Scientific Writing using LaTeX

CEPLAS Grad School Classes

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What is LaTeX?

TeX is a low-level markup and programming language created by Donald Knuth to typeset documents **attractively** *and* **consistently**[1]

LaTeX is a macro package based on TeX created by Leslie Lamport. Its purpose is to simplify TeX typesetting[1]

[1] https://en.wikibooks.org/wiki/LaTeX/Introduction

Why LaTeX?

1. You are forced to structure your documents correctly
2. Indexes, footnotes, citations and references are generated, maintained, updated automatically
3. Once you define the document style, maintaining the layout (fonts, text sizes, line heights, tables, bibliography etc.) consistent is not your problem anymore

. . . using LaTeX is an investment!

[1] https://en.wikibooks.org/wiki/LaTeX/Introduction

OK, let's get started with LaTeX!

Welcome to WYSIWYM

What *You* See Is What YOU **Mean**

Welcome to WYSIWYM

What *Y**ou* **S**ee Is What YOU **M**ean

. . . please go to the classes page

https://wiki.hhu.de/display/QTBP/Scientific+Writing+with+LaTex

and download the file `day1.tex`

Commands

```
\command[option1, option2]{argument1}{argument2}
```

\command is different from \Command!

commands can also have no options and no arguments

Special characters

Character	Type	Reserved for
#	\#	arguments
$	\$	math
%	\%	comment
&	\&	tab delimiter
\	\textbackslash{}	commands
^	\textasciicircum{}	math
_	_	math
{	\{	arguments
}	\}	arguments
~	\textasciitilde{}	spacing
>	\textgreater	T1 font encoding
<	\textless	T1 font encoding

Spacing & linebreak 1

In LaTeXyou will never introduce double spaces unintentionally, same for linebreaks

```
In
\LaTeX
you will
never introduce
double      spaces
unintentionally,
same
for
linebreaks
```

Spacing & linebreak 2

To break a line you can use
or
or you can leave an empty line
like this

```
To break a line you can use\\
or \newline
or you can leave an empty line

like this\\[2ex]
```

The empty line in documents will actually start a new paragraph and this kind of gives a direction on how to structure your text:

do not overbreak thoughts!

Spacing & linebreak 3

I'll put two spaces
now three spaces
also three spaces, but these are unbreakable
now I put arbitrary space

now I fill till the end of line
now I fill till the end of line
now I fill till the end of line

can fill vertical space too

Spacing & linebreak 4

```
I'll put two\ \ spaces\\
now three\ \ \ spaces\\
also three~~~spaces, but these are unbreakable\\
now I put arbitrary\hspace{2cm}space\\[2ex]
now I fill till the end of\hfill line\\
now I fill till the end\hfill of line\\
now I fill till the\hfill end of line

\vfill

can fill vertical space too
```

Environments

A key concept in LaTeX

```
\begin{center}
  Centered text
  \end{center}
```

is the same as

```
{\centering
  Centered text
 }
```

Document structure

```
    \documentclass{...}

%this is the preamble

    \begin{document}
%here goes your content

    \end{document}
```

documentclass

```
\documentclass[option1,option2,...]{class}
```

Classes: article, book, report, letter, beamer, ...

Options: 10pt, 11pt, 12pt, a4paper, openright, twocolumn, twoside, ...

The preamble

Here you can declare the packages needed, set styles, or even define your own commands

```
\usepackage[option1, option2, ...]{package}
```

Some useful packages are

```
\usepackage[english]{babel}
\usepackage[utf8]{inputenc}
\usepackage{graphicx}
\usepackage{multirow,bigdelim}
\usepackage[hdivide={2cm, *, 2cm}, vscale=0.85,
    bindingoffset=1cm]{geometry}
\usepackage{booktabs}
```

Article example

```
\documentclass[10pt]{article}
\usepackage{booktabs}
\usepackage[english]{babel}
\usepackage[utf8]{inputenc}
\usepackage{lipsum}%just for text generation
\usepackage{multirow}
\usepackage{graphicx}
\author{Your Name}
\title{A first article with \LaTeX}
\begin{document}
\maketitle
\begin{abstract}
  \lipsum[1]
\end{abstract}
\section{Introduction}\label{sec:intro}
  \lipsum[2-3]
\end{document}
```

Lists

- bullet list first item
- bullet list second item

1. numbered list first item
2. numbered list second item

```
\begin{itemize}
\item bullet list first item
\item bullet list second item
\end{itemize}

\begin{enumerate}
\item ordered list first item
\item ordered list second item
\end{enumerate}
```

