INTRODUCTION

The Super Bowl activity is a teaching tool that utilizes a “hook” and “model” technique. It is best used as a review of biology concepts including molecular genetics and inheritance patterns, those where students often have weak scores on standardized biology exams. The teaching activity was specifically created for 9th grade Biology courses; however, as presented here, it has been and can be used successfully in AP Biology high school courses as well as undergraduate introductory and nonmajors biology courses. The technique activates prior biology knowledge and incorporates scientific practices and modeling which are emphasized by the Next Generation Science Standards (NGSS) (http://www.nextgenscience.org). Learning objectives (Appendix 2) and the K–12 teaching standards in both Florida (NGSSS) and nationwide (AP Biology, NGSS, and Common core) (Appendix 4) are tied to this activity.

PROCEDURE

The activity is a guided inquiry, case study–based activity sheet with additional supplies of a Super Bowl Activity Kit and color-coded genetic code (Appendices 1 and 3).

Instructor preparation

Each student group receives a Super Bowl activity kit and color-coded genetic code (Appendix 3). Each student receives a student activity sheet (Appendix 1). A teacher’s guide is provided with answers and tips (Appendix 2). The Super Bowl activity kit is easy and fairly cheap to construct. Each Super Bowl activity kit consists of a resealable bag containing two pipe cleaner type strands (1 green and 1 white) approximately 20 inches each, 2 red pom pom balls, approximately 1 inch in diameter, and a collection of small pony beads, approximately ¼ inch in diameter (16 red beads, 20 blue beads, and 14 yellow beads).

The “Hook”

The activity follows a football player, Ryan, who has sickle cell trait and cannot play in the Super Bowl due to the high altitude in Denver and the health complications that could arise. The names and teams have been altered, but this is based on a real situation (1). The teaching activity delves deeper into Ryan’s disease to discuss the specific mutation that occurs, how that affects oxygen levels in his system (2), and how the disease may affect his entire family.

The “Modeling”

The students create a mutated and normal folded hemoglobin protein model based on amino acid chemical characteristics and use it to simulate Mendelian genetics, inheritance patterns, and heterozygous advantage. This reinforces how the hydrophobicity of amino acid side chains determines protein folding. Briefly, students place 18 color-coded beads on the pipe cleaner to represent the first 18 amino acids of hemoglobin (after Methionine). Each bead color represents a different amino acid character (blue = hydrophilic, red = hydrophobic, and yellow = intermediate). The students then fold the protein according to hydrophobicity. Simply, a hydrophobic amino acid (red) will stay in the center of the folded protein while the hydrophilic amino acid (blue) will be on the outside of the folded protein (2). The normal hemoglobin protein (white strand) can hold oxygen (represented by the red ball) more efficiently than the mutated hemoglobin protein (green strand). The end product should be a 3D shape with red/yellow beads toward the interior of the protein and blue/yellow beads surrounding the outer portion of the protein. The normal and mutated hemoglobin will have a different shape with the red oxygen ball only found in the normal hemoglobin protein (see Fig. 1). This serves as a simple visual of hemoglobin’s function.

Students utilize the hemoglobin models to answer the guided questions and model inheritance patterns, codominance patterns, and heterozygous advantage in front of the class. A student representing Ryan will show the class what
type of hemoglobin protein he has in his body (1 copy of normal and 1 copy of mutated) and review the terms to describe this. A mock inheritance demonstration of alleles (normal or mutated protein models) to a son will determine if he can be drafted by the Denver Broncos. Lastly, students model who could be protected from malaria on a trip to Africa.

Safety issues

There are no issues with safety as no live organisms are used in this activity.

CONCLUSION

This teaching activity was created to address content areas where students perform poorly on standardized tests by introducing the material in an engaging manner using kinesthetic and visual models. This activity can be used by instructors teaching middle/high school biology courses as well as undergraduate introductory and nonmajor biology courses. Megan Malone, a biology instructor at Riverview High School in Florida teaching Biology, Honors Biology, and AP Biology has used this in her 9th grade honors Biology class and has stated, “I used this activity for Biology EOC (Biology end-of-course exam) review at the end of the year. I was so impressed by the level of engagement my students displayed with this activity. Students were able to participate in an in-depth review of Mendelian and molecular genetics topics and even make connections back to evolution. Most importantly students were having fun and asking questions. I will use this activity during the molecular genetics unit next year!”

SUPPLEMENTAL MATERIALS

Appendix 1: Super Bowl activity – student version
Appendix 2: Super Bowl activity – instructor version
Appendix 3: Super Bowl activity – color-coded genetic code
Appendix 4: Super Bowl activity standards

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