|  |  |
| --- | --- |
| **Title of Unit** | Removing the Hassle from Henderson-Hasselbalch, part I  or  Shakespeare on Acid: To ionize or not to ionize…that is the question? |
| **Date and**  **Location of SI** | Tuesday - 7-23-2013  Mountain West Summer Institute, University of Colorado, Boulder |
| **Unit Developers & Contact Information** | Facilitator: Graciela Unguez gunguez@nmsu.edu  **Baylor University**  Erika Abel: Erika\_Abel@baylor.edu  Vanessa Castleberry Vanessa\_Castleberry@baylor.edu  Rizalia Klausmeyer Rizalia\_Klausmeyer@baylor.edu  **University of California, San Diego**  Aaron Snead asnead@ucsd.edu  **University of New Mexico**  Martina Rosenberg: mrosenberg@salud.unm.edu  William Sherman Garver wgarver@salud.unm.edu  Marcy Osgood mosgood@salud.unm.edu |
| **Context** | Introduction to Biochemistry, early in course  Juniors  Introductory and Organic Chemistry pre-req  **Unit progression**   * H20 as biological solvent * **Introduction to acid/base in biological systems** * **TIDBIT: Relationship between pH and pKa** * Henderson Hasselbalch Equation * Amino acids are weak polyprotic acids |
| **Abstract**  (< 200 words) | This tidbit walks students through some of the most common misconceptions related to pH, pKa, and the behavior of weak acids in aqueous solutions. It begins with a medically relevant example (absorption of a commonly used drug, aspirin); it then addresses definitions of pH, pKa, ionization, acids and bases; it compares and contrasts pH and pKa; illustrates the effect of environmental pH on ionization state of a weak acid; and returns to the initial medical example, which the students now address in terms of the tidbit topic. |
| **Rationale** | Understanding and using the relationship between pH and pKa is difficult for all levels of students, from those in freshman introductory chemistry classes, through medical school courses. It is also one of the most important concepts for understanding how certain drugs and other substances can enter cells, and effect change. |
| **Learning Goals:** what students will know, understand, and be able to do; includes content knowledge, attitudes, & skills | Students will:  • Understand the effect of environmental pH on the ionization status of weak acids and weak bases  • Explain to ‘layperson’ why this relationship matters in human health (unit goal) |
| **Learning Outcomes:** Student behaviors or performances that will indicate they have successfully accomplished the goals | Students will be able to  1. Characterize an aqueous environment as acidic or basic  2. Explain that pKa is a measure of how easy it is to remove a proton from a molecule  3. Predict ionization state of a molecule @ particular environmental pH based on its pKa (use the HH equation QUALITATIVELY)  4. Apply in medical context |
|  |  |

|  |  |  |
| --- | --- | --- |
| **Incorporation of Scientific Teaching Themes** | | |
| **Active Learning** | **Assessment** | **Diversity** |
| How students will engage actively in learning the concepts   * Clicker vote –discuss-revote * Think Pair Share * EnGauging environmental pH and substance pKa Exercise   (stickie notes) | How teachers will measure learning; how students will self-evaluate learning  **Formative, in class**  TPS  Clicker Questions  Comparison of answers on group exercises  **Formative, homework**  Transfer knowledge to predicting charge on amino acids at different pH values  **Summative**  Exam question(s) similar to the aspirin example using other drugs with different chemical structures and pKa values | Accommodates students who have yet to build a pH ‘scaffold’ so that transfer can be accomplished  The concept of pKa is addressed from multiple angles  Aspirin should be a drug that is widely recognized and used  Uses pictures and structures in addition to common drug name  Slides avoid red/green color blindness problem  Uses quantitative and qualitative expressions and pictures to explain concept |
| *Activities outside of class:*  pre class reading: part of a chapter in any Biochemistry text  *Activities during tidbit*:   1. Clicker question: Relate pKa to pH Exercise with Misconception Correction 2. Think Pair Share on ionization of strong versus weak acid 3. Determine ionization status under varying pHs-stickie note exercise followed by group discussion and whole class discussion 4. Place in Order of pKa Exercise with Misconception Correction 5. Compare absorption of aspirin in different locations in the body/pH environment | *Pre-assessments:*  On-line pre-quiz associated with the reading assignment (most Biochem books now offer these)  *Post-tidbit assessments:*  **Formative, homework**  Transfer knowledge to predicting charge on amino acids at different pH values  **Formative, homework**  Calculate the **concentration** of protonated aspirin in the stomach (after introduction of Henderson Hasselbalch equation in follow-up lecture/class session)  **Summative**  Exam question similar to aspirin using other drugs with different chemical structure and pKa |  |

**Sample** Presentation Plan (general schedule with approximate timing for unit)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | | | | |
| **Time (min)** | Learning Outcome(s) | Activity/assessment | Explanation, notes, suggestions, tips |
| *1 hour* | Students should be able to:  Recall the definition of pH and pKa  Explain that pKa is a measure of how easy it is to remove a proton from a molecule | Before Class:  Read related textbook chapter portion and take publisher’s prepared online quiz | Online quiz should be targeted to determine whether students have corrected any misconception that high pH is associated with high [H+]  Online quiz should identify similar misconceptions about pKa values |
| *5 minutes* | Apply in medical context | Intro of aspirin example (the hook) | Other interesting things may come up here...what if you have food in your stomach, etc. |
| *5 minutes* | Rank weak acids with known pKa according to willingness to donate a proton | Clicker question and discussion | It may be necessary to review Le Chatelier’s Principle if students struggle with this preparatory information |
| *10 minutes* | Predict ionization of a weak acid in aqueous environment where pH<pKa, pH=pKa, and pH>pKa | Stickie note activity and group comparison/discussion | Depending on class size this activity can be adjusted. It is visually stimulating to actually have the students come to the white board and affix their sticky notes to drawn beakers of aqueous solutions at different pHs. The pH 7 beaker is critical as pH=pKa and this situation is not discussed in preparatory material |
| *10 minutes* | Predict ionization status of a drug with ionizable groups in stomach versus small intestine  Relate ionization status to a health endpoint: permeability of membrane to ionizable drugs under variable pH conditions | Using aspirin as an example, have students determine whether the drug is charged or uncharged in the stomach and small intestine  Ask students to consider the characteristics of the cell membrane and determine absorption in the two compartments | It may be helpful to have students identify the ionizable group on aspirin. Some have difficulty identifying ionizable functional groups, initially. |
| *Unpredictable* |  | Ask students what questions this brings to mind. Perhaps stimulate discussion by asking what the effect of taking aspirin plus an antacid might be |  |

*Add additional activities information as needed for the unit.*

Resources for Teaching the Unit

Some possible web sites...but, any Biochem text will have a chapter on Water/Weak Acids

<https://www.youtube.com/watch?v=VYEAPPJdIVI>!

http://www.wiley.com/college/pratt/0471393878/student/review/acid\_base/4\_strong\_and\_weak.html http://www.mhhe.com/physsci/chemistry/carey5e/Ch27/ch27-1-3.html

Effectiveness of unit (if you have used it in your own teaching)

Several of us have used aspects of the tidbit in our teaching and feel that the weaker students responded much better to this presentation than a traditional, more mathematically/graphically oriented presentation. Stronger students may become bored with the preparatory material but enjoy the biological application to aspirin absorption.

Acknowledgements

The Mountain West 2013 Summer Institute participants!