Change bullet style

+ bullet list first item
  - bullet list second item

- bullet list first item
- bullet list second item

* bullet list first item
* bullet list second item

$ bullet list first item
$ bullet list second item

```
\begin{itemize}
\item[+] bullet list first item
\item[-] bullet list second item
\end{itemize}

\begin{enumerate}[-]
\item bullet list first item
\item bullet list second item
\end{enumerate}

\begin{enumerate}[*]
\item bullet list first item
\item bullet list second item
\end{enumerate}

\begin{enumerate}[\$]
\item bullet list first item
\item bullet list second item
\end{enumerate}
```

Change ordering label

a) ordered list first item
b) ordered list second item

-A- ordered list first item
-B- ordered list second item

(i) ordered list first item
(ii) ordered list second item
(iii)
(iv)
(v) ...

```
\begin{enumerate}[a)]
\item ordered list first item
\item ordered list second item
\end{enumerate}

\begin{enumerate}[-A-]
\item ordered list first item
\item ordered list second item
\end{enumerate}

\begin{enumerate}[(i)]
\item ordered list first item
\item ordered list second item
\item
\item
\item \dots
\end{enumerate}
```

Floating environments

```
\begin{floatenv}[placement specifier]
...
\end{floatenv}
```

specifier	meaning
h	float here, i.e., approximately at the same point it occurs in the source text (however, not exactly at the spot)
t	top of the page
b	bottom of the page
p	on a special page for floats only
!	Override internal parameters LaTeX uses for determining "good" float positions

Table: placement specifier parameters

https://en.wikibooks.org/wiki/LaTeX/Floats,_Figures_and_Captions

LaTeX knows better...

...usually, so try to

- be careful with floats to text ratio
- use reasonable sized floats within the text
- consider devoting an appendix to large tables/pictures (yes, you can have many-pages-long tables; no, they do not look good in the middle of a chapter)
- use commands that "clean" the page to avoid figures going to other sections/chapters (*e.g.* clearpage)

Tables 1

```
\begin{table}[htb]\centering
\begin{tabular}{cp{.6\textwidth}}\toprule
specifier & meaning\\\midrule
h & float here, i.e., approximately at the same
    point it occurs in the source text (however, not
     exactly at the spot)\\
t & top of the page \\
b & bottom of the page \\
p & on a special page for floats only \\
! & Override internal parameters LaTeX uses for
    determining ‘‘good’’ float positions\\
\bottomrule\end{tabular}\caption{placement
    specifier parameters}\end{table}
```

Tables 2

	Col1	Col2	Col2
row1	left	right	center
row2	a	b	c
row3	d	e	f

Table: dummy table for example

```
\begin{table}[htb]\centering
\begin{tabular}{clrc}\toprule
 & Col1 & Col2 & Col2 \\\midrule
row1 & left & right & center\\
row2 & a & b & c\\
row3 & d & e & f \\
\bottomrule\end{tabular}\caption{dummy table for
    example}\end{table}
```

Tables 3

	Col1	Col2	Col2
row1	0	0	0
row2	a a	b b	c c
row3	d	e	f
row4		g	
row5 row6	h j		i

```
\begin{tabular}{cccc}\toprule
 & Col1 & Col2 & Col2 \\\midrule
row1 & 0 & 0 & 0\\\midrule
\multirow{2}{*}{row2} & a & b & c\\
 & a & b & c\\\midrule
row3 & d & e & f \\\midrule
row4 & \multicolumn{3}{c}{g} \\\midrule
row5 & h & \multicolumn{2}{c}{\multirow
      {2}{*}{i}}\\
row6 & j & & \\
\bottomrule\end{tabular}
```

Figures 1

```
\begin{figure}[htb]\begin{center}
\includegraphics[width=0.8\textwidth]{LaTeX_diagram
    .png}
\caption{From \url{https://en.wikibooks.org/wiki/
    LaTeX/}\label{figcompilation}}
\end{center}\end{figure}
```

