk}) are
```

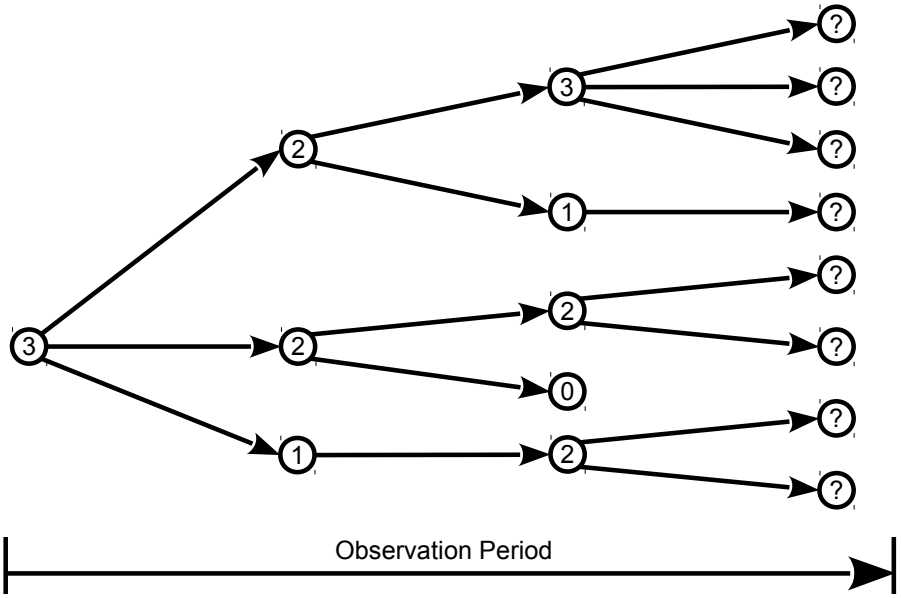

Figure 9: Example 3 of graphic created in OpenOffice.org Draw program and exported as an Encapsulated PostScript (EPS) file: The reproductive number in infectious disease transmission dynamics

```
provided below:
```

The `\ref` command contains the label of the object of interest (table, figure, equation, etc.) and produces the number that corresponds to that object (if the object is numbered). The `\pageref` inserts the page number for the labeled object. The ~ character keeps the number next to the object descriptor (e.g., `Equation~\ref{eq:norm}`) so that they are not separated by a linebreak.

Sections can also be labeled and cross-referenced. For example, to cross-reference Section 2 on p. 3 use the following label:

```
\section{Getting started with \LaTeX}
\label{sec:getting-started}
```

And here is the source code to make the cross-reference:

```
Sections can also be labeled and cross-referenced. For example, to
cross-reference Section~\ref{sec:getting-started} on
p.~\pageref{sec:getting-started} use the following label:
```

Because good graphics and images are used over and over and over again (e.g., documents, slide presentations, etc.), it makes sense to have one image library folder. When an image is updated or improved, recompiling our LaTeX documents automatically updates all the images. There is no need to go into every single document or slide presentation and replace the old image with the new one. For example, our image library has the following file path:

/User/<user>/Documents/images/

4 Bibliographies

In this section we learn how to cite references in the narrative body and how to build a corresponding bibliography at the end of the document. First, we cover how to do this manually, then how to do this using BibTEX—a bibliography database for LATEX.

4.1 Creating bibliographies manually

The International Committee of Medical Journal Editors (ICMJE)[19] Uniform Requirements for Manuscripts Submitted to Biomedical Journals has published online sample references[20] for journal articles, books, electronic materials, and others publications.

For standard journal articles, list up to six authors [3]. If there are more than six authors, list the first six authors followed by "et al." [6]. If a journal carries continuous pagination throughout a volume (as many medical journals do) the month and issue number may be omitted [3b]. The addition of a database's unique identifier for the citation is optional [3c]. Book citations can have personal authors [5], editors [2], both personal authors and editors [1], organization(s) as author [7], or chapter(s) in a book [4].

References

[1] Breedlove GK, Schorfheide AM. Adolescent pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of Dimes Education Services; 2001.

[2] Gilstrap LC 3rd, Cunningham FG, VanDorsten JP, editors. Operative obstetrics. 2nd ed. New York: McGraw-Hill; 2002.

[3] Halpern SD, Ubel PA, Caplan AL. Solid-organ transplantation in HIV-infected patients. N Engl J Med. 2002 Jul 25;347(4):284–7.

[3b] Halpern SD, Ubel PA, Caplan AL. Solid-organ transplantation in HIV-infected patients. N Engl J Med. 2002;347:284–7.

[3c] Halpern SD, Ubel PA, Caplan AL. Solid-organ transplantation in HIV-infected patients. N Engl J Med. 2002 Jul 25;347(4):284–7. Cited in PubMed; PMID 12140307.

[4] Meltzer PS, Kallioniemi A, Trent JM. Chromosome alterations in human solid tumors. In: Vogelstein B, Kinzler KW, editors. The genetic basis of human cancer. New York: McGraw-Hill; 2002. p. 93–113.

[19] http://www.icmje.org/

[20] http://www.nlm.nih.gov/bsd/uniform_requirements.html

[5] Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA. Medical microbiology. 4th ed. St. Louis: Mosby; 2002.

[6] Rose ME, Huerbin MB, Melick J, Marion DW, Palmer AM, Schiding JK, et al. Regulation of interstitial excitatory amino acid concentrations after cortical contusion injury. Brain Res. 2002;935(1–2):40–6.

[7] Royal Adelaide Hospital; University of Adelaide, Department of Clinical Nursing. Compendium of nursing research and practice development, 1999–2000. Adelaide (Australia): Adelaide University; 2001.

Now, let's study the LaTeX source code for generating the previous paragraph followed by the corresponding references. Here it is in its entirety:

