Names: _____ Period: _____ Date: _____
Biology ~ Mr. Croft

Milk Coagulation Lab

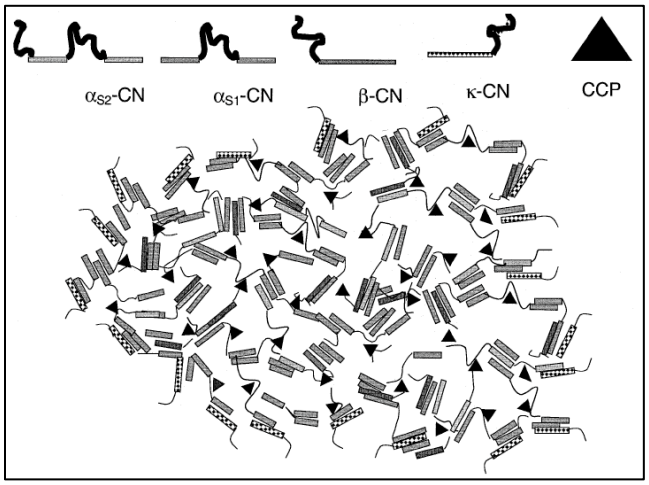
50 Points

I. Introduction:

Bacteria have played a fundamental role in the evolution of the earth. Over 90% of bacteria cannot be cultured in a lab. One relatively simple man-made microbial system is cheese. This simple ecosystem can be used to study colonization, biofilm formation, quorum sensing (response to crowding or population high density), changes in metabolism and the evolution of the microbial cheese community over time. The great diversity of cheeses is due in part to the diversity and type of bacteria and other microbes that are able to colonize and grow on the cheese. Most of the diversity is found in the rind of cheeses, particularly in natural rinds.

Cheese making has been a fine tuned art in Europe, but not as prevalent in North America. Artisan cheeses have gained popularity over the past 10 years, with the increase of farmers markets. This curiosity makes cheese making an ideal setting for studying bacteria in a classroom.

In this lab, milk coagulation is investigated. Several criteria are necessary for milk coagulation. One pathway is through the enzymatic activity of rennin (or chymosin). The second is through the acidification of the milk environment. The major protein found in milk is Casein (80% of milk protein). All other milk proteins are called whey proteins (mostly beta-lactoglobulin and alpha-lactalbumin). There are 4 types of casein: two alphas, one beta, and one Kappa. The alpha and beta caseins are hydrophobic proteins that precipitate in water in the presence of calcium.



Today, you will investigate the effects of various concentrations of acetic acid on milk coagulation. You will be given stock solutions of the various concentrations of acetic acid and determine the ideal concentration for coagulation.

II. Problem:

What is the effect of increasing acidity (decreasing pH) on the coagulation of milk?

III. Hypothesis:

IV. Materials:

acetic acid (vinegar) solutions	centrifuge
whole milk	five 15mL centrifuge tubes
	10 mL graduated cylinder
	plastic pipets

V. Procedure:

1. Your teacher will assign your group five acetic acid solutions.
   A - 2.1%, 2.2%, 2.3%, 2.4%, 2.5%
   B - 2.6%, 2.7%, 2.8%, 2.9%, 3.0%
2. Label your centrifuge tubes.
3. Add 9mL of whole milk to each tube.
4. Add 1mL of the acetic acid solutions to the appropriate tubes.
5. Shake each tube vigorously 10 times.
6. Centrifuge at 3,000 RPM for 5 minutes. Be sure that the centrifuge is balanced.
7. Carefully extract the whey (yellowish liquid) from each tube, if possible, into a graduated cylinder. Be sure that you do not disturb the curd (solid).
8. Record the volume of whey produced for each tube in the data table provided.
9. Record observations for each tube in the data table as well.
10. Compare your data with the class.

VI. Results:

Acetic Acid Solution	mL of Whey Produced (if any)	Observations

VII. Conclusion (summary of experiment, analysis of results, discussion of error):

VIII. Questions:

1. What is coagulation?

2. What causes coagulation?

3. How does rennin cause coagulation?

4. What effect does pH have on coagulation?

5. At what concentration of acetic acid does milk start coagulating? Relate this to optimal conditions.

6. What is the pH of the solution when milk first coagulates?

7. What is the volume ratio of whey:casein where coagulation is first seen?