Figures 2

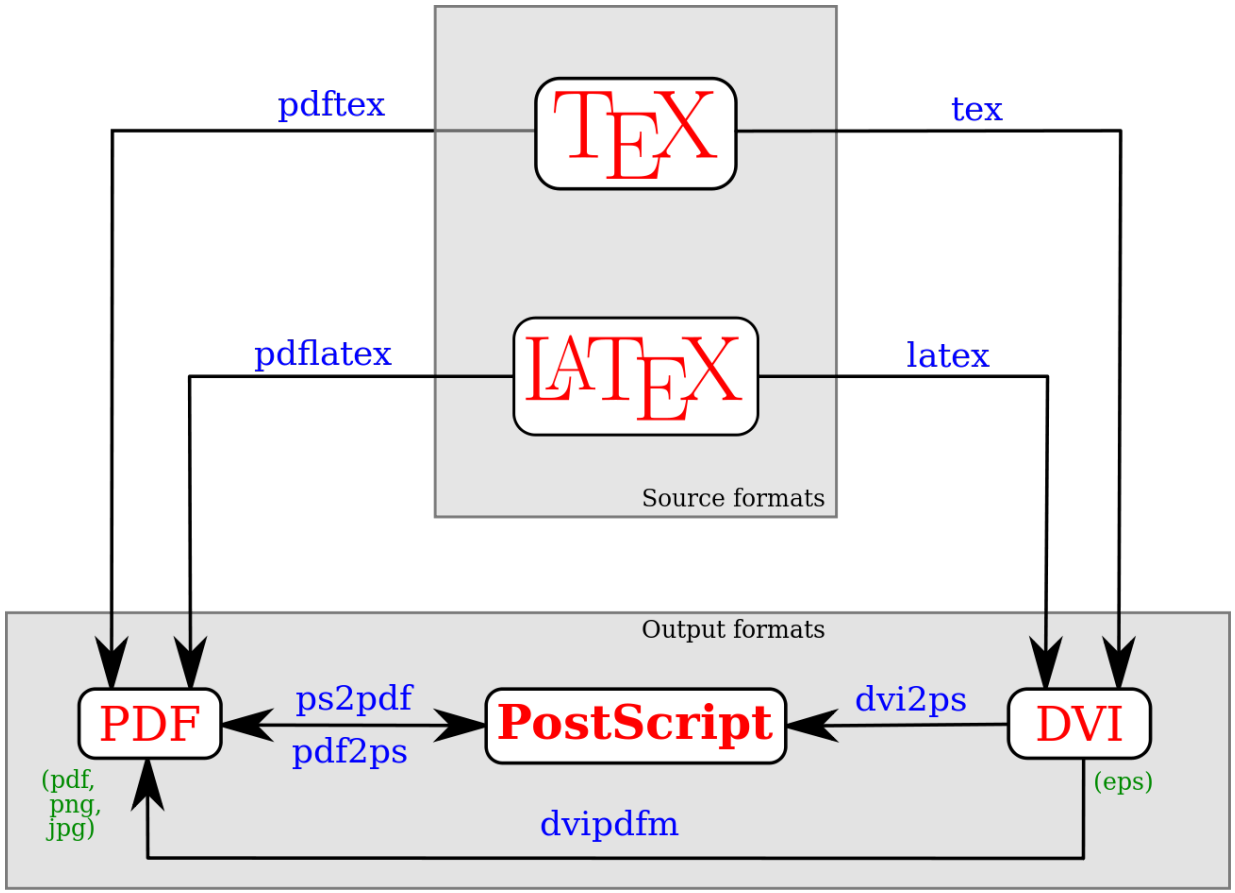
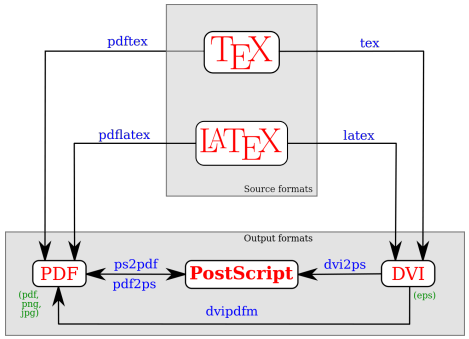


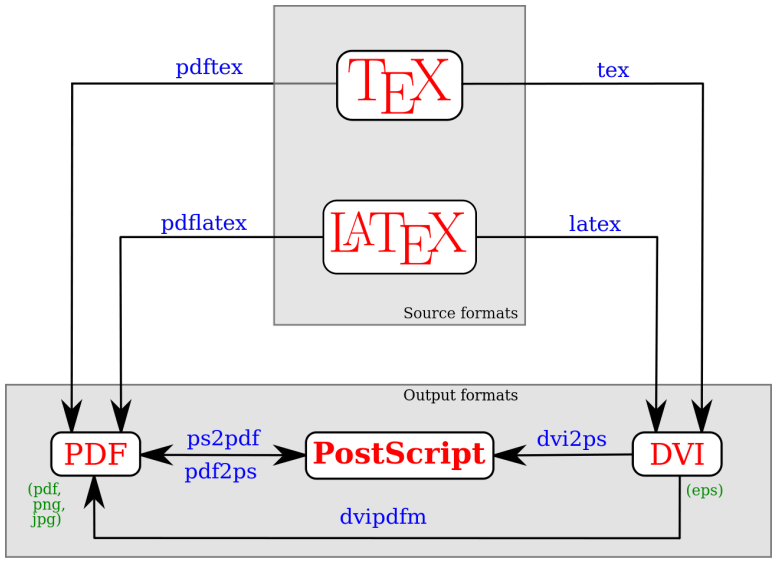
Figure: From https://en.wikibooks.org/wiki/LaTeX/