```
For standard journal articles, list up to six authors
\cite{Halpern2002a}. If there are more than six authors, list the
first six authors followed by et al \cite{Rose2002}. If a journal
carries continuous pagination throughout a volume (as many medical
journals do) the month and issue number may be omitted
\cite{Halpern2002b}. The addition of a database's unique identifier
for the citation is optional \cite{Halpern2002c}.  Book citations can
have personal authors \cite{Murray2002}, editors \cite{Gilstrap2002},
both personal authors and editors \cite{Breedlove2001},
organization(s) as author \cite{Royal2001}, or chapter(s) in a book
\cite{Meltzer2002}.

\begin{thebibliography}{99}
\bibitem{Breedlove2001} Breedlove GK, Schorfheide AM. Adolescent
  pregnancy. 2nd ed. Wieczorek RR, editor. White Plains (NY): March of
  Dimes Education Services; 2001.
\bibitem{Gilstrap2002} Gilstrap LC 3rd, Cunningham FG, VanDorsten JP,
  editors. Operative obstetrics. 2nd ed. New York: McGraw-Hill; 2002.
\bibitem{Halpern2002a} Halpern SD, Ubel PA, Caplan AL. Solid-organ
  transplantation in HIV-infected patients. N Engl J Med. 2002 Jul
  25;347(4):284--7.
\bibitem[3b]{Halpern2002b} Halpern SD, Ubel PA, Caplan AL. Solid-organ
  transplantation in HIV-infected patients. N Engl J
  Med. 2002;347:284--7.
\bibitem[3c]{Halpern2002c} Halpern SD, Ubel PA, Caplan AL. Solid-organ
  transplantation in HIV-infected patients. N Engl J Med. 2002 Jul
  25;347(4):284--7. Cited in PubMed; PMID 12140307.
\bibitem{Meltzer2002} Meltzer PS, Kallioniemi A, Trent JM. Chromosome
  alterations in human solid tumors. In: Vogelstein B, Kinzler KW,
```

```
  editors. The genetic basis of human cancer. New York: McGraw-Hill;
  2002. p. 93--113.
\bibitem{Murray2002} Murray PR, Rosenthal KS, Kobayashi GS, Pfaller
  MA. Medical microbiology. 4th ed. St. Louis: Mosby; 2002.
\bibitem{Rose2002} Rose ME, Huerbin MB, Melick J, Marion DW, Palmer
  AM, Schiding JK, et al. Regulation of interstitial excitatory amino
  acid concentrations after cortical contusion injury. Brain
  Res. 2002;935(1--2):40--6.
\bibitem{Royal2001} Royal Adelaide Hospital; University of Adelaide,
  Department of Clinical Nursing. Compendium of nursing research and
  practice development, 1999--2000. Adelaide (Australia): Adelaide
  University; 2001.
\end{thebibliography}
```

To compile the bibliography manually, just process the source file (e.g., mydoc.tex) using the `latex` command.

First, we placed `thebibliography` environment where we wanted the bibliography to appear in the document. For articles, the section is automatically labeled **References**, and for books and theses, the section is labeled **Bibliography**. The `thebibliography` environment has the following syntax:

```
\begin{thebibliography}{<sample label>}
\bibitem[<optional label>]{<citation key>} reference text
\end{thebibliography}
```

The *sample label* is a dummy variable that should be as long as the longest label in the bibliography. For example, if we have over 100 references, and some will be of the type "124c", then *sample label* could be set to 9999 (or any alphanumeric string of length 4). For our example, the length of the longest label was 2, so we set *sample label* to 99. This information is used to set the indentation for the bibliography.

Next, we use `\bibitem` to list the references, similar to `\item` in the `\itemize` or `\enumerate` environments. The bibliography items will be numbered in the order they are listed, not in the order they are cited in the document. If we want the bibliography to be numbered in the order they are cited then we must manually order the items in the order they are first cited in the document. In our bibliography, it was (manually) listed in alphabetical order.

After the `\bibitem` declaration, we can provide an *optional label*. If we provide an optional label, that item will not be numbered. For example, knowing that Halpern2002a was the third item, we labeled items Halpern2002b and Halpern2002c, 3b and 3c, respectively.

Next, we must provide a unique *citation key* for the reference that follows. The key can contain any characters except commas. We chose to create a unique key using the first author's last name and the year of publication. Next, we must provide the *reference text* as we want it to appear in the bibliography. Here we have complete flexibility to use LaTeX to format the bibliography items.

Finally, use the `\cite` command with the *citation key* in the document body to reference a bibliography item. You can even cite multiple references like this: [3, 3b, 6, 5, 7]. Here is the source code:

