

Supplemental Material

CBE—Life Sciences Education

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Supplemental Material for *Integrating Concepts in Biology: A Model for More Effective Ways to Introduce Students to Biology: E-text Formats, Tools and User Experience*

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ICB must be viewed on Trunity’s proprietary “eLearning platform.” One version is a login-protected website and the other is a proprietary reader for iOS and android tablets and cellphones available free of charge through the Apple App Store.

The **website portal** is entirely dependent on a working internet connection. We tested it with recent versions of several browsers on Macintosh and Windows-based computers. Function seemed uniform across platforms. Because the website is server-based, the time to navigate to different pages varied as did the time needed to save annotations to the text (see below). Navigation was straightforward and depended on expandable menus (Fig. S.1).

Figure S.1. A partial view of the web portal navigation system. Selecting “Information in Molecules and Cells” reveals an overview of the section and its three chapters. One of the chapters is expanded to show links to its subsections including BMEs and ELSIs. The mobile app navigation is very similar.

The screenshot displays the web portal interface. On the left is a sidebar menu titled "Integrating Concepts in..." with a dropdown menu set to "Information in Molecules and Cells". Below this, a list of chapters is shown with expandable arrows: "Chapter 1: Heritable Material", "Chapter 2: Central Dogma", and "Chapter 3: Reproduction and Cell Division". Further down are subsections like "Evolution of Molecules and Cells", "Cells at the Molecular and Cellular Levels", "Homeostasis of Molecules and Cells", "Emergent Properties of Molecules and Cells", "Information in Populations and Ec...", "Evolution in Populations and Ec...", "Cells in Populations and Ecological Systems", "Emergent Properties in Populations and Ec...", "Homeostasis of Populations and Ec...", "Foreword and Acknowledgements", "Instructor Resources", and "Student Resources".

The main content area is titled "Big Idea: Information in Molecules and Cells" and features a search bar at the top right. Below the title are two tabs: "Overview" (selected) and "Textbook Glossary". The "Overview" tab contains the following text:

Examine the Big Idea of Information at the molecular, cellular and organismal levels

The Big Idea is that living systems have multiple mechanisms to store, retrieve, and transmit information.

The main themes that are integrated throughout this Big Idea are:

- Heritable information provides for continuity of life.
- Imperfect information transfer produces variation.
- Information can be expressed and regulated without loss of content.
- Non-heritable information is transmitted within and between biological systems.

Below this is a "Contents" section with a list of expandable items:

- ▶ Chapter 1: Heritable Material
- ▼ Chapter 2: Central Dogma
 - ▶ 2.1 How does DNA communicate information to the cell?
 - ▶ Ethical, Legal, Social Implications 2.1: Choose your words carefully
 - ▶ 2.2 How is gene transcription regulated?
 - ▶ Bio-Math Exploration 2.1: How can you measure the strength and speed of gene induction?
 - ▶ Bio-Math Exploration 2.2: How can you quantify a sequence pattern?
 - ▶ 2.3 How do cells make proteins?
 - ▶ 2.4 Can cells pick and choose information?
 - ▶ Ethical, Legal, Social Implications 2.2: Is science possible if you are uncertain about what is true?
 - ▶ Conclusions
- ▶ Chapter 3: Reproduction and Cell Division

Readers can expand text figures by clicking on them (a larger version appears in a separate window). Web portal users can open an unlimited number of tabs or windows and login simultaneously using several browsers at the same time allowing quick consultations with other parts of the book. Effective use of the hyper medium includes the following features:

- Important terms appear in boldface; clicking on these elicits a pop-up window with succinct definitions.
- Links are provided to other websites that are expository or feature animations or simulations. These are well integrated with accompanying questions to guide student inquiry.
- The ability to highlight and annotate text is especially useful. A user's annotations are saved to a private secure storage area maintained by Trunity; these are available permanently to the user. Pointing to the area the user originally highlighted causes a small window with the annotation to appear; it is apparently not editable. Because they are server based, the annotations are available any time a new web portal session is opened, whether on the same or different browser. However, in our tests there were occasional glitches. Sometimes annotations seemed to have been saved (users can monitor this process by watching a Trunity icon in the webpage navigation bar) when they weren't. These problems were infrequent but they could be frustrating.
- We found the bookmark feature to be less useful – only the start of a section could be bookmarked, not particular passages within the section. We attempted to work around this by using annotations as bookmarks, but this was not serviceable due to the lack of a list of annotations on the web portal version of the text (in contrast to the mobile app).
- An internal mail system is available to users for discussions (as in email), but we did not test it.

The free **Trunity mobile app** is similar to the web portal, but it has several important differences in functionality.

- The material can be read without an internet connection; with the app, the e-text resides on the tablet. However, functions that invoke external links are, of course, absent until a connection is re-established.
- The display functions in landscape mode only; text size and brightness are easily controlled from a "settings" menu.
- The display is divided into three sections:
 - The text and two sections on the left of the text that can nest and be hidden.
 - A navigation window similar to that used with the webpage (see Fig. 2).
 - A memory management window that allows individual sections of the e-text to be loaded, deleted and re-loaded into the device's memory system.
- Annotations can be made but there is no discrete bookmark capability. A nice feature is that all of the user's annotations are available in list form broken down by section of the textbook.

Tapping a particular section lists its annotations.

There are two very important issues/limitations with regard to annotations. First, the two instantiations of the e-book do not talk to each other: annotations made on the web portal do not move to the mobile app or vice versa nor will annotations made on different devices using the mobile app move from one box to another.) Second, whenever a section of the e-textbook is deleted from a mobile device's memory, all annotations for that section that were saved to the mobile device are permanently lost. So, if at a later date a section is reloaded, previous annotations will not reappear. This is one significant disadvantage of the mobile app

KNP did the comparative testing and preferred the mobile app on an iPad mini even though he normally prefers computers to tablets. He found it to be more nimble, as it was faster and a bit easier to navigate and every bit as easy to read.

Support features are not obvious in either the web portal or mobile app, but the support section of the Trunity website provides a brief FAQ and a series of tutorials, organized by accession frequency, not topic. They are not uniformly helpful, but in general both the portal and app are easy to use and

require little support. The Trunity website support area promises replies to questions within one business day and that was our experience.