Subfigures 1

Needs the `subfigure` package



(a)



(b)

Figure: Dummy example, (a) is the same as (b) just smaller

Subfigures 2

Needs the subfigure package

```
\begin{figure}[htb]\begin{center}
\subfigure[]{\label{fig:a}
\includegraphics[width=0.3\textwidth]{LaTeX_diagram
    .png}}
\subfigure[]{\label{fig:b}
\includegraphics[width=0.5\textwidth]{LaTeX_diagram
    .png}}
\caption{Dummy example, (a) is the same as (b) just
     smaller}
\end{center}\end{figure}
```

Exercise!

Day two with LaTeX

Welcome to "fundamentals+"!

- we now know how to write in LaTeX
- getting familiar with the syntax is a matter of exercise (practice makes perfect!)
- we can play with two fundamental environments: tables and figures

Load your draft document and let's move further!

Linking

Load the `hyperref` package in your preamble

```
\usepackage{hyperref}
```

in case you did not have it already, add the table of content and the list of figures and tables:

```
\tableofcontents
\listoffigures
\listoftables
```

and recompile two times your document (you might have to delete the .aux file)

Referencing

Label things like:

```
...
\end{tabular}\caption{This is an example}\label{tab
    :example}
\end{table}
...
```

and reference them like:

```
as seen in Table~\ref{tab:example}
```

Link styles

the `hyperref` package has a lot of customizable options, e.g.:

```
\usepackage[ocgcolorlinks,bookmarks=true,
    bookmarksnumbered=false,bookmarksopen=false,
    colorlinks=true,linkcolor=webred]{hyperref}
```

google for instance "latex hyperref nice colors"!

Web links

You can use the package `url` or hyperref

```
\url{https://en.wikibooks.org/wiki/LaTeX}\\
\href{https://en.wikibooks.org/wiki/LaTeX}{With
    href you can link a text}
```

https://en.wikibooks.org/wiki/LaTeX
With href you can link a text

Bibliography

Managing the bibliography is easy!

- your collection goes into a file `.bib`, e.g. `biblio.bib`
- you load your preferred (e.g. `unsrt`) style with

```
\bibliographystyle{unsrt}
```

- and insert the bibliography in the document environment with

```
\bibliography{biblio}
```

The bib file

```
@article{Loughlin1964a,
author = {Loughlin, Richard E. and Elford, Howard L
    . and Buchanan, John M.},
journal = {J. Biol. Chem.},
month = sep,
number = {9},
pages = {2888--2895},
title = {{Enzymatic Synthesis of the Methyl Group
    of Methionine. VII. ISOLATION OF A COBALAMIN-
    CONTAINING TRANSMETHYLASE (5-
    METHYLTETRAHYDROFOLATE-HOMOCYSTEINE) FROM
    MAMMALIAN LIVER}},
url = {http://www.jbc.org/cgi/content/long
    /239/9/2888},
volume = {239},
year = {1964}
}
```

Citations

Cite in the text like:

```
the results from~\cite{Loughlin1964a}
```

then you will have to

- compile once the pdf (pdflatex namefile.tex)
- compile once the bib (bibtex namefile.aux)
- compule twice the pdf

to have the references correctly linked

Citations 2

You can also cite more references:

```
the results from~\cite{ref1ID, ref2ID, ref3ID}
```

or specific parts:

```
the results from~\cite[Chapter 3]{ref1ID}
```

You can also add references to your final bibliography without citing it in the document by adding

```
\nocite{refXID, refYID, refZID}
```

Bibliography styles

`acm`

Items are cited: *The LaTeX Companion* book [2], the Einstein journal paper [1], and The LaTeX related items are [2, 3].

References

[1] Einstein, A. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik 322*, 10 (1905), 891–921.

