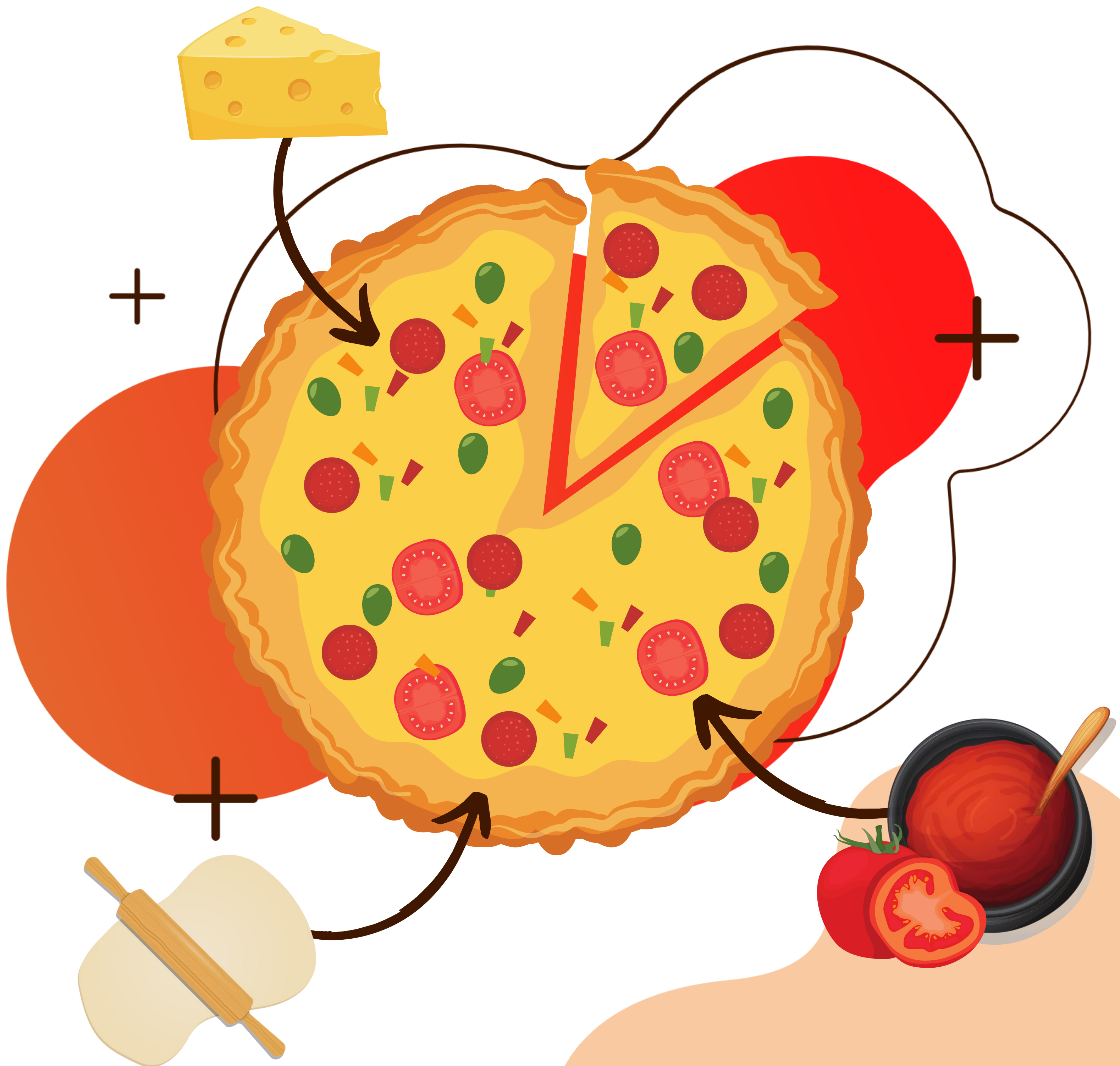
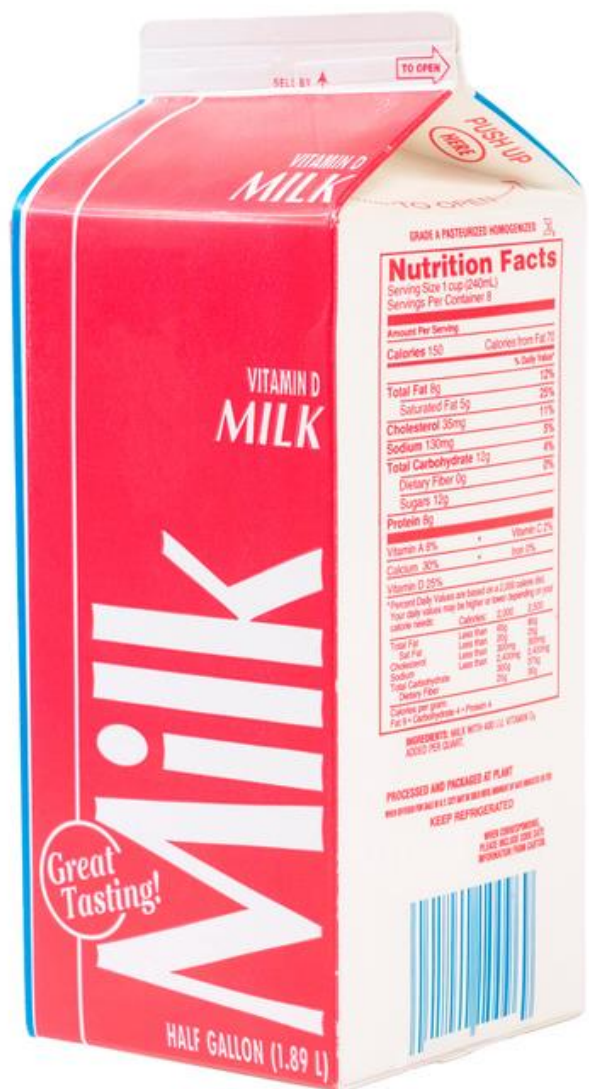
