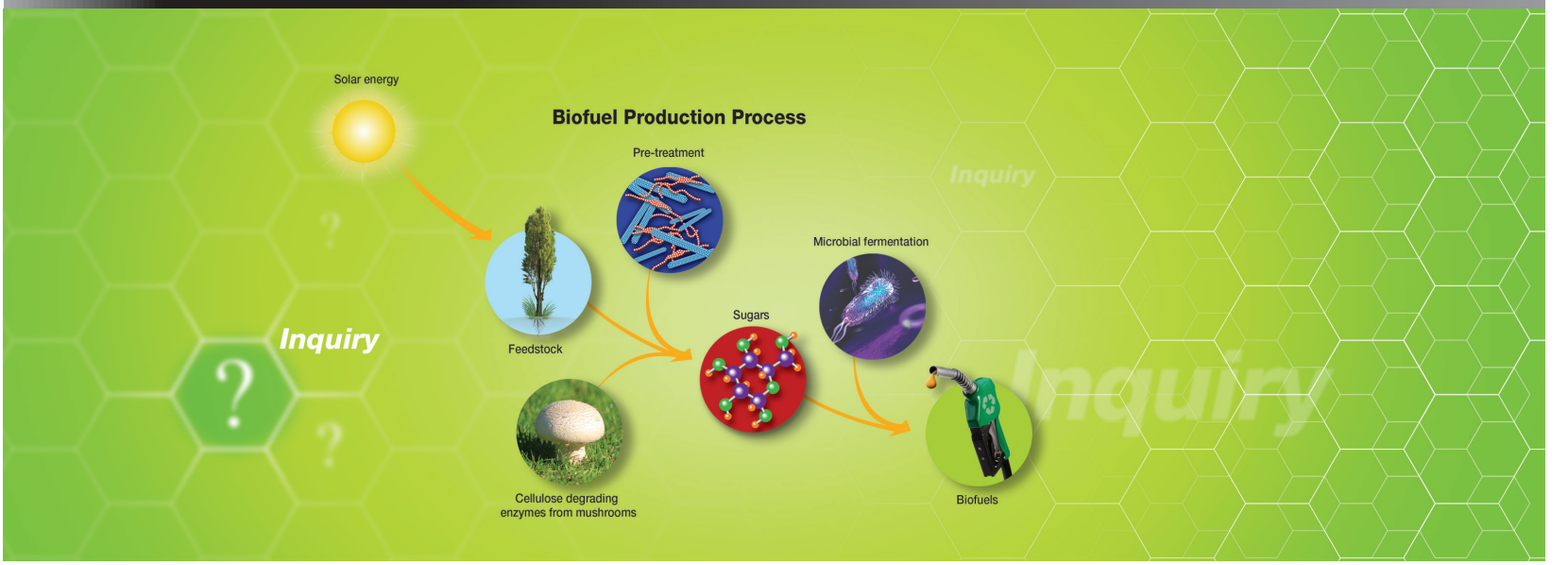
BIO-RAD Explorer™



Biofuel Enzyme Reactions Kit

A ThINQ!™ Investigation

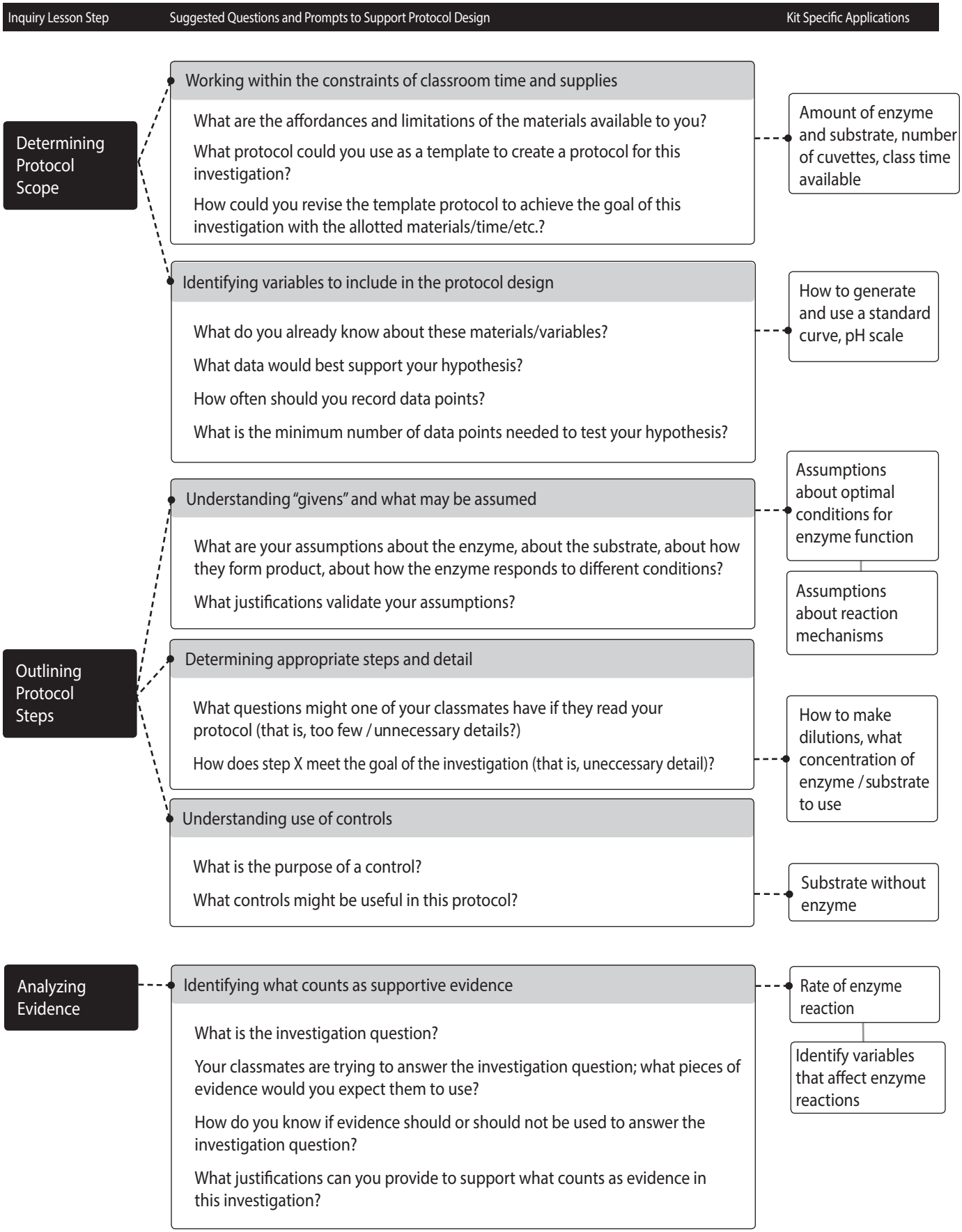
Teacher Model Process

BIO-RAD

Guide to Student Inquiry and Investigation

This table is designed to highlight specific steps during protocol design where students may require additional support. As students design their protocols you may find it useful to support their thinking and writing by using the questions and prompts below. This table can be used in conjunction with the Experimental Planning and Design Worksheet (bio-rad.com/doc/biofuelAPresources) as a formative or summative assessment tool and during class time to support students in the protocol design process.

Inquiry Lesson Step	Suggested Questions and Prompts to Support Protocol Design	Kit Specific Applications
Making Observations	Making observations that lead to an investigation question What did you notice during Investigation 1 when using mushroom extract to determine reaction rate? How might different conditions affect the rate of the enzyme reaction? What kinds of observations would you need to make in order to answer your questions? Describe the phenomenon that you observed in Investigation 1.	Determining reaction rate using enzyme extracted from mushroom, comparing enzyme activity from different mushrooms
Defining the Purpose of the Investigation	Clarifying the purpose of the investigation What was the purpose of Investigation 1? How does the purpose of Investigation 1 differ from the purpose of this investigation? What small changes could you make to the protocol in Investigation 1 to meet the purpose of this investigation? What steps from the protocol in Investigation 1 can you use to design this investigation?	Comparing different conditions of temperature, pH, enzyme concentration, and substrate concentration
Hypothesis Formation	Clarifying goals for the investigation Can you explain in your own words what the investigation question is asking? What do you already know about how enzymes work? How does your knowledge about enzymes help you describe the phenomena that you observed in Investigation 1? Knowing this, how would you modify your model to describe the phenomena that you observe in this investigation? What evidence would you need in order to answer the investigation question?	Understanding how enzymes function under different conditions (e.g., some denature at high temperatures)