[2] Goossens, M., Mittelbach, F., and Samarin, A. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[3] Knuth, D. Knuth: Computers and typesetting.

`alpha`

Items are cited: *The LaTeX Companion* book [GMS93], the Einstein journal paper [Ein05], and The LaTeX related items are [GMS93, Knu].

References

[Ein05] Albert Einstein. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921, 1905.

[GMS93] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[Knu] Donald Knuth. Knuth: Computers and typesetting.

`apalike`

Items are cited: *The LaTeX Companion* book [Goossens et al., 1993], the Einstein journal paper [Einstein, 1905], and The LaTeX related items are [Goossens et al., 1993, Knuth,].

References

[Einstein, 1905] Einstein, A. (1905). Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921.

[Goossens et al., 1993] Goossens, M., Mittelbach, F., and Samarin, A. (1993). *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts.

[Knuth,] Knuth, D. Knuth: Computers and typesetting.

`plain`

Items are cited: *The LaTeX Companion* book [1], the Einstein journal paper [2], and The LaTeX related items are [1, 3].

References

[1] Albert Einstein. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921, 1905.

[2] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[3] Donald Knuth. Knuth: Computers and typesetting.

`siam`

Items are cited: *The LaTeX Companion* book [2], the Einstein journal paper [1], and The LaTeX related items are [2, 3].

References

[1] A. Einstein, *Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]*, Annalen der Physik, 322 (1905), pp. 891–921.

[2] M. Goossens, F. Mittelbach, and A. Samarin, *The LaTeX Companion*, Addison-Wesley, Reading, Massachusetts, 1993.

[3] D. Knuth, *Knuth: Computers and typesetting.*

`unsrt`

Items are cited: *The LaTeX Companion* book [1], the Einstein journal paper [2], and The LaTeX related items are [1, 3].

References

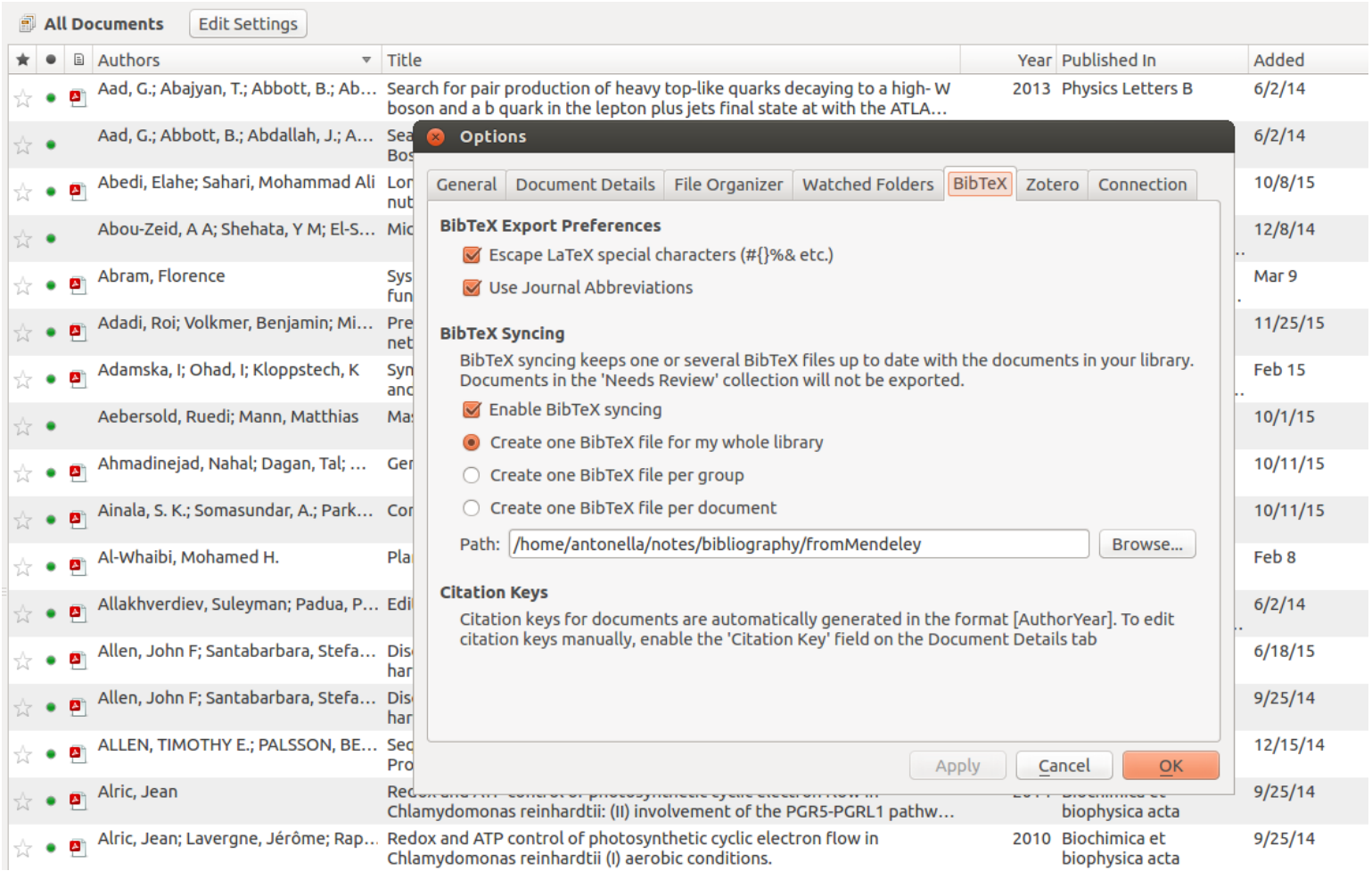
[1] Michel Goossens, Frank Mittelbach, and Alexander Samarin. *The LaTeX Companion*. Addison-Wesley, Reading, Massachusetts, 1993.