```
You can even cite multiple references like this: \cite{Halpern2002a,
  Halpern2002b, Rose2002, Murray2002, Royal2001}.
```

What are the advantages of a manual bibliography?

- Complete control in the appearance of the bibliography items: This is useful if we are submitting a manuscript to an obscure journal with a nonconventional bibliography style that is not available as a BibTEX style.
- Bibliography items are contained in one source file: Collaborators can edit, remove, or add to the bibliography items using only a text editor.

What are the disadvantages of a manual bibliography? Too many to list! Hence, the popularity of bibliography management software such as Endnote. For LATEX, we will be working with BibTEX—a text-based reference database, and JabRef, an open source reference manager for managing BibTEX databases.

http://www.tug.org/tex-archive/help/Catalogue/entries/vancouver.html

4.2 Creating bibliographies using the BibTEX database

Using a bibliographic database and program is a more efficient method to cite references and generate bibliographies. For LATEX documents we use BibTEX. Creating a BibTEX bibliography involves the following steps:

- Create a BibTEX database file (e.g., myrefs.bib)
- Use the `\bibliography` command to specify the path to the BibTEX database (e.g., `~/Documents/bibtex/myrefs.bib`)
- Use the `\bibliographystyle` command to select a bibliography style (e.g., the Vancouver style complies with the Uniform Requirements for Manuscripts Submitted to Biomedical Journals[21])
- Use the `latex` and `bibtex` commands to compile a LATEX document: process the source file with `latex`, run `bibtex`, and run `latex` twice.

The BibTEX database file is a simple ASCII text file that ends with a `.bib` extension. The core BibTEX entry types include the following:

- `article`: an article from a journal or magazine; Required fields: `author`, `title`, `journal`, `year`; Optional fields: `volume`, `number`, `pages`, `month`, `note`, `key`

[21] http://www.icmje.org/

- book: a book with an explicit publisher; Required fields: author or editor, title, publisher, year; Optional fields: volume, series, address, edition, month, note, key
- booklet: a work that is printed and bound, but without a named publisher or sponsoring institution; Required fields: title; Optional fields: author, howpublished, address, month, year, note, key
- conference or inproceedings: an article in a conference proceedings; Required fields: author, title, booktitle, year; Optional fields: editor, pages, organization, publisher, address, month, note, key
- inbook: a part of a book, which may be a chapter (or section or whatever) and/or a range of pages; Required fields: author or editor, title, chapter and/or pages, publisher, year; Optional fields: volume, series, address, edition, month, note, key
- incollection: a part of a book having its own title; Required fields: author, title, booktitle, year; Optional fields: editor, pages, organization, publisher, address, month, note, key
- manual: Technical documentation; Required fields: title; Optional fields: author, organization, address, edition, month, year, note, key
- mastersthesis: a Master's thesis; Required fields: author, title, school, year; Optional fields: address, month, note, key
- misc: For use when nothing else fits; Required fields: none; Optional fields: author, title, howpublished, month, year, note, key
- phdthesis: a Ph.D. thesis; Required fields: author, title, school, year; Optional fields: address, month, note, key
- proceedings: The proceedings of a conference; Required fields: title, year; Optional fields: editor, publisher, organization, address, month, note, key
- techreport: a report published by a school or other institution, usually numbered within a series; Required fields: author, title, institution, year; Optional fields: type, number, address, month, note, key
- unpublished: a document having an author and title, but not formally published; Required fields: author, title, note; Optional fields: month, year, key

To understand the syntax for a single BibTEX entry, we will study a journal article entry in myrefs.bib:

```
@Article{Halpern2002b,
  author  = {Halpern, S.D. and Ubel, P.A. and Caplan, A.L.},
  title   = {Solid-organ transplantation in {HIV}-infected patients.},
  journal = {N Engl J Med},
```

```
  volume  = {347},
  number  = {4},
  pages   = {284--7},
  note    = {Cited in PubMed; PMID 12140307.},
  year    = 2002
}
```

The syntax `@Article`, specifies an article entry type and is not case sensitive, so `@ARTICLE`, or `@article` are equivalent. For a book use `@book`, for a report use `@techreport`, for a Ph.D. thesis use `@phdthesis`, etc. The entry type is followed by an opening curly bracket, then a unique BibTEX key for that citation. The unique key usually contains some combination of author name(s) and year (e.g., `Halpern2002b`). The key can have any character except commas. The key is followed by a comma.

After the BibTEX key, comes the fields separated by commas (there is no comma after the last field). A single field consist of the following:

```
<fieldname> = {<text entry>}
```

For an article, the required fields are `author`, `title`, `journal`, and `year`, and the optional fields are `volume`, `number`, `pages`, `month`, `note`, and `key`. These fields can be placed in any order; the only requirement is that they are separated by commas.

For the `author` field, the authors are separated by `and`. The authors' names should be entered like this:

```
author  = {Halpern, S.D. and Ubel, P.A. and Caplan, A.L.}
```

like this:

```
author  = {Scott D. Halpern and Peter A. Ubel and Arthur L. Caplan}
```

or like this:

```
author  = {S.D. Halpern and P.A. Ubel and A.L. Caplan}
```

When we search and retrieve citations from PubMed's MEDLINE using JabRef, the authors' names come formatted like `Aragon, T.J.` (the first example). As expected, the field text can contain LATEX markup. For example, to add accents to Tomas Aragon, it would look like this:

```
author  = {Tom\'{a}s J. Arag\'{o}n}
```

The `title` field contains the journal title. By default, only the first letter is capitalized. To change this, wrap any combination of lower and upper case characters in curly brackets. For example, the following syntax

