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MODULE TOPICS:
Principle of Homeostasis
SI Measurement and Conversions

RATIONALE: Students often express a lack of understanding regarding the correlation between mathematics and science in biology class. The use of SI measurement and the conversion of such between units and measurement systems has been a recurrent point of difficulty for my students. It has become evident that without a fully developed understanding of *why* they are being taught to solve problems using SI measurements/conversions; my students will continue to experience difficulty in executing such problems.

STANDARD(S) & INDICATOR(S):
5.1.12.B.1: Design investigations, collect evidence, analyze data, and evaluate evidence to determine measures of central tendencies, causal/correlational relationships, and anomalous data.
5.2.4.A.3 Determine the weight and volume of common objects using appropriate tools.
5.1.12.D.1 Engage in multiple forms of discussion in order to process, make sense of, and learn from others' ideas, observations, and experiences.

OBJECTIVE(S): SWBAT:
- **Explain** why it is necessary to use units of measurement in system international (SI) while conducting scientific experimentation.
- **Conduct** conversions of units/values between standard and SI .
- **Infer** the relationship between medicine/chemical dosage and homeostasis in living systems.

MATERIALS:
Digital scales
Measuring trays
Citric acid powder
Baking soda
pH paper
Pure water (pH of 7)
Beakers
Empty capsules
Making a killing video

LIST OF HANDOUTS
"Patient profiles" Lab manual
Conversion activity sheet
Making a killing video sheet
Cellular requirements lecture guide

BACKGROUND INFORMATION:

Living systems attempt to maintain equilibrium at all times, yet medicine is often designed in a "one size fits all" format; and thus often fails to meet dosage requirements that induce true wellness . This lesson provides students with an interactive experience in calculating medical dosage tailored to the specific needs of patients.

The lab associated with this unit is designed as an enrichment opportunity. Student comprehension regarding the purpose of using SI measurement in science will be taught based on the idea of administering medicines that neither exceed, nor fail to reach individual dosage requirements.

CLASSROOM ACTIVITY DESCRIPTION (LABORATORY/EXERCISES/PROBLEMS) including detailed procedures:

Following this module, students will have gained an understanding of SI units, dimensional analysis, and the importance of using exact measurement to maintain biological homeostasis . Students will demonstrate understanding of these concepts by designing "prescription dosages" tailored to the specific qualities of the "patients" who will be taking them.

1. **Part 1 A:** The module will begin with a lesson on cellular requirements. Themes such as diffusion, osmosis, permeability, solubility, homeostasis, and equilibrium will be taught in a lecture based format (see attachment: Cellular requirements).
2. **Part 1 B: Medicine Discussion**: Students will watch the video "Making a Killing". Students will write a one page summary explaining the dangers associated with using precise, rather than specific medicine dosage.
3. **Part 2 A:** Combining the themes from parts 1A and 1B, students will be asked to choose the standard measurement unit that would best enable a doctor to prescribe medicine. The teacher will guide the students in realizing that even the smallest unit of measurement in standard form would exceed dosage requirements for most drugs. Students will then be introduced to the SI units as they relate to their respective standard units.
4. **Part 2 B:** Students will be given lecture/guided practice based instruction on the conversions of unit quantity prefixes (i.e. milligrams to grams). Student readiness for moving to part 2 C will be evident based on performance on the materials listed as "SI value conversions" and "Arranging the SI prefixes"
5. **Part 2 C:** Students will be given lecture/guided practice based instruction on the execution of factor label method (i.e. pounds to milligrams). Student readiness for moving to part 3 will be evident based on performance on the materials listed as "Factor label practice sheet" and "dimensional analysis quiz".
6. **Part 3: Unit Project**

- As an introduction to the project, students will be asked to discuss what they know about medicines and how they work. The teacher will provide an overview of different types of medication and explain how they affect living systems.
- Students will be asked to consider what they have learned about the cells ability to acquire, and reject substances, and explain how this process might be impacted by the excessive or deficient presence of drugs being used.
- Students will be asked to consider the advantages of using SI, versus standard measurement systems during the process of engineering medicines.
- Students will be given an overview of the project. In this activity, students will play the role of doctors. They will be given profiles of three patients, and will be asked to calculate unit conversions in order to prescribe medicines that meet the patients exact needs based on body mass and age. It should be noted that no two students will have the exact same patient profiles, though many of the patient profiles will appear to be similar when their dimensions are considered in standard units.
- Upon completion of the dosage conversions, students will use the digital scales in order to measure out the dose of "medicine" (baking soda) that will be prescribed for each patient. Students will be asked to note how incredibly small each of these doses actually are.
- The teacher will prepare citric acid solutions that match the pH of the expected dosage calculations for each patient. After observing the variation (or apparent lack thereof) in dosage sizes, the students will add their dose (baking soda) to the respective "patient" solution. Student success in calculating

the dosage will be evident based on whether or not their dose encourages homeostasis (a pH nutral solution) or not.
- The class will convene as a whole, and the teacher will guide them in creating a line graph that shows the correlation between body mass and milligrams in dosage.
- Students will write an accompanying conclusion that describes the correlation between specific measurement and homeostasis in medicine, as well as the importance of using SI rather than standard measurements in scientific practices.
- Special notes: This lesson will be applied to classes with fewer than 10 students, as such students will be asked to work in groups no larger than two.

SAMPLE QUESTIONS TO ELICIT CLASS DISCUSSION:
After comparing your dosage with a classmate, how does each pound of body mass impact the dosage size?
How does this activity relate to homeostasis?
Would it have been appropriate to use ounces while formulating your patients dosage?
What is the relationship between approximate dosage and medicine not working properly?
How would patients benefit from specific dosage systems?
Why would knowledge of SI and unit conversions be important to in engineering specific dosage systems?

HOMEWORK ACTIVITY/EXERCISES/PROBLEMS:
Students will be asked to complete the written portion of this activity for homework
Conversion sheets
Section Reviews
Lab data charts

Assessment
The class will convene as a whole. As a group, the students will be led in creating line graphs that show the correlation between body mass and milligrams in "medicine" dosage.
Students will write an accompanying conclusion that describes the correlation between specific measurement and homeostasis in medicine, as well as the importance of using SI rather than standard measurements in scientific practices.

A: Patient/dosage Conversions
B: Achievement of a pH neutral solution after administering "dose".
C: Lab performance (Observation)
D: Graphing/Communication of results/ Conclusion

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