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# Social distance teaching and learning: An online DNA nucleotide binding lab experience for health sciences and non-major students

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**Abstract**

DNA analysis is a common diagnostic tool in healthcare: ranging from microbial typing (e.g. DNA strands of viral, bacterial and even fungal pathogens), oncological screen (e.g. Breast cancer detection via DNA analysis of any BRCA gene mutations), genetic amniocentesis test (a medical technique used in determining chromosomal conditions such as down syndrome in the fetus) and a host of other medical diagnostics based on the knowledge of deoxyribonucleic acid (DNA) and the genetic information carried in this macromolecule. However, such a wide-range of medical diagnostic mechanisms using DNA begs the question: How much does the undergraduate health sciences and/or non-major students understand about the basic biochemical properties of DNA? Here, a virtual lab module was used (with the addition of Pre and Post Lab Questions and a Discussion Topic relating DNA to Healthcare) along with a learning management system, to help undergraduate health sciences students visualize the biochemical properties of DNA molecule, such as binding constant and Gibbs free energy of binding. This lab was adapted to offer a platform on which an Instructor can design steps for students to explore the DNA nucleotide binding module during a time in which social distance curricula is necessary.

**KEYWORDS**

laboratory exercises, medical education, web-based learning

## 1 | INTRODUCTION

A fall semester virtual lab (VL) chemistry course designed for undergraduate nursing students (of which less than 10% were exercise science majors), has hosted over 530 enrollees with a passing rate of over 95% (from Fall 2017–2019). The general VL set-up is for students to use laptops or tablets (with a previously installed Firefox or Chrome internet browser) to complete the lab tasks in a lecture hall, following a Pre-Lab presentation by the Lab Instructor - but during this pandemic paradigm the VL class is able to meet via video conferencing. A principle objective of this course was to make connections between General, Organic, Biological, and Analytical (GOB-A) chemistry topics and healthcare.[1] In doing so, students were often encouraged to transcribe answers to discussion questions proposing connections between each chemistry lab topic and healthcare practices (in a Lab Report submitted online).

  

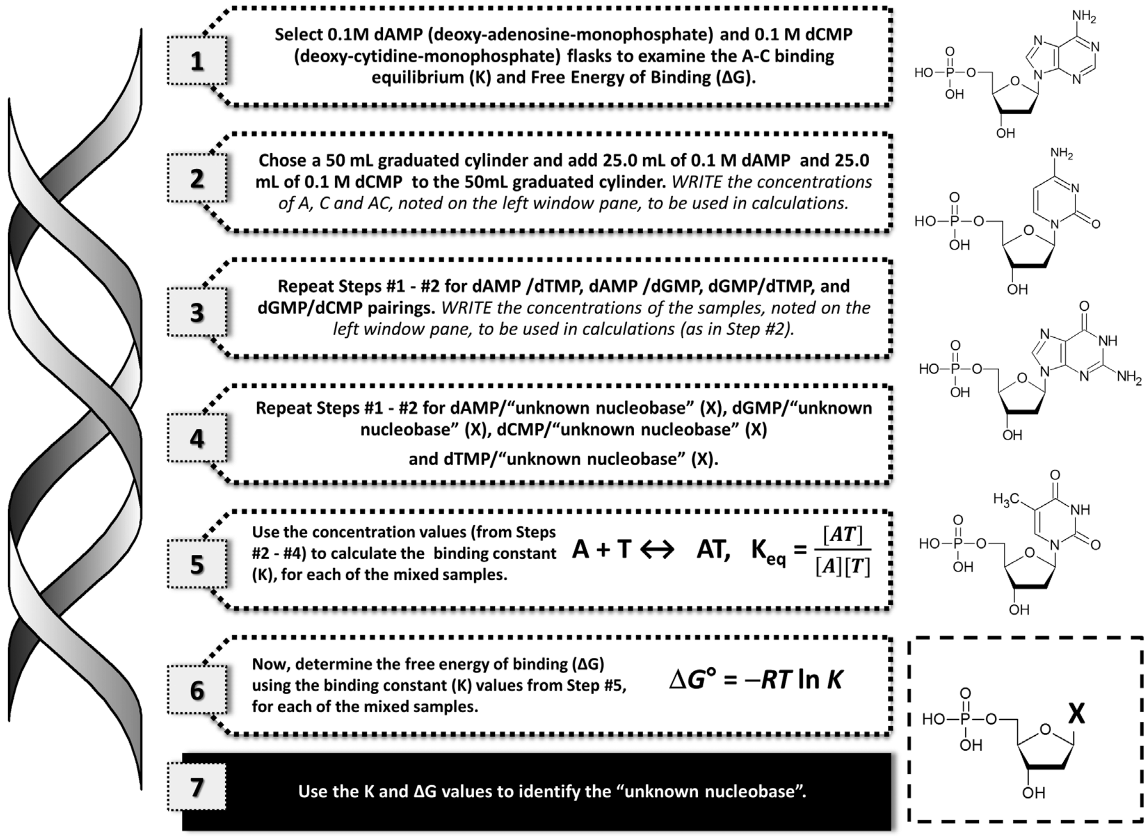


**FIGURE 1** DNA lab instructions. Students were provided with the following instructions for completing the online lab module

## 2 | DEVELOPING AN ONLINE "DNA" CHEMISTRY LAB EXPERIENCE

The VL module employed was the "DNA Problem" online module at chemcollective.org[2] (http://chemcollective.org/vlab/86). In this experience, students investigated the binding constants (*K*) and free energy of binding (Δ*G*) of four nucleotides (dAMP, dCMP, dGMP, and dTMP) and an unknown nucleotide "X". The steps specifically designed for the health sciences (or non-major) students in this online lab course are outlined in Figure 1. The time allotted for the "DNA Problem" lab was 1 hour, 55 min. The Lab Instructor gave a Pre-Lab lecture outlining Nucleic Acid structures (RNA vs DNA), calculations for enthalpy (*H*), entropy (*S*) and Gibbs free energy (Δ*G*), and binding constant (*K*). Following the Pre-Lab lecture, students logged into the Chemcollective.org site, completed the step-wise instructions (Figure 1) and tabulated data. Data for this experiment was both recorded from the information provided in the left pane of the "virtual workbench" window for the VL module (e.g. nucleotide concentration values) and student calculations. A Post-Lab quiz was administered via Sakai LMS[3] consisting of questions such as defining terms, calculating *K* and Δ*G* values of each nucleotide sample, and identifying the unknown nucleotide "X." Finally, students were instructed to write and upload a Lab Report with datasets and their response (and the interviewed response of a classmate) to a discussion question asking them to identify biochemical practices of DNA research and/or diagnostics in healthcare.

## 3 | QUALITATIVE STUDENTS REPONSES

During the fall 2019 semester, 120 of the 161 enrolled students completed a survey outlining their experience with the "DNA Problem" lab. Of the 120 students surveyed (i) 99% agreed that the VL was easy to use, (ii) 92% agreed that the overall lab experience helped to increase "their knowledge of chemistry," and (iii) 88% agreed that they would "recommend the DNA Lab Problem [experience] to be utilized in future undergraduate chemistry for health professions lab courses."

## 4 | CONCLUSION

Adapting the presently available online chemistry lab resources to promote course objectives can be helpful during this time of "social distance" teaching and learning. Student qualitative responses to the lab experience suggests the successful applicability of this lab in future health sciences (non-major) VL chemistry lab courses.

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