[2] Albert Einstein. Zur Elektrodynamik bewegter Körper. (German) [On the electrodynamics of moving bodies]. *Annalen der Physik*, 322(10):891–921, 1905.

[3] Donald Knuth. Knuth: Computers and typesetting.

https://www.sharelatex.com/learn/Bibtex_bibliography_styles

Obtain a bib file - Mendeley



Obtain a bib file - EndNote

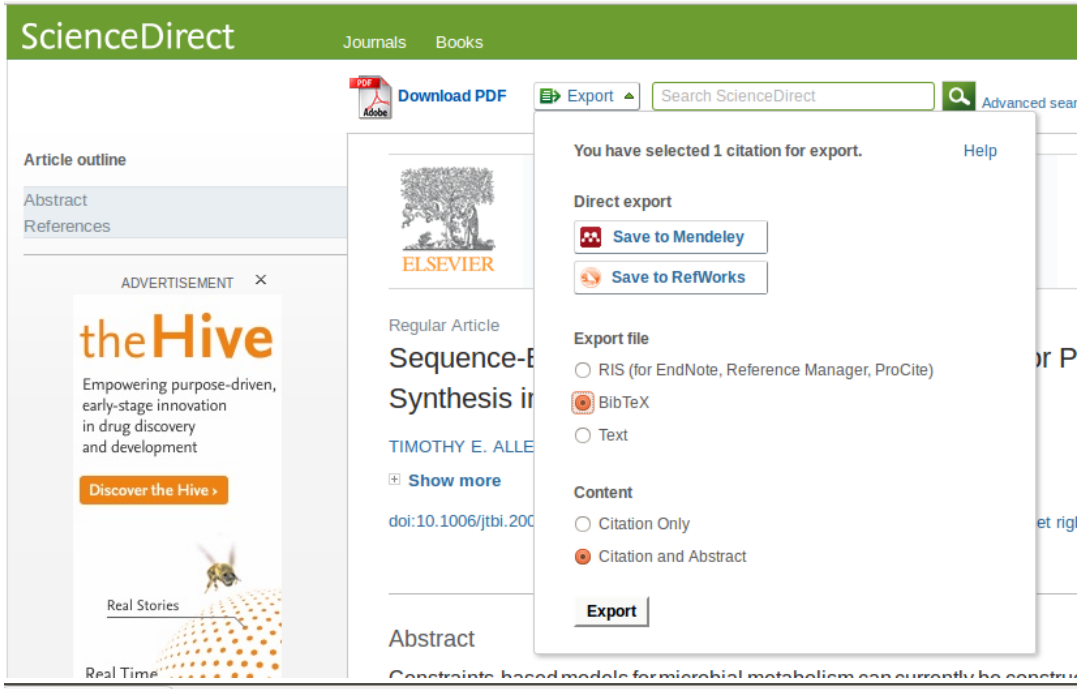
- Open EndNote, and open the library of references that you would like to export to BibTeX.
- In the drop-down menu in the toolbar at the top of the screen, click "Select Another Style..." and in the list that appears, chose BibTeX Export.
- Now you should see the BibTeX-formatted citation in the preview screen.
- From the File menu, select Export.
- Navigate to the directory where your main document is or will be saved.
- Change the name of the file that you are saving to filename.bib. Then click Save.

