

This Module for Interactive Teaching (MINT) may be found online at
<https://ivv.rit.edu/pr-mint.php>

Acids Bases and Buffers

- Buffers regulate pH by absorbing and releasing protons

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MINT Learning Objectives

- Describe the relationship between the pH of a solution and the concentration of protons in solution.
- Explain that buffers are molecular compounds that bind or give up protons, and as a result stabilize pH and prevent changes in the concentration of free protons.
- Acknowledge that there is a limit in the amount of protons buffers can bind to or give up
- Articulate that regulating pH is a characteristic of living organisms because they have buffering systems.
- Construct a concept map to answer the focus question, "How do living organisms regulate pH?"
- Describe, in molecular terms, how products from normal cellular metabolism can lower the pH of the surrounding media.


National Standards Alignments:

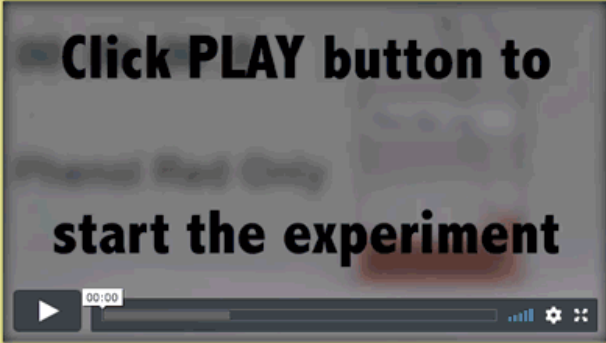
- Vision and Change Core Concepts and Competencies (<http://visionandchange.org>)
 - Core Concept:
 - Structure and Function: Basic units of structure define the function of all living things.
 - Systems: Living systems are interconnected and interacting.
 - Core Competencies:
 - Ability to apply process of science: Biology is evidence based and grounded in the formal practices of observation, experimentation, and hypothesis testing.
 - Ability to tap into the interdisciplinary nature of science: Biology is an interdisciplinary science

- Ability to use quantitative reasoning: Biology relies on applications of quantitative analysis and mathematical reasoning.
- Biocore Guide (Brownell et al., <https://doi.org/10.1187/cbe.13-12-0233>)
 - Structure and Function: Biological structures exist at all levels of organization, from molecules to ecosystems. A structure's physical and chemical characteristics influence its interactions with other structures, and therefore its function.
 - Systems: Biological molecules, genes, cells, tissues, organs, individuals, and ecosystems interact to form complex networks. A change in one component of the network can affect many other components.
- Process of Science Skills, Pelaez, N, *et al.* "The Basic Competencies of Biological Experimentation: Concept-Skill Statements" (2017). PIBERG Instructional Innovation Materials. Paper 4. <http://docs.lib.purdue.edu/pibergiim/4>
 - Posing problems
 - Transfer of knowledge from other subjects/classes
 - Generating hypotheses
 - Designing experiments
 - Identification of proper controls
 - Comparison requires holding all but the queried variable constant
 - Interpreting/evaluating data
 - Visual representations used to interpret data

Interactive Video Vignette Information

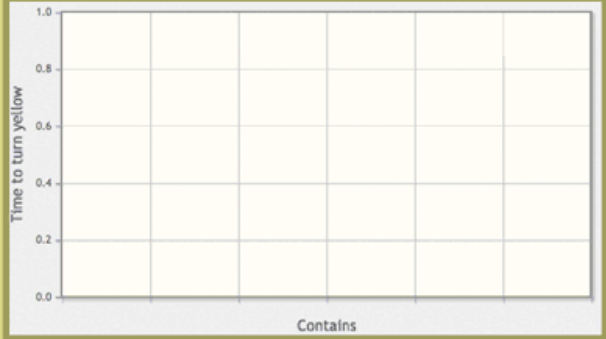
WHY IS MY PHENOL RED YELLOW?
INTERACTIVE VIDEO VIGNETTES





Fill in the Table Below

No.	Contains water, phenol red, and...	Time to turn yellow (seconds)
1	<input type="text"/>	<input type="text"/>
2	<input type="text"/>	<input type="text"/>
3	<input type="text"/>	<input type="text"/>
4	<input type="text"/>	<input type="text"/>
5	<input type="text"/>	<input type="text"/>
6	<input type="text"/>	<input type="text"/>



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IVV Title: *Why is My Phenol Red Yellow?*

IVV URL for students: <https://ivv.rit.edu/PR/2/>

Copy the URL to the Clipboard. Either paste it into an email to your students, or use it to create a link in your course management system.

IVV description:

A biology student and her friend wonder why cell culture media changes from red to yellow as the culture ages. A link is made between CO₂ release and bicarbonate and acid production. The students also design an experiment to test each of the ingredients in the media, and make the connection that chemical buffers can prevent acidification of the solution. The concept of a buffer is clarified by considering the buffering capacities of the buffer compared to the amino acids.

Novice Ideas and IVV Learning Goals

Novice Ideas

- Water and carbon dioxide do not react.
- Water and carbon dioxide react to make glucose.
- Buffers are “magic boxes” that somehow maintain a neutral pH.
- Organisms are able to maintain their own pH levels independently of any molecular interactions.
- Students do not see a connection between cellular growth and metabolic byproduct accumulation.

Ideas addressed in the IVV

- Carbonic acid (H₂CO₃) is produced when carbon dioxide (CO₂) and water (H₂O) react.
- The production of carbonic acid can lower the pH of a solution
- Buffers protect against a decrease in pH of a solution by binding to free protons (H⁺) in the solution.
- There is a limit to the quantity of protons that a buffer can bind to.
- Molecules such as amino acids have chemical structures that allow them to act as buffers.
- Metabolic byproducts of normal cellular growth (respiration) are produced and can accumulate in the environment.

Recommended In-class Curricular Material

Please see the MINT FAQ (<https://ivv.rit.edu/FAQ.php>) for general information on the use of MINTs and IVVs with your class. The following curricular materials are provided as examples of resources that may be used in class to further student learning towards IVV and MINT learning objectives.

1. Platt T. Acids, pH, and Buffers: Some Basic Chemistry for Biological Science. National Center for Case Study Teaching in Science Case Collection.
http://sciencecases.lib.buffalo.edu/cs/collection/detail.asp?case_id=498&id=498
2. Taylor ATS, Cliff WH. One Headache After Another: Physiology Edition, or One Headache After Another: Biochemistry Edition. National Center for Case Study Teaching in Science Case Collection.
http://sciencecases.lib.buffalo.edu/cs/collection/detail.asp?case_id=714&id=714

Assessment Question Information:

The research team has developed multiple select questions for assessing IVV effectiveness. Please contact the research team (<https://ivv.rit.edu/about.php>) if you are interested in assessing IVV use in your course.

Acknowledgement

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