Inquiry Lesson Step
Suggested Questions and Prompts to Support Protocol Design
Kit Specific Applications
Determining Protocol Scope
Working within the constraints of classroom time and supplies
What are the affordances and limitations of the materials available to you?
What protocol could you use as a template to create a protocol for this investigation?
How could you revise the template protocol to achieve the goal of this investigation with the allotted materials/time/etc.?
Amount of enzyme and substrate, number of cuvettes, class time available
Identifying variables to include in the protocol design
What do you already know about these materials/variables?
What data would best support your hypothesis?
How often should you record data points?
What is the minimum number of data points needed to test your hypothesis?
How to generate and use a standard curve, pH scale
Outlining Protocol Steps
Understanding "givens" and what may be assumed
What are your assumptions about the enzyme, about the substrate, about how they form product, about how the enzyme responds to different conditions?
What justifications validate your assumptions?
Assumptions about optimal conditions for enzyme function
Assumptions about reaction mechanisms
Determining appropriate steps and detail
What questions might one of your classmates have if they read your protocol (that is, too few / unnecessary details?)
How does step X meet the goal of the investigation (that is, uneccessary detail)?
How to make dilutions, what concentration of enzyme / substrate to use
Understanding use of controls
What is the purpose of a control?
What controls might be useful in this protocol?
Substrate without enzyme
Analyzing Evidence
Identifying what counts as supportive evidence
What is the investigation question?
Your classmates are trying to answer the investigation question; what pieces of evidence would you expect them to use?
How do you know if evidence should or should not be used to answer the investigation question?
What justifications can you provide to support what counts as evidence in this investigation?
Rate of enzyme reaction
Identify variables that affect enzyme reactions

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