This will save your references in the correct format for BibTeX to read and create a bibliography from.

http://libguides.mit.edu/c.php?g=176170&p=1158648

Obtain a bib file - single citation

Directly from the journal web page



science.bib

```
@article{ALLEN20031,
title = "Sequence-Based Analysis of Metabolic Demands for Protein Synthesis in Prokaryotes ",
journal = "Journal of Theoretical Biology ",
volume = "220",
number = "1",
pages = "1 - 18",
year = "2003",
note = "",
issn = "0022-5193",
doi = "http://dx.doi.org/10.1006/jtbi.2003.3087",
url = "http://www.sciencedirect.com/science/article/pii/S0022519303930876",
author = "TIMOTHY E. ALLEN and BERNHARD Ø. PALSSON"
}
```

Exercise

OK, let's now work on document structure!

Open `latex_class_CEPLAS-main_file.tex`

Sectioning etc

```
\chapter{title of chapter}
...
\section[Short section title for ToC]{Long section
    title too long for ToC}
...
\subsection{}
...
\subsubsection{}
...
```

An * will make the section numberless (and not in ToC)

Book class

```
%preamble

\begin{document}

\frontmatter

\maketitle

% Introductory chapters
\phantomsection
\addcontentsline{toc}{chapter}{Introduction}
\chapter*{Introduction}
\input{intro.tex}
\clearpage{\pagestyle{empty}\cleardoublepage}
```

Book class

```
%index and list of figures and list of tables
\pdfbookmark[1]{Index}{Index}
\tableofcontents
\clearpage{\pagestyle{empty}\cleardoublepage}

\phantomsection
\addcontentsline{toc}{chapter}{List of Figures}
\listoffigures
\clearpage{\pagestyle{empty}\cleardoublepage}

\phantomsection
\addcontentsline{toc}{chapter}{List of Tables}
\listoftables
\clearpage{\pagestyle{empty}\cleardoublepage}
```

Book class

```
\mainmatter
\chapter{First chapter}
\input{chap01.tex}
\clearpage{\pagestyle{empty}\cleardoublepage}
%etc...

\phantomsection
\addcontentsline{toc}{chapter}{Conclusions}
\chapter*{Conclusions}
\input{conclusions}
\clearpage{\pagestyle{empty}\cleardoublepage}

\appendix
\chapter{First Appendix}
\input{app01.tex}
\clearpage{\pagestyle{empty}\cleardoublepage}
%etc...
```

Book class

```
\backmatter

%\nocite{}
\phantomsection
\addcontentsline{toc}{chapter}{Bibliography}

\bibliographystyle{unsrt}
\bibliography{biblio}

\clearpage{\pagestyle{empty}\cleardoublepage}
```

Math

Useful packages for math

```
\usepackage{amssymb}
\usepackage{amsmath}
\usepackage{latexsym}
\usepackage{amsthm}
```

Starting a math environment

$$\frac{dx}{dt} = y$$

```
$\dfrac{dx}{dt} = y$
```

$$\frac{dx}{dt} = y$$

```
$$\dfrac{dx}{dt} = y$$
```

$$\frac{dx}{dt} = y \tag{1}$$

```
\begin{equation}\label{eq:example}
\dfrac{dx}{dt} = y
\end{equation}
```

Super- and subscripts

Fibonacci serie:

$$F_n = F_{n-1} + F_{n-2}$$

```
$$F_n = F_{n-1} + F_{n-2}$$
```

$$\pm x = \sqrt{x^2}$$

```
$$\pm x = \sqrt{x^{2}}$$
```

Sets of equations

$$\frac{dC_1}{dt} = v_1 C_1 - v_2 C_2 \tag{2}$$

$$\frac{dC_2}{dt} = v_3 C_2 \tag{3}$$

```
\begin{align}\label{eq:metabolites}
\dfrac{dC_1}{dt} &= v_1 C_1 - v_2 C_2 \\
\dfrac{dC_2}{dt} &= v_3 C_2
\end{align}
```

Heaviside Step Function

$$H(x) = \begin{cases} 0 & x < 0 \\ \frac{1}{2} & x = 0 \\ 1 & x > 0 \end{cases}, \tag{4}$$

```
\begin{equation}\label{eq:H}
H(x) = \left\{ \begin{array}{cl}
  0 & x < 0\\
  \dfrac{1}{2} & x=0\\
  1 & x > 0
\end{array} \right.,
\end{equation}
```