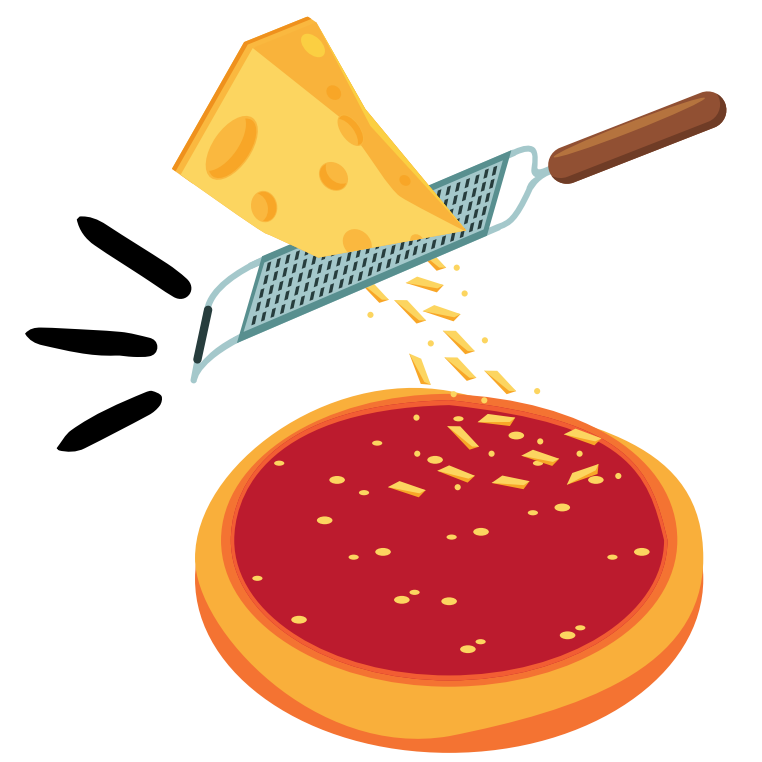


