

# LABORATORY 2: ENZYME CATALYSIS

## OVERVIEW

In this laboratory you will observe the conversion of hydrogen peroxide ( $\text{H}_2\text{O}_2$ ) to water and oxygen gas by the enzyme catalase. You will then measure the amount of oxygen generated and calculate the rate of the enzyme-catalyzed reaction.

## OBJECTIVES

Before doing this laboratory you should understand:

- the general functions and activities of enzymes;
- the relationship between the structure and function of enzymes;
- the concept of initial reaction rates of enzymes;
- how the concept of free energy relates to enzyme activity; and
- that changes in temperature, pH, enzyme concentration, and substrate concentration can affect the initial reaction rates of enzyme-catalyzed reactions.

After doing this laboratory you should be able to:

- measure the effects of changes in temperature, pH, enzyme concentration, and substrate concentration on reaction rates of an enzyme-catalyzed reaction in a controlled experiment; and
- explain how environmental factors affect the rate of enzyme-catalyzed reactions.

## INTRODUCTION

In general, **enzymes** are proteins produced by living cells; they act as catalysts in biochemical reactions. A **catalyst** affects the rate of a chemical reaction. One consequence of enzyme activity is that cells can carry out complex chemical activities at relatively low temperatures.

In an enzyme-catalyzed reaction, the substance to be acted upon (the **substrate** = **S**) binds reversibly to the **active site** of the enzyme (**E**). One result of this temporary union is a reduction in the energy required to activate the reaction of the substrate molecule so that the **products** (**P**) of the reaction are formed.

In summary:

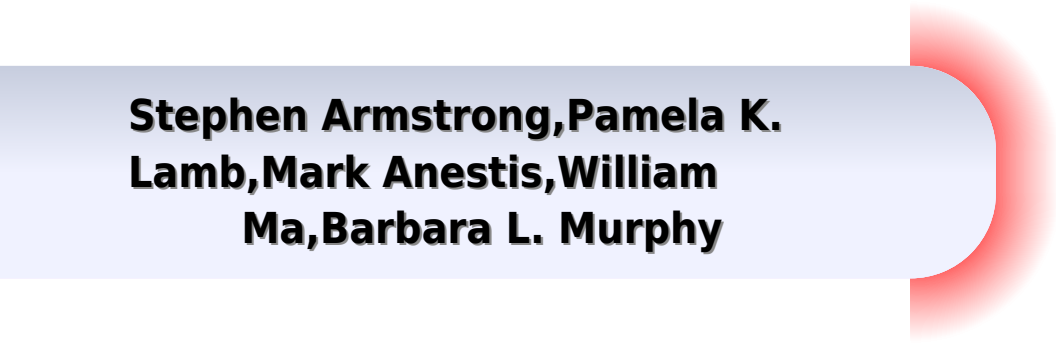


Note that the enzyme is not changed in the reaction and can be recycled to break down additional substrate molecules. Each enzyme is specific for a particular reaction because its amino acid sequence is unique and causes it to have a unique three-dimensional structure. The **active site** is the portion of the enzyme that interacts with the substrate, so that any substance that blocks or changes the shape of the active site affects the activity of the enzyme. A description of several ways enzyme action may be affected follows.

1. **Salt concentration.** If the salt concentration is close to zero, the charged amino acid side chains of the enzyme molecules will attract each other. The enzyme will denature and form an inactive precipitate. If, on the other hand, the salt concentration is very high, normal interaction of charged groups will be blocked, new interactions will occur, and again the enzyme will precipitate. An intermediate salt concentration such as that of human blood (0.9%) or cytoplasm is the optimum for many enzymes.
2. **pH.** pH is a logarithmic scale that measures the acidity of  $\text{H}^+$  concentration in a solution. The scale runs from 0 to 14 with 0 being highest in acidity and 14 lowest. When the pH is in the range of 0-7, a solution is said to be acidic; if the pH is around 7, the solution is neutral; and if the pH is in the range of 7-14, the solution is basic. Amino acid side chains contain groups such as  $-\text{COOH}$  and  $-\text{NH}_2$  that readily gain or lose  $\text{H}^+$  ions. As the pH is lowered an enzyme will tend to gain  $\text{H}^+$  ions, and eventually enough side chains will be affected so that the enzyme's shape is disrupted. Likewise, as the pH is raised, the enzyme will lose  $\text{H}^+$  ions and eventually lose its active shape. Many enzymes perform