Matrix

$$\mathbf{S} = \left(\begin{array}{ccccc} s_{11} & s_{12} & \multicolumn{2}{c}{\dots} & s_{1n} \\ \multicolumn{5}{c}{\dots\dots} \\ s_{i1} & \dots & s_{ij} & \dots & s_{in} \\ \multicolumn{5}{c}{\dots\dots} \\ s_{m1} & s_{m2} & \multicolumn{2}{c}{\dots} & s_{mn} \end{array} \right)$$

```
$$
\mathbf{S} = \left( \begin{array}{ccccc}
s_{11} & s_{12} & \multicolumn{2}{c}{\dots} & s_{1n
    } \\
\multicolumn{5}{c}{\dots\dots}\\
s_{i1} & \dots & s_{ij}& \dots & s_{in} \\
\multicolumn{5}{c}{\dots\dots}\\
s_{m1} & s_{m2} & \multicolumn{2}{c}{\dots} & s_{mn
    } \end{array} \right)
$$
```

NB you also have `matrix`, `pmatrix`, `bmatrix` environments...

Misc

$$\text{words} != words; \quad \mathcal{MATH}; \quad \alpha, \beta, \gamma$$

```
$$\text{words} != words; \quad \mathcal{MATH}; \
    quad \alpha, \beta, \gamma$$
```

$$\int y\; \mathrm{d}x; \quad \sum_{i=0}^{N} n_i$$

```
$$\int y\; \mathrm{d}x; \quad \sum_{i=0}^{N} n_i$$
```

Symbols

Set and/or Logic Notation

Symbol	Script	Symbol	Script
$\exists$	`\exists`	$\rightarrow$	`\rightarrow` or `\to`
$\nexists$	`\nexists`	$\leftarrow$	`\leftarrow` or `\gets`
$\forall$	`\forall`	$\mapsto$	`\mapsto`
$\neg$	`\neg`	$\Longrightarrow$	`\implies`
$\subset$	`\subset`	$\Rightarrow$	`\Rightarrow` or `\implies`
$\supset$	`\supset`	$\leftrightarrow$	`\leftrightarrow`
$\in$	`\in`	$\Longleftrightarrow$	`\iff`
$\notin$	`\notin`	$\Leftrightarrow$	`\Leftrightarrow` (preferred for equivalence (iff))
$\ni$	`\ni`	$\top$	`\top`
$\land$	`\land`	$\bot$	`\bot`
$\lor$	`\lor`	$\emptyset$ and $\varnothing$	`\emptyset` and `\varnothing`

https://en.wikibooks.org/wiki/LaTeX/Mathematics

Symbols

Symbol	Script	Symbol	Script	Symbol	Script
$<$	`<`	$>$	`>`	$=$	`=`
$\leq$	`\leq`	$\geq$	`\geq`	$\doteq$	`\doteq`
$\ll$	`\ll`	$\gg$	`\gg`	$\equiv$	`\equiv`
$\subset$	`\subset`	$\supset$	`\supset`	$\approx$	`\approx`
$\subseteq$	`\subseteq`	$\supseteq$	`\supseteq`	$\cong$	`\cong`
$\nsubseteq$	`\nsubseteq`	$\nsupseteq$	`\nsupseteq`	$\simeq$	`\simeq`
$\sqsubset$	`\sqsubset`	$\sqsupset$	`\sqsupset`	$\sim$	`\sim`
$\sqsubseteq$	`\sqsubseteq`	$\sqsupseteq$	`\sqsupseteq`	$\propto$	`\propto`
$\preceq$	`\preceq`	$\succeq$	`\succeq`	$\neq$	`\neq`

https://en.wikibooks.org/wiki/LaTeX/Mathematics

Symbols

Symbol	Script	Symbol	Script
$\parallel$	\parallel	$\nparallel$	\nparallel
$\asymp$	\asymp	$\bowtie$	\bowtie
$\vdash$	\vdash	$\dashv$	\dashv
$\in$	\in	$\ni$	\ni
$\smile$	\smile	$\frown$	\frown
$\models$	\models	$\notin$	\notin
$\perp$	\perp	$\mid$	\mid
$\prec$	\prec	$\succ$	\succ
$\sphericalangle$	\sphericalangle	$\measuredangle$	\measuredangle

https://en.wikibooks.org/wiki/LaTeX/Mathematics

That's all for introduction!

Have fun with LaTeX!