Authoring and presenting university courses with Emacs

© 2014–2024 James Endres Howell, PhD
* Introduction, overview, and fundamentals

* What is biochemistry?

* Consider the relative components of an *E. coli* cell.

<table>
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</tr>
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<td>1</td>
</tr>
<tr>
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<td>6%</td>
<td>&gt; 3,000</td>
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<tr>
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<td>3%</td>
<td>5</td>
</tr>
<tr>
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<tr>
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* What can you conclude from these numbers?

* Biochemistry is "the study of biological macromolecules and their metabolic pathways."

* What kinds of *biological macromolecules* are there?

* Which small monomers *polymerize* to produce macromolecules?

* What is an example of a *metabolic pathway*?

* The structure of macromolecules determines the function of macromolecules

* Macromolecular polymers are synthesized from small-molecule monomers
1 Introduction, overview, and fundamentals

1.1 What is biochemistry?

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1.2 Macromolecular structure determines function

Macromolecular polymers are synthesized from small-molecule monomers

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- Which of these three categories of polymer has a geometric structural difference from the other two?
- Which category of biomolecules is missing from this chart? How is that category different?

Polymerizations are condensation reactions; cleavage and depolymerization are hydrolysis reactions.

Figure 1: Polymerization of amino acids into proteins is a condensation reaction; the reverse reaction, depolymerization of proteins back to amino acids, is a hydrolysis reaction. Similarly, polymerization of nucleotides into nucleic acids,
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\[
\begin{align*}
\text{Condensation} & : \text{Polymer} + \text{Water} \\
\text{Hydrolysis} & : \text{Monomer} + \text{Water}
\end{align*}
\]

Figure 1: Polymerization of amino acids into proteins is a condensation reaction; the reverse reaction, depolymerization of proteins back to amino acids, is a hydrolysis reaction. Similarly, polymerization of nucleotides into nucleic acids.
Org macros for producing course slides and handouts from a single source

org-teach

Org mode macros and some LaTeX and Beamer hacking for producing class slides and printable handouts for science courses. (Also a template for producing printed classroom worksheets.)

Note that the 'code' (minimal as it may be) is distributed under the GNU General Public License version 3, while the contents of the documents are distributed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (CC BY-NC-SA 4.0).
authoring
presenting
presenting
Many others present and teach with Emacs!

David Wilson      system-crafters.net
Protesilaos Stavrou   prote silicaos.com
Mike Zamansky   cestlaz.github.io

John Kitchin   prior art
Eric Fraga   prior art
Olivier Berger   prior art
Ro and Namkoon   citation
Hardware
Every course meeting!
Presentation hardware: everything fits in a small backpack
Presentation hardware: everything fits in a small backpack

GNU/Linux laptop
Presentation hardware: everything fits in a small backpack

GNU/Linux laptop

GNU/Linux tablet *with stylus*
Presentation hardware: everything fits in a small backpack

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USB webcam and knobby tripod
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video output to USB input capture
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connectors, dongles, power supplies, spare batteries
Bonus:
You can do it on a very small budget!
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libre software $0
Bonus:
You can do it on a very small budget!

- libre software: $0
- used computer: $400
- used tablet: $200
Bonus:
You can do it on a very small budget!

<table>
<thead>
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</thead>
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<tr>
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<td>$0</td>
</tr>
<tr>
<td>used computer</td>
<td>$400</td>
</tr>
<tr>
<td>used tablet</td>
<td>$200</td>
</tr>
<tr>
<td>used monitors</td>
<td>$100</td>
</tr>
<tr>
<td>webcam</td>
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<td><strong>Total</strong></td>
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Especially if you’re willing to upcycle and build.
Which of the following would be an obstacle to demonstrating Koch's postulates (in their original, classical form)?

- The suspected pathogen is present in healthy individuals.
- The suspected pathogen cannot be grown in pure culture.
- The suspected pathogen is a prion.
- All of the above
- None of the above
Which of the following would be an example of demonstrating Koch's postulates in the context of a classical form?

- The suspected pathogen is present in the infected tissue.
- The suspected pathogen is absent in healthy tissue.
- The suspected pathogen can be grown in pure culture.
- All of the above
- None of the above
Software
Presentation software: flexibility in function
Presentation software: flexibility in function

drawing and annotation

Xournal++
Presentation software: flexibility in function

drawing and annotation
web browser

Xournal++
Firefox
Presentation software: flexibility in function

drawing and annotation: Xournal++
web browser: Firefox
video player: VLC
Presentation software: flexibility in function

drawing and annotation  Xournal++
web browser  Firefox
video player  VLC
show code, take notes, examine text  Emacs
**Presentation software: flexibility in function**

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Demonstrations
Xournal++ allows drawing with a stylus on a tablet.

Most lecture halls do not have blackboards or whiteboards!

Even better: highlight and annotate the slides in real time.

*It’s the reason for producing slides as PDFs rather than presenting directly with Emacs.*
Assignments are all online, so we can review them in class.