```
title = {Solid-organ transplantation in {HIV}-infected patients.}
```

assures that "HIV" remains upper case in the bibliography.

Previously, we manually created the bibliography on p. 39. Now we will generate this bibliography using BibTEX. Here are the contents of `myrefs.bib`:

```
@Book{Breedlove2001,
  author    = {Breedlove, G.K. and Schorfheide, A.M.},
  ALTeditor    = {Wieczorek, R.R.},
  title     = {Adolescent pregnancy},
  publisher = {March of Dimes Education Services},
  address   = {White Plains (NY)},
  edition   = {2},
  year      = 2001
}

@Book{Gilstrap2002,
  editor    = {Gilstrap, 3rd, L.C. and Cunningham, F.G. and VanDorsten
     , J.P.},
  title     = {Operative obstetrics},
  publisher = {McGraw-Hill},
  address   = {New York},
  edition   = {2},
  year      = 2002
}

@Article{Halpern2002a,
  author  = {Halpern, S.D. and Ubel, P.A. and Caplan, A.L.},
  title   = {Solid-organ transplantation in {HIV}-infected patients.},
  journal = {N Engl J Med},
  volume  = {347},
  number  = {4},
  pages   = {284--7},
  year    = 2002
}

@Article{Halpern2002b,
  author  = {Halpern, S.D. and Ubel, P.A. and Caplan, A.L.},
  title   = {Solid-organ transplantation in {HIV}-infected patients.},
  journal = {N Engl J Med},
  volume  = {347},
  number  = {4},
  pages   = {284--7},
```

```
  note    = {Cited in PubMed; PMID 12140307.},
  year    = 2002
}

@Article{Halpern2002c,
  author  = {Halpern, S.D. and Ubel, P.A. and Caplan, A.L.},
  title   = {Solid-organ transplantation in {HIV}-infected patients.},
  journal = {N Engl J Med},
  volume  = {347},
  number  = {4},
  pages   = {284--7},
  month   = {Jul 25},
  year    = 2002
}

@InBook{Meltzer2002,
  author    = {Meltzer, P.S. and Kallioniemi, A. and Trent, J.M.},
  editor    = {Vogelstein, B. and Kinzler, K.W.},
  title     = {The genetic basis of human cancer},
  chapter   = {Chromosome alterations in human solid tumors},
  pages     = {93--113},
  publisher = {McGraw-Hill},
  address   = {New York},
  year      = 2002
}

@Book{Murray2002,
  author    = {Murray, P.R. and Rosenthal, K.S. and Kobayashi, G.S.
     and
                Pfaller, M.A.},
  title     = {Medical microbiology},
  publisher = {Mosby},
  address   = {St. Louis},
  edition   = {4},
  year      = 2002
}

@Article{Rose2002,
  author  = {Rose, M.E. and Huerbin, M.B. and Melick, J. and
             Marion, D.W. and Palmer, A.M. and Schiding, J.K. and
             Kochanek, P.M.  and Graham, S.H.},
```

```
  title   = {Regulation of interstitial excitatory amino acid
             concentrations after cortical contusion injury.},
  journal = {Brain Res},
  volume  = {935},
  number  = {1--2},
  pages   = {40--6},
  year    = 2002
}

@Book{Royal2001,
  title         = {Compendium of nursing research and practice
    development,
                   1999-2000},
  publisher     = {Adelaide University},
  address       = {Adelaide (Australia)},
  organization  = {{Royal Adelaide Hospital} and {University of
    Adelaide,
                   Department of Clinical Nursing}},
  year          = 2001
}
```

For the book entry `Breedlove2001`, `editor` was set to `ALTeditor` so that this field will not be read. Remember, the `book` type can have `author` or `editor`, but not both. We will add the editor field manually at the very end.

The International Committee of Medical Journal Editors[22] Uniform Requirements for Manuscripts Submitted to Biomedical Journals has published online sample references[23] for journal articles, books, electronic materials, and others publications. The Vancouver style[24] is the BibTEX bibliography style that implements the ICMJE requirements.

For standard journal articles, list up to six authors [3]. If there are more than six authors, list the first six authors followed by et al [6]. If a journal carries continuous pagination throughout a volume (as many medical journals do) the month and issue number may be omitted [3b]. The addition of a database's unique identifier for the citation is optional [3c]. Book citations can have personal authors [5], editors [2], both personal authors and editors [1], organization(s) as author [7], or chapter(s) in a book [4].

Study the the new citations in the paragraph and the new bibliography. Notice that the Vancouver style automatically sorts the bibliography to match the order that the references were cited. Now, let's study the LATEX source code for generating this paragraph and new bibliography. Here it is in its entirety:

[22] http://www.icmje.org/
[23] http://www.nlm.nih.gov/bsd/uniform_requirements.html
[24] http://www.tug.org/tex-archive/help/Catalogue/entries/vancouver.html

```
\bibliography{/Users/tja/Documents/bibtex/myrefs}
\bibliographystyle{/Users/tja/Library/texmf/tex/bibtex/vancouver}
```

From the command line we ran:

