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Late-Breaking Abstract
 (in meeting addendum)

Development and Assessment of Web-based Resources for Teaching Cancer Biology



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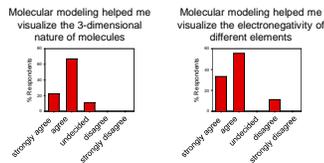
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Abstract

Education research has documented many factors that hinder learning in introductory science courses, including failure to relate to other disciplines, lack of a unifying concept, and irrelevance to life outside the classroom [1-3]. To overcome such problems, many teachers use cancer as a theme in their courses. Here we present two resources to assist in teaching the basic concepts of cancer biology. The first, *Cancer - Biology and Beyond*, is a short hypertextbook that uses the theme of cancer to introduce students to basic scientific concepts. The "Breaking News" links encourage users to consider interdisciplinary issues such as the ethics of mandatory vaccinations. Descriptions of in-class and lab activities are also provided. The second resource, *Perspectives on Cancer*, resulted from an inter-institutional collaboration. This site provides information on the molecular basis of cancer and the epidemiology of the disease. While exploring the molecular basis of cancer, users track changes in the DNA of fictional characters, observing gene mutations and how these changes may, or may not, lead to a cancer diagnosis. *Perspectives on Cancer* also introduces the concepts of correlation and causation in the context of cancer epidemiology. The associated Map Viewer allows students to quickly and easily search for correlations between lifestyle and cancer mortality. Preliminary assessment of both resources will be presented.

Introduction to Chemical Bonds

On the "Lab Exercises" page of the *Cancer - Biology and Beyond* site, descriptions of several activities can be found, including two that employ molecular modeling. Such exercises have been shown to increase student confidence and understanding [4]. The first molecular modeling exercise was adapted from Shusterman and Shusterman [5] and allows students to build simple molecules, visualize electron densities, and "re-create" the hydrogen bonding between guanine and cytosine. Student responses to this molecular modeling exercise are provided below:



"I could see the electronegativity and actually create the bonds and molecules myself."
 "I gained a better feel for the shape of molecules and how atoms and molecules interact."

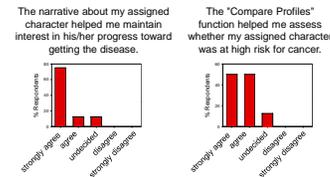
Perspectives on Cancer

The *Perspectives on Cancer* site was developed collaboratively by Birmingham-Southern College and the Learning Objects Studio at Wesleyan University. This site provides a variety of opportunities to explore the molecular basis of cancer, the prevalence of cancer in the American population, and relationships between the two. Like all Learning Objects (LOs), this site is designed to be widely adaptable. Non-science majors can learn about the fundamental concepts behind the origins of cancer, while more advanced students can be pushed to explore the role of specific genes in the progression of cancer.

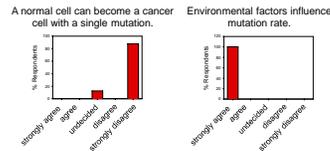


Character Profiles

In addition to viewing the "Average DNA Damage Model", students can explore "High Risk Profiles". Users can also adopt character profiles. These profiles provide narratives and questions to complement the animation which displays the accumulation of mutations. Furthermore, students within a given class can compare their character's profile to those of their classmates.



"I liked watching the profiles as they age and seeing the correlation between mutation and cancer risk and lifestyle."
 "It provided good illustration of how cancer develops and made it seem a little more personal and interesting."
 "It takes many mutations to get cancer. Wear sunscreen!! Live a healthy life and eat well and exercise."



Overall, the *Perspectives on Cancer* site helped students meet several key pedagogical goals such as learning about the multiple hit hypothesis and the role of environmental factors in cancer development.

Interpreting Data Maps

The "Interpreting Data Maps" portion of the *Perspectives on Cancer* site introduces students to fundamental concepts in epidemiology. The Map Viewer allows students to search for correlations between cancer mortality and various behavioral and environmental factors.



Conclusions

Here we have presented the development of two resources for teaching cancer biology to undergraduates.

Assessment of the molecular modeling exercises available on the *Cancer - Biology and Beyond* site confirms previous studies [4, 5], demonstrating the usefulness of molecular modeling in the process of visualizing the shapes and electron densities of molecules.

The *Perspectives on Cancer* site appears to be a powerful teaching tool, as it helped students visualize a variety of key concepts in the field of cancer biology, including:

- the stochastic nature of mutations
- the multiple hit hypothesis
- the role of the environment in cancer risk

Future work will focus on the continued development of the *Cancer - Biology and Beyond* site. Additional assessment of both sites will also be conducted.

Individuals interested in participating in the further development or assessment of these resources should contact:



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Cancer - Biology and Beyond

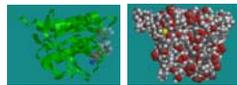
The theme of cancer biology is often used as a "hook" when teaching science to non-science majors. Although this topic helps stimulate student interest, the resources available for such thematic courses are scattered at best, and at worst they are out of date or incorrect. To help bridge the scattered resources available on the internet, the brief hypertextbook *Cancer - Biology and Beyond* is in development. This freely available online resource will include the following features:

- A brief introduction to fundamental concepts in chemistry
- An overview of the origins, diagnosis, and treatment of cancer
- Links to more in-depth resources
- Descriptions of in-class and lab activities
- Links to news stories related to ethical, legal, and social implications of cancer research

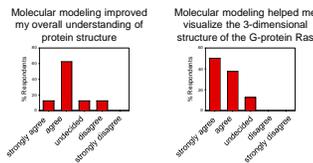


Molecular Modeling of Ras

A molecular modeling exercise has also been developed to assist students in the visualization of complex molecules such as proteins. In this exercise students work with the protein Ras, examining its overall structure, extracting its bound guanine nucleotide, and locating an amino acid residue that is often mutated in cancer cells.



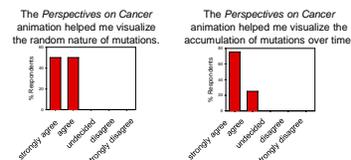
Two views of the Ras protein are provided above, and student feedback about the exercise is provided below.



"It let me visualize the structure of Ras and how mutations can affect it... I saw how changing one codon can have the potential to drastically change the protein."
 "I can visualize structures better, it helps to connect what we've learned in class."

Understanding the Molecular Basis of Cancer

Two key pedagogical goals of the *Perspectives on Cancer* site are to help students (a) understand the stochastic nature of mutations and (b) visualize the accumulation of mutations over time. To achieve these aims, we developed flash animations that track the mutations in a cell over the span of 75 years, as seen below:



References

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