# Laboratory 2 Enzyme Catalysis Student Guide Answers

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Laboratory Guide to Biochemistry, Enzymology, and Protein Physical Chemistry Marc le Maire, Raymond Chabaud, Guy Hervé, 2012-12-06 The study of a single well chosen substance here aspartate transcarbamoylase can provide an excellent basis for a laboratory course The student is introduced to a variety of scientific ideas and to many experimental and interpretive techniques This enzyme is readily available is relatively stable has an extensive literature and its behavior has many facets substrate inhibition a large change in structure upon homotropic activation by substrates allosteric stimulation by ATP allosteric inhibition by CTP synergistic with VTP positive cooperativity for substrates negative cooperativity for CTP binding and dissociation and reassembly of subunits C and R2 from the holoenzyme CI 5 In addition 3 6 to the known biochemical aspects of these properties the results obtained here can be interpreted in the light of the high resolution X ray diffraction structures of the T and R forms the low angle X ray scattering results and the large number of mutants now available by recombinant DNA methods Future development of this course could also involve part of these methods as well as the carefully chosen experiments described here This approach resembles research more than the approaches one usually finds in biochemical laboratory courses A consistent development of ideas about a single enzyme which shows so many facets in its behavior is sure to hold the interest of the student Moreover one explores a depth and reasons to move forward that are an essential part of research

Laboratory Manual for Practical Biochemistry Mr. Ajeet Singh, 2018-05-14 A practical manual containing detailed protocols safety guidelines and analytical techniques for biochemical experiments designed to develop hands on skills for students in laboratory settings

Learning and Understanding National Research Council, Division of Behavioral and Social Sciences and Education, Center for Education, Committee on Programs for Advanced Study of Mathematics and Science in American High Schools, 2002-09-06 This book takes a fresh look at programs for advanced studies for high school students in the United States with a particular focus on the Advanced Placement and the International Baccalaureate programs and asks how advanced studies can be significantly improved in general It also examines two of the core issues surrounding these programs they can have a profound impact on other components of the education system and participation in the programs has become key to admission at selective institutions of higher education By looking at what could enhance the quality of high school advanced study programs as well as what precedes and comes after these programs this report provides teachers parents curriculum developers administrators college science and mathematics faculty and the educational research community with a detailed assessment that can be used to guide change within advanced study programs

**AP - Biology** Gabrielle I. Edwards, Marion Cimmino, 2001 General advice on test preparation and Advanced Placement Test question types is followed by extensive topic reviews that cover molecules and cells genetics and evolution and organisms and populations Four full length model AP Biology exams are given followed by answers and explanations for all questions

**Discovery-Based Learning in the Life Sciences** Kathleen M.

Susman,2015-09-28 For nearly a decade scientists educators and policy makers have issued a call to college biology professors to transform undergraduate life sciences education As a gateway science for many undergraduate students biology courses are crucial to addressing many of the challenges we face such as climate change sustainable food supply and fresh water and emerging public health issues While canned laboratories and cook book approaches to college science education do teach students to operate equipment make accurate measurements and work well with numbers they do not teach students how to take a scientific approach to an area of interest about the natural world Science is more than just techniques measurements and facts science is critical thinking and interpretation which are essential to scientific research Discovery Based Learning in the Life Sciences presents a different way of organizing and developing biology teaching laboratories to promote both deep learning and understanding of core concepts while still teaching the creative process of science In eight chapters the text guides undergraduate instructors in creating their own discovery based experiments The first chapter introduces the text delving into the necessity of science education reform The chapters that follow address pedagogical goals and desired outcomes incorporating discovery based laboratory experiences realistic constraints on such lab experiments model scenarios and alternate ways to enhance student understanding The book concludes with a reflection on four imperatives in life science research climate food energy and health and how we can use these laboratory experiments to address them Discovery Based Learning in the Life Sciences is an invaluable guide for undergraduate instructors in the life sciences aiming to revamp their curriculum inspire their students and prepare them for careers as educated global citizens

**Photosynthesis and Respiration** John William Marklewitz,1995 *Student Handbook* Stephen Armstrong,Pamela K. Lamb,Mark Anestis,William Ma,Barbara L. Murphy,2000 The Student Handbook is designed to provide students with ready access to information with problem solving techniques and study skill guides that enable them to utilize the information in the most efficient manner Amazon com *Barron's how to Prepare for the Advanced Placement Examination AP Biology* Gabrielle I. Edwards,Marion Cimmino,1992 This newly updated manual contains three model exams with answers and explanations plus a detailed review of college level biology that covers all AP exam topics Practical advice is also given for the essay question and short answer questions *Biology/science Materials* Carolina Biological Supply Company,1991

**Medical Books and Serials in Print** ,1984 [The Absolute, Ultimate Guide to Lehninger Principles of Biochemistry](#) Marcy Osgood,Karen A. Ocorr,2008-04-04 The Absolute Ultimate Guide combines an innovative study guide with a reliable solutions manual in one convenient printed volume *Medical and Health Care Books and Serials in Print* ,1987

**El-Hi Textbooks in Print** ,1978 *Biology* ,1999 [Essential Biochemistry](#) Charlotte W. Pratt,Kathleen Cornely,2023-08-25 Essential Biochemistry 5th Edition is comprised of biology pre med and allied health topics and presents a broad but not overwhelming base of biochemical coverage that focuses on the chemistry behind the biology This revised edition relates the chemical concepts that scaffold the biology of biochemistry providing practical knowledge as well as many

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