```
pdflatex mydoc
bibtex mydoc
pdflatex mydoc
latex mydoc
```

Then create a PDF file using the methods previously described for MS Windows and Mac OS.

Wow, that was easy! We used the `\bibliography` command to specify the location of `myrefs.bib`—our BibTEX database. Notice we did not specify the `.bib` extension; BibTEX automatically looks for `.bib` files. The `\bibliographystyle` command specifies the location of our BibTEX style. Again, we do not specify the `.bst` extension. Additionally, we had to specify the location of the Vancouver style because it was installed separately; it was not part of our MacTeX distribution.

For the MacTeX distribution (Mac OS), we downloaded `vancouver.zip` from http://www.tug.org/tex-archive/help/Catalogue/entries/vancouver.html. After unzipping the file, we placed `vancouver.bst` in the following directory (which was created beforehand):

```
/Users/<user>/Library/texmf/tex/bibtex/
```

From the Mac OS Terminal command line, we ran `texhash`; this registered the Vancouver style with LATEX.

In the MikTeX distribution (MS Windows), just use the following:

```
\bibliographystyle{vancouver}
```

If the Vancouver style is not already installed, MikTeX automatically installs it for you.

4.2.1 Using the `cite` package

For consecutive citations, BibTEX does not combine them into an abbreviated form. For example, if we want these citation: [3, 4, 5, 6, 9] to be [3–6, 9], then load the `cite` package in the preamble.

4.2.2 Manually editing BibTEX bibliographies

Although the Vancouver style implements the ICMJE uniform requirements, it is not perfect. Sometimes we need to make minor edits or additions to the final bibliography. The trick is to leave this step until the very end—we only want to do this once. For example, the `Breedlove2001` entry is a book with authors and an editor; however, the `book` BibTEX type only uses authors or editors, but not both. We will manually add the editor information. We do this by editing the `.bbl` text file (in this case, `mydoc.bbl`).

Here are the entire contents of `mydoc.bbl`:

```
\begin{thebibliography}{1}
\bibitem{Halpern2002a} Halpern SD, Ubel PA, Caplan AL.
\newblock Solid-organ transplantation in {HIV}-infected patients.
\newblock N Engl J Med. 2002;347(4):284--7.

\bibitem{Rose2002} Rose ME, Huerbin MB, Melick J, Marion DW,
Palmer AM, Schiding JK, et~al.
\newblock Regulation of interstitial excitatory amino acid
    concentrations after
  cortical contusion injury.
\newblock Brain Res. 2002;935(1--2):40--6.

\bibitem{Halpern2002b} Halpern SD, Ubel PA, Caplan AL.
\newblock Solid-organ transplantation in {HIV}-infected patients.
\newblock N Engl J Med. 2002;347(4):284--7.
\newblock Cited in PubMed; PMID 12140307.

\bibitem{Halpern2002c} Halpern SD, Ubel PA, Caplan AL.
\newblock Solid-organ transplantation in {HIV}-infected patients.
\newblock N Engl J Med. 2002 Jul 25;347(4):284--7.

\bibitem{Murray2002} Murray PR, Rosenthal KS, Kobayashi GS, Pfaller MA
    .
\newblock Medical microbiology.
\newblock 4th ed. St. Louis: Mosby; 2002.

\bibitem{Gilstrap2002} Gilstrap LC 3rd, Cunningham FG, VanDorsten JP,
    editors.
\newblock Operative obstetrics.
\newblock 2nd ed. New York: McGraw-Hill; 2002.

\bibitem{Breedlove2001} Breedlove GK, Schorfheide AM.
\newblock Adolescent pregnancy.
\newblock 2nd ed. White Plains (NY): March of Dimes Education Services
    ; 2001.

\bibitem{Royal2001} {Royal Adelaide Hospital};
{University of Adelaide, Department of Clinical Nursing}.
\newblock Compendium of nursing research and practice development,
    1999-2000.
\newblock Adelaide (Australia): Adelaide University; 2001.
```

```
\bibitem{Meltzer2002} Meltzer PS, Kallioniemi A, Trent JM.
\newblock Chromosome alterations in human solid tumors.
\newblock In: Vogelstein B, Kinzler KW, editors. The genetic basis of
    human
  cancer. New York: McGraw-Hill; 2002. p. 93--113.

\end{thebibliography}
```

To fix the `Breedlove2001` entry, edit the following:

```
\bibitem{Breedlove2001} Breedlove GK, Schorfheide AM.
\newblock Adolescent pregnancy.
\newblock 2nd ed. White Plains (NY): March of Dimes Education Services
    ; 2001.
```

to this:

```
\bibitem{Breedlove2001} Breedlove GK, Schorfheide AM.
\newblock Adolescent pregnancy. 2nd ed.
\newblock Wieczorek RR, editor.
\newblock White Plains (NY): March of Dimes Education Services; 2001.
```

and save the changes to `myrefs.bib`. Notice we only added `\newblock Wieczorek RR, editor.` to the correct position in the citatation. Recompile the DVI file running the `latex` command twice, then create a PDF file. Do not run the `bibtex` command again, otherwise it creates a new `.bbl` file, overwriting our `.bbl` edits. That's why we leave editing the `.bbl` file to the last step.

Alternatively, aftering studying how the Vancouver style compiles the bibliography from the BibTEX database, we can edit the following entry in `myrefs.bib`:

```
@Book{Breedlove2001,
  author    = {Breedlove, G.K. and Schorfheide, A.M.},
  ALTeditor = {Wieczorek, R.R.},
  title     = {Adolescent pregnancy},
  publisher = {March of Dimes Education Services},
  address   = {White Plains (NY)},
  edition   = {2},
  year      = 2001
}
```

to this:

