Pineapple-Enzyme Lab
Background Information

Pineapples
Pineapple's lush, tropical sweetness is reason enough to enjoy it any way you can, but this fruit also contains vitamin C and manganese. This fruit's most promising nutritional asset, though, may be bromelain, a natural enzyme found in both the fruit and the stem.

Most of the pineapple consumed in the United States is canned (in the form of juice as well as fruit), but fresh pineapple is much more flavorful, and despite its tough bristly shell, is easy to prepare.

The fruit probably first grew wild in parts of South America and then spread to the Caribbean, where Columbus encountered it. By 1600, early European explorers had carried pineapples as far as China and the Philippines. In the 18th century, pineapples were taken to the Hawaiian Islands, eventually becoming the major fruit crop. Hawaiian pineapple producers were the first to can the fruit.

Bromelain
The pineapple plant contains protein-digesting enzymes called, as a group, bromelain. In the health world, these enzymes are regarded as useful in reducing muscle and tissue inflammation (hence the joint pain and wound-healing possibilities), as well as acting as a digestive aid. In the cooking world, on the other hand, bromelain is regarded as the enemy of the gelatin dessert. If you use fresh pineapple in gelatin, the enzyme eats the protein and the gelatin will not gel—in fact bromelain is measured in units called GDU, or gelatin digesting units. The classic kitchen trick for getting around this pineapple-gelatin incompatibility is to cook the pineapple, thus reducing the power of the bromelain.

Recipes that would highlight the benefits of bromelain start with fresh pineapple (which has two to three times the amount of bromelain as canned pineapple does), and is then subjected to as little heat as possible.

Bromelain is used in meat tenderizers, in hill-proofing beer, manufacturing precooked cereals, in certain cosmetics, and in preparation to treat edema and inflammation.

Gelatin
Gelatin, a familiar, ingredient in cooking, is obtained by boiling the skin, tendons, and ligaments of animals. As a result, it contains protein called collagen (a primary component of joints, cartilage, and nails), and various amino acids (histidine, lysine, leucine, tryptophan, and valine, to name a few). Remember: amino acids are the building blocks of proteins.

Gelatin has long been a key ingredient for providing support for "jelled" deserts, salads, frozen drinks, and soft candies such as Gummi Bears. (In fact, the word gelatin is derived from the Latin "gelatus", meaning stiff or frozen.)

Scientists have been studying gelatin for centuries. It has no smell or taste of its own, adapting to whatever it is added to. During the Napoleonic Wars, the French, desperate for nutrition sources during the English blockade, reportedly first turned to gelatin as a source of protein (albeit a weak one). Gelatin began its long run as a popular consumable, however, in the 1890's, when it was first developed and then heavily promoted as a commercial product by Charles Knox, founder of the Knox Gelatin Corporation.

In addition to its famous "jiggly" food uses, gelatin with its flexible, dissolvable structure, is also used to manufacture capsules (both hard and "soft-gel") to hold medications, vitamins, and other dietary supplements. It also has a range of industrial and medical engineering applications: Gelatin is an ingredient in film coatings, medical devices such as artificial heart valves, and in specialized meshes used to repair wounds, to name a few.

Collagen

About one quarter of all the protein in your body is collagen. It is a major structural material that forms molecular cables to strengthen the tendons and resilient sheets that support the skin and internal organs. Bones and teeth are made by adding mineral crystals to collagen. Collagen provides structure to our bodies, protecting and supporting the softer tissues and connecting them with the skeleton. But, in spite of its critical function in the body, collagen is a relatively simple protein.

Collagen from livestock animals is a familiar ingredient in cooking. Collagen is a protein, and like most proteins, when heated, it loses all of its structure. The polymer molecule unwinds. Then, when the denatured mass cools down, it soaks up all of the surrounding water like a sponge, forming gelatin.

QUESTIONS

1. Clearly describe the results of your experiment. In which cup did the gelatin jell and which did not?
2. Clearly explain the results of your experiment. Why did the cup of gelatin jell or not jell? Be specific!
3. What is the enzyme in your experiment?
4. What is the substrate in your experiment?
5. What is (are) the product(s) in your experiment?
6. What type of organic molecule is gelatin?
7. What type of organic molecule is bromelain?
8. Write a "word equation" to describe the chemical reaction that occurs when pineapple is mixed with the gelatin.
9. Is the reaction of bromelain and gelatin dehydration synthesis or hydrolysis? Explain.
10. What would happen if freshly cooked pineapple was used? How would it have been different than the results of the fresh, raw pineapple?
11. What is meat tenderizer and what does it do?
12. On a sheet of paper, design an experiment to test at what specific temperature the pineapple enzyme denatures. You must include the following information:
    a. Question and Hypothesis
    b. List of independent and dependent variables
    c. Setup of your experiment including how you will test and measure your dependent variable
    d. Predicted results and why