We jump to Wikipedia or image search almost every day!
Inserting myself into animations is the killer app!
Emacs allows sophisticated presentation and manipulation of text.
Authoring with Emacs
Slides and handouts from a single Org mode document
entirely assembled in Emacs
Org mode: part of GNU Emacs
Org mode: part of GNU Emacs

write documents in plain text
Org mode: part of GNU Emacs

write documents in plain text

mark up text (and tables!) with legible formatting
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Org mode: part of GNU Emacs

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Org mode: part of GNU Emacs

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export \textsc{LaTeX} to produce PDF documents like the handouts

export \textsc{Beamer} to produce PDF slides like these ones
Pedagogy first!
Simply a collection of export customizations
Spell out and linger upon one idea
Make explicit one idea at a time
Some concepts are best explained (in text?)
BUT OTHER IDEAS

CAN SIMPLY BE SHOWN
Pedagogy first!

Make explicit one idea at a time.

Some concepts are best explained in text. can simply be shown. require a sequence of images. require an animation.

Contrast: death by Powerpoint
These methods improve course authoring in multiple fundamental ways:
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Effective course materials must provide a way to take notes onto complex figures.
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Slides are terrible handouts and notes are terrible slides.
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Write a single hierarchical document and produce both handouts and slides.
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Write a single hierarchical document and produce both handouts and slides.

Separate the work of writing, developing, scaffolding from the work of wrangling class slides.
* Introduction, overview, and fundamentals

{{section-slide(1)}}

* What is biochemistry?

{{subsection-slide}}

{{impact-slide(The study of \macromolecules and \metabolic pathways)}}

{{impact-slide(Activate your \prior learning)}}

{{impact-slide(small molecules vs. macromolecules)}}

* Consider the relative components of an /E. coli/ cell.

| | \(<\text{r}>\) | \(<\text{r}>\) |
|---|---|
| | \(*\text{Percent}^*\) | \(*\text{Number}^*\) |
| | \(*\text{by mass}^*\) | \(*\text{of species}^*\) |
| water | 70% | 1 |
| proteins | 15% | 3,000 |
| DNA | 1% | 1 |
| RNA | 6% | > 3,000 |
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Polymerizations are condensation reactions; cleavage and depolymerization are hydrolysis reactions.

![Figure 1: Polymerization of amino acids into proteins is a condensation reaction](image)

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\[ R-C-OH + H-N-R' \rightarrow R-C-NH-R' + H_2O \]

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Everything is an outline
Edward Tufte, *The Cognitive Style of PowerPoint*
No executive function to waste
org-teach
A peek at the sources
org-teach: Org mode macros for custom BEAMER markup

#+INCLUDE: org-teach-headers-include.org

{{{pause}}} force split a frame into multiple overlay slides

{{{newline}}} break a line in the slides

but not in the handouts

{{{whitespace-break}}} break a line in the slides and add extra whitespace
org-teach: Org mode macros for custom BEAMER frames

#+INCLUDE: org-teach-headers-include.org

text slides  H3 beamer frame
figure slides H3 beamer frame

slide includes include other Org files

version control

{{section-slide}}} insert a custom H1 frame
{{subsection-slide}}} insert a custom H2 frame
{{impact-slide}}} insert a high-impact text frame
{{image-slide}}} insert an image-only frame
{{blank-slide}}} insert a blank white slide
{{include-slides-pdf}}} insert single- or multi-page PDF
Section slides (H1)

#+MACRO: COURSE_NUMBER BMB 401
#+MACRO: COURSE_TITLE General Biochemistry 1
#+MACRO: SEMESTER Summer 2024

* Introduction, overview, and fundamentals

{{section-slide(Module 1)}}
Subsection slides (H2)

** Macromolecular structure determines function

*Figure 2:* Subsection slides correspond to major lecture topics
Biochemistry is "the study of biological macromolecules and their metabolic pathways."

What kinds of *biological macromolecules* are there?

Which small monomers *polymerize* to produce macromolecules?

What is an example of a *metabolic pathway??*
*** Glycolysis: carbons in glucose are oxidized to make ATP

![Glycolysis pathway](./_img/glycolysis-pathway.png)

**Figure 4:** Figure slides include a title, an image, and optionally text.
Impact slides (under H1 or H2)

{{impact-slide ( small molecules \ vs. \ macromolecules ) }}

Figure 5: Impact slides: "Let us pause and consider this key idea."
Image slides (under H1 or H2)

{{image-slide(./_img/rough-er.jpg)}}

Figure 6: Image slides contain an image filling the entire frame.
Blank slides (under H1 or H2)

{{blank-slide}}

Figure 7: Blank slides are an empty white frame.
PDF includes (under H1 or H2)


Figure 8: PDF includes: directly imports multi-page PDFs in place (useful for importing e.g. graphical sequences produced in LibreOffice Impress)
Please use and share!
Org mode macros and some LaTeX and Beamer hacking for producing class slides and printable handouts for science courses. (Also a template for producing printed classroom worksheets.)

Note that the 'code' (minimal as it may be) is distributed under the GNU General Public License version 3, while the contents of the documents are distributed under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International license (CC BY-NC-SA 4.0).
I hope to hear from you!

James Endres Howell

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email  howell@psu.edu

mastodon  @jameshowell@emacs.ch

sourcehut  ~jamesendreshowell