```
@Book{Breedlove2001,
```

```
  author    = {Breedlove, G.K. and Schorfheide, A.M.},
  ALTeditor = {Wieczorek, R.R.},
  title     = {Adolescent pregnancy},
  publisher = {March of Dimes Education Services},
  address   = {Wieczorek RR, editor. White Plains (NY)},
  edition   = {2},
  year      = 2001
}
```

Notice that we only edited the `address` field. As before, we can run `latex`, `bibtex`, and `latex` twice. The only problem with this approach is that other BibTEX styles may not compile BibTEX entries similar to the Vancouver style.

To summarize, we build a BibTEX database (in the next section we use a reference manager for this), we cite the references in our document using the unique BibTEX keys, we select a BibTEX style that matches the requirements of the journal to which we are submitting a manuscript, we compile the document using the `bibtex` and `latex` commands. Finally, we may need to do minor edits to either the `.bbl` file or to the `.bib` database to get the final bibliography we want.

4.2.3 More on BibTEX styles

Most public health and biomedical journals use the the ICMJE Uniform Requirements for Manuscripts Submitted to Biomedical Journals, so the Vancouver style is a good place to start. Be sure to review the Vancouver documentation because it includes the complete set of ICMJE requirements, corresponding BibTEX entries, and new customized BibTEX types to handle citing maps, patents, dictionaries, web pages, and more.

The following journals also have their own BibTEX styles:

- BioMed Central: Available at http://www.biomedcentral.com/info/ifora/tex
- Elsevier journals. LATEX guidelines at http://authors.elsevier.com/getting_published.html?dc=QG3
- Public Library of Science (PLoS): Available at http://journals.plos.org/plos.bst
- Science: Available at http://www.sciencemag.org/about/authors/prep/TeX_help/index.dtl

To check what BibTEX style is available for a specific journal, query the BibTEX styles database at http://jo.irisson.free.fr/bstdatabase/.

4.3 Creating bibliographies using the JabRef—a BibTEX reference manager

The GNU Emacs text editor comes with a BibTEX mode for managing, editing, creating BibTEX entries (Figure 10 on the following page). When a `.bib` file is opened in Emacs, the BibTEX mode is activated.

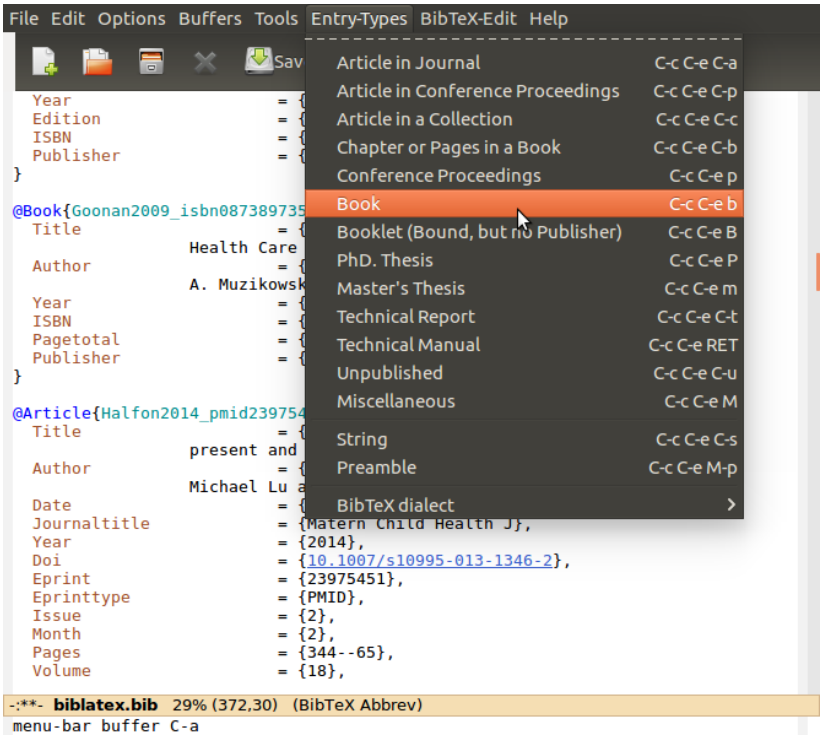

Figure 10: BibTEX mode in GNU Emacs: Carbon Emacs running in Mac OS Tiger. This screen shows the menu selection for inserting a BibTEX entry.

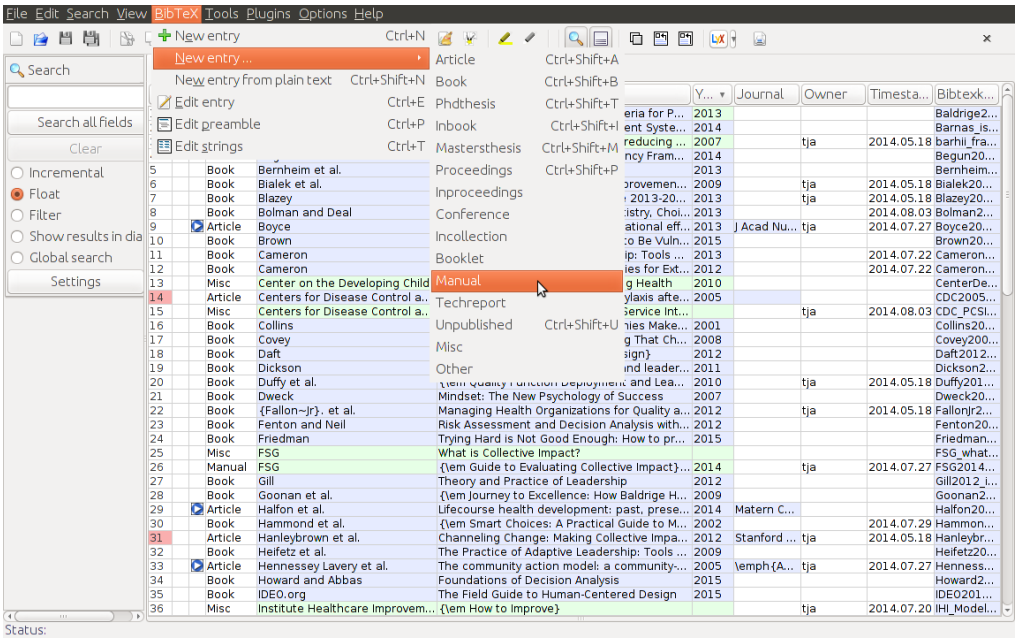

Figure 11: JabRef: A open source, multi-platform BibTEX reference manager.

However, to really take advantage of BibTEX, we highly recommend using a BibTEX reference manager such as JabRef. JabRef is an open source program written in Java, so it runs on all platforms (see Figure 11). From within JabRef, we can search PubMed's MEDLINE and directly import citations into JabRef. When we select a JabRef citation, a window opens with the following tabs:

- Required fields
- Optional fields
- General
- Abstract
- Review
- BibTEX source

By default, most of the fields are already filled out. The Review field is empty and can be filled out by the user. The user can also create new fields for data collection; e.g., if one is conducting a systematic review. The BibTEX source field displays the BibTEX entry as it is saved in the `.bib` file.

JabRef can manage multiple BibTEX databases (i.e., `.bib` files). For a specific document, select a JabRef database. Highlight a citation. If the citation does not already have a BibTEX key, from the main menu select Tools > Autogenerate BibTeX keys. A BibTEX key will be generated for the highlighted entry. To copy a BibTEX key for pasting into our source document, select a

citation and right-click the mouse. From the context menu, select "Copy BibTeX key" or "Copy \cite{BibTeX key}". Paste the key into the LaTeX document source file. As before, using the `\bibliography` and `\bibliographystyle` commands, compile the latex document.

A major benefit of JabRef is fetching and managing bibliographic references. JabRef has many advanced features not found in proprietary software such as EndNote (take a test drive to see). Like EndNote, article PDF files and URL links can also be managed. For example, similar to having one centralized image library, it makes sense to have one electronic reference library. We save all our PDF journal articles in one folder using a concise, unambiguous, duplication-free file naming convention: the PubMed Identification (PMID) number. We link to these files using JabRef. For example, one of our articles is named `12911836.pdf`, and it resides in the following folder:

```
/Users/<user>/Documents/elib/
```

where `elib` is an abbreviation for "electronic library." If someone sends us a PDF file with this naming convention, then we can quickly retrieve the full citation from PubMed, PubMed via JabRef, or JabRef (if it's in one of our BibTeX databases).

5 Articles

Fortunately, preparing journal manuscripts using LaTeX is very straightforward. ICMJE manuscripts for submission to biomedical journals have a basic structure:

- Title page
- Conflict of Interest Notification Page
- Abstract and Key Words
- Introduction
- Methods
- Results
- Discussion
- References
- Tables
- Illustrations (Figures)
- Legends for Illustrations (Figures)

We are sure to review the ICMJE requirements posted at http://www.icmje.org/.

We also review the requirements of the journal publisher to which we will be submitting our manuscript. Some questions we consider include:

- Do they accept PDF manscripts?
- Do they accept native LaTeX documents?
- Do they have a recommended or own LaTeX document class?
- Do they have a LaTeX template?
- Do they have a recommended or own BibTeX style?
- What are their font style and font size requirements?
- Do they have a margin size requirement?

High quality, technical, and quantitative scientific journals accept LaTeX: it is the standard for professionally typeset scientific publications.

Some journals are still in the dark ages and only accept MS Word. These journals tend to be clinically oriented and cater to authors that are generally unfamiliar with markup languages. From a philosophical perspective, we prefer to submit manuscripts to Open Access journals such as the Public Library of Science.[25] These journals adhere to the highest standards for scientific peer review, and not only accept LaTeX documents, but some have extensive LaTeX support (e.g., document class and/or templates, BibTeX style, etc.)

5.1 Preparing manuscript template

The first step is to create a LaTeX text file (`manuscript.tex`) and outline the manuscript. This file will serve as a template for future manuscripts. Because LaTeX is very powerful, it is tempting to create a complex, publication-ready document; however, it's very important to keep the document as simple as possible. The manuscript is not a final document; it will be typeset by the journal publisher and they want to process the text and bibliography without problems.

For this section we review the contents of the source file `manuscript.tex` and the document file `manuscript.pdf`, both available at http://www.medepi.net/latex/.

5.1.1 Manuscript preamble

For manuscript `manuscript.tex`, we used the `article` document class. The default font size is 10pt. We can change the font size to 11pt or 12pt like this:

```
\documentclass[11pt]{article}
```

We use the `geometry` package to set the margins. The `setspace` package enables double spacing. Any text following the `\doublespacing` command will be doubled spaced. To return to single spacing insert the `\singlespacing` command. The `verbatim` package enables the `comment` environment in order to insert extensive comments in the source `.tex` file. The `cite` package abbreviates citations from [2, 3, 4, 5] to [2–5]. The `url` packages enable the proper display of URLs.

[25] http://www.plos.org

If a URL does not break correctly at the end of a line, install and load the `breakurl` package. The `breakurl` package requires the preloading of the `hyperref` package. The `hyperref` package activates URL hyperlinks.

5.1.2 Manuscript title page

The manuscript title page should carry the following information:

- The title of the article; should include all information in the title that will make electronic retrieval of the article both sensitive and specific.
- Authors' names and institutional affiliations.
- The name of the department(s) and institution(s) to which the work should be attributed.
- Disclaimers, if any.
- Corresponding author name, mailing address, telephone and fax numbers, and e-mail address.
- The name and address of the author to whom requests for reprints should be addressed or a statement that reprints will not be available from the authors.
- Source(s) of support in the form of grants, equipment, drugs, or all of these.
- A running head of no more than 40 characters (count letters and spaces)
- A word count for the text only (excluding abstract, acknowledgments, figure legends, and references) and the abstract
- The number of figures and tables.

The `\title`, `\author`, `\date`, and `\maketitle` commands were use to create a title, listing of authors, and date.

```
\title{The full title goes here}
\author{Tomas J. Aragon$^{1, 2}$ \and Wayne T. Enanoria$^1$ \and
  Travis C. Porco$^3$ \and Arthur L.  Reingold$^2$} \date{\today}
\date{\today}
\maketitle

\begin{itemize}
\item [$^1$] School of Public Health, University of California,
  Berkeley, CA
\item [$^2$] San Franciso Department of Public Health, San Francisco,
  CA
\item [$^3$] Francis I. Proctor Foundation, University of California,
```

```
  San Francisco, CA
\end{itemize}
```

The authors were separated by `\and`. We used the math mode (`$^{1, 2}$`) and the `itemize` environment to footnote the authors affiliations. The `\thanks` command also creates author footnotes, but they are placed at the bottom of the page.

For the rest to the title page, we arbitrarily used `\subsubsection` and `\paragraph` headings to address the ICMJE requirements. We added a section for the co-authors' email addresses. The `\hfill` command horizontally fills space pushing content to its right to be flush right.

5.1.3 Manuscript abstract and body

We used the `\newpage` command to start new pages. We also started double spacing the text using the `\doublespacing` command. To restore single spacing we use the `\singlespacing` command. To center the abstract section heading, we used the following syntax:

```
\section*{\protect \centering Abstract}
```

Also notice that we suppressed section numbering using the * symbol.

For a publication-ready abstract use the `abstract` environment:

```
The abstract goes here.
```

We started the manuscript body (introduction, methods, results, discussion) with a new page. In the introduction we cited some references using BibTEX and `cite` package. The rest of the body is straightforward.

5.1.4 Manuscript bibliography, tables, and figures

For the bibliography, we started a new page and re-instituted single spacing. The bibliography was constructed using BibTEX's `\bibliography` and `\bibliographystyle` commands.

For the tables and figures, we started a new page for each table and figure. We used `[!h]` to assure the table and figures are on the same page. Unfortunately, LATEX does not have a simple method to create table footnotes, so we did it manually using the recommended ICMJE symbols (Figure 10 on the following page). For a manuscript, manual table footnotes are adequate. However, for a publication-ready document consider the `ctable` package.[26]

The figures are vertically centered on the page using the `\vfill` command above and below the `figure` environment. Although the figures are included in the manuscript, they will need to be submitted as separate files. The figure legends are on their own page.

This generic manuscript can now be adapted for any manuscript submission. In the next section, we will review some manuscript LATEX templates provided by journal publishers.

[26] http://www.ctan.org/tex-archive/help/Catalogue/entries/ctable.html

Table 10: ICMJE table footnote symbols

Footnote order	Source code	Yields
1	*	*
2	\dag	†
3	\ddag	‡
4	\S	§
5	$||$	‖
6	\P	¶
7	**	**
8	\dag\dag	††
9	\ddag\ddag	‡‡
10	\S\S	§§
11	$||||$	‖‖
12	\P\P	¶¶

5.2 Using journal LaTeX manuscript templates

Some journal publishers provide a BibTeX style (`.bst`) file and/or a document class (`.cls`) file for submitting a manuscript. For example, BioMed Central, an Open Access publisher, provides both at http://www.biomedcentral.com/info/ifora/tex. For convenience, the files have be placed at http://www.medepi.net/latex/. By providing their own temple, BMC Central accelerates the publication process because the final manucript source file can be used to generate a near publication-ready document.

Elsevier publishes many biomedical journals[27] and provide customized LaTeX document class, BibTeX style, and sample source files.[28] The journal Science also provides customized files.[29] Both provide detailed guidelines.

[27] http://authors.elsevier.com/home.html
[28] http://authors.elsevier.com/getting_published.html?dc=QG3
[29] http://www.sciencemag.org/feature/contribinfo/prep/TeX_help/index.dtl