THE SCIENCE OF PIZZA



**Department of Food Science and Technology
University of Nebraska-Lincoln**

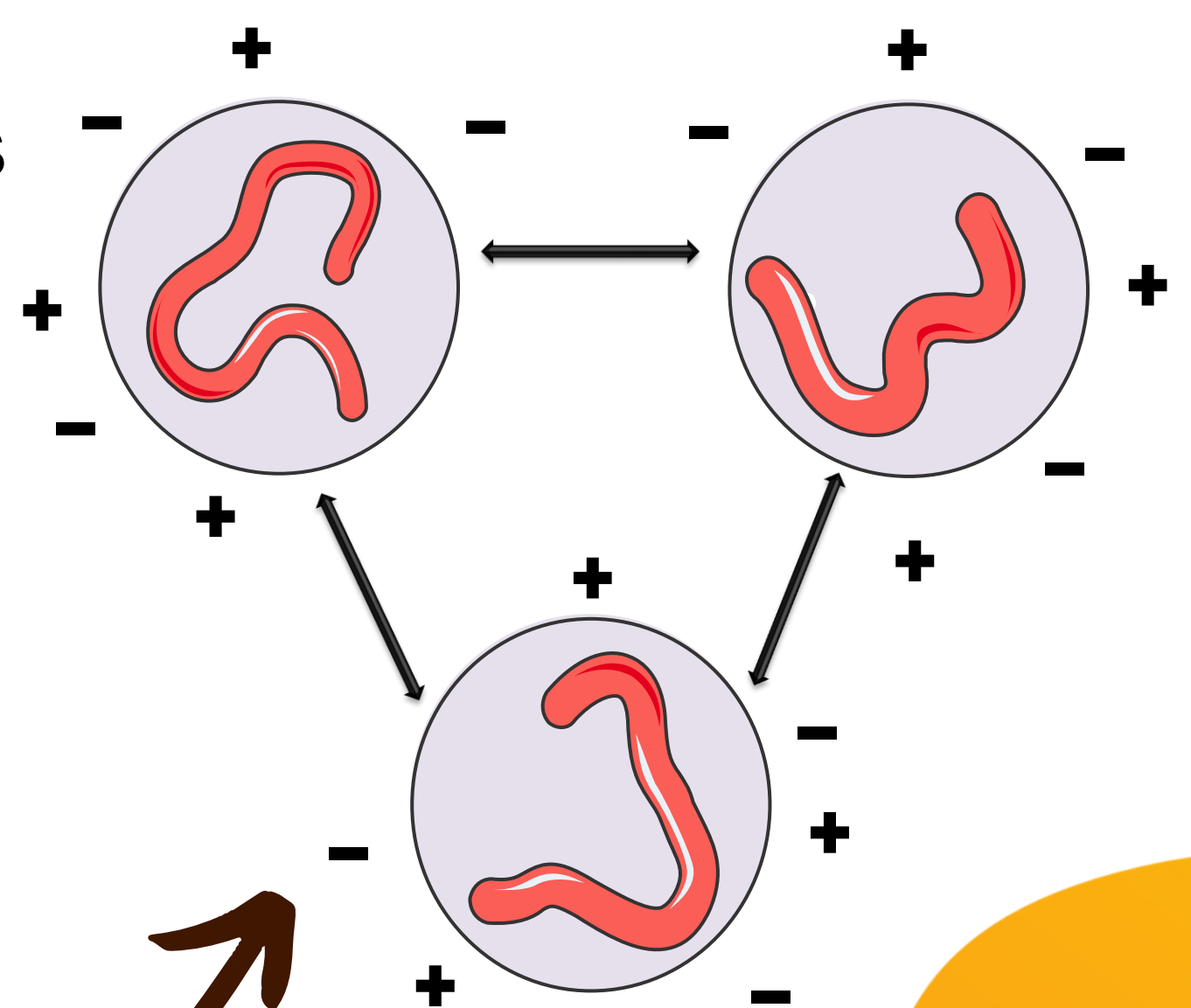
THE SCIENCE OF CHEESE



- All cheese starts as milk. Studying the label of a milk container reveals that there are many components in milk; including fat, protein, and carbohydrates.
- To make cheese, the proteins in milk need to coagulate or curdle. Coagulation occurs by acidifying milk, by heating it up, adding an enzyme called Rennet, or by adding good bacteria.

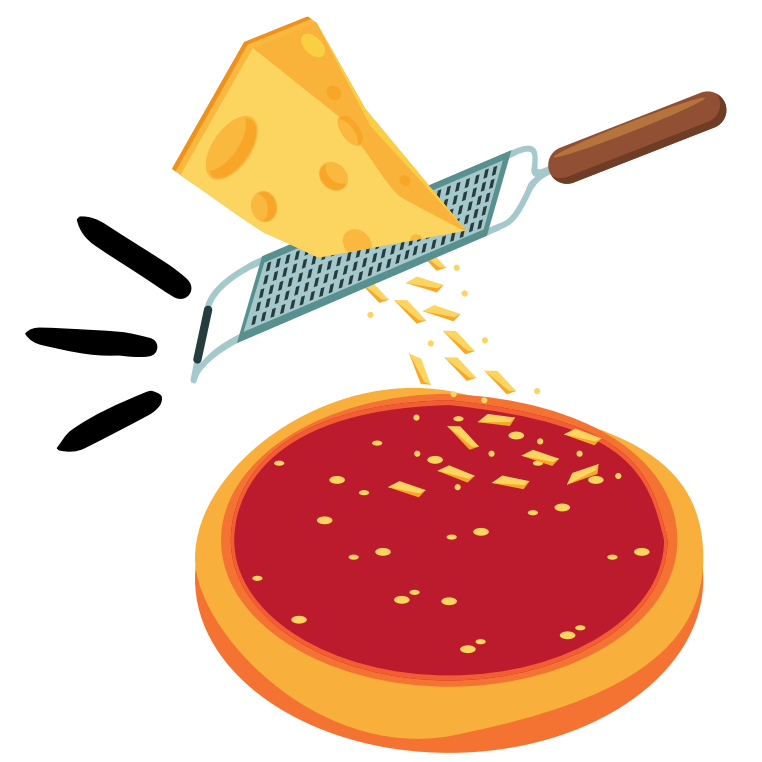
Milk proteins in solution

- The side chains of milk proteins carry an electric charge which is determined by the pH of the milk.
- Naturally, milk has a pH of 6. At this pH protein molecules remain in solution and separated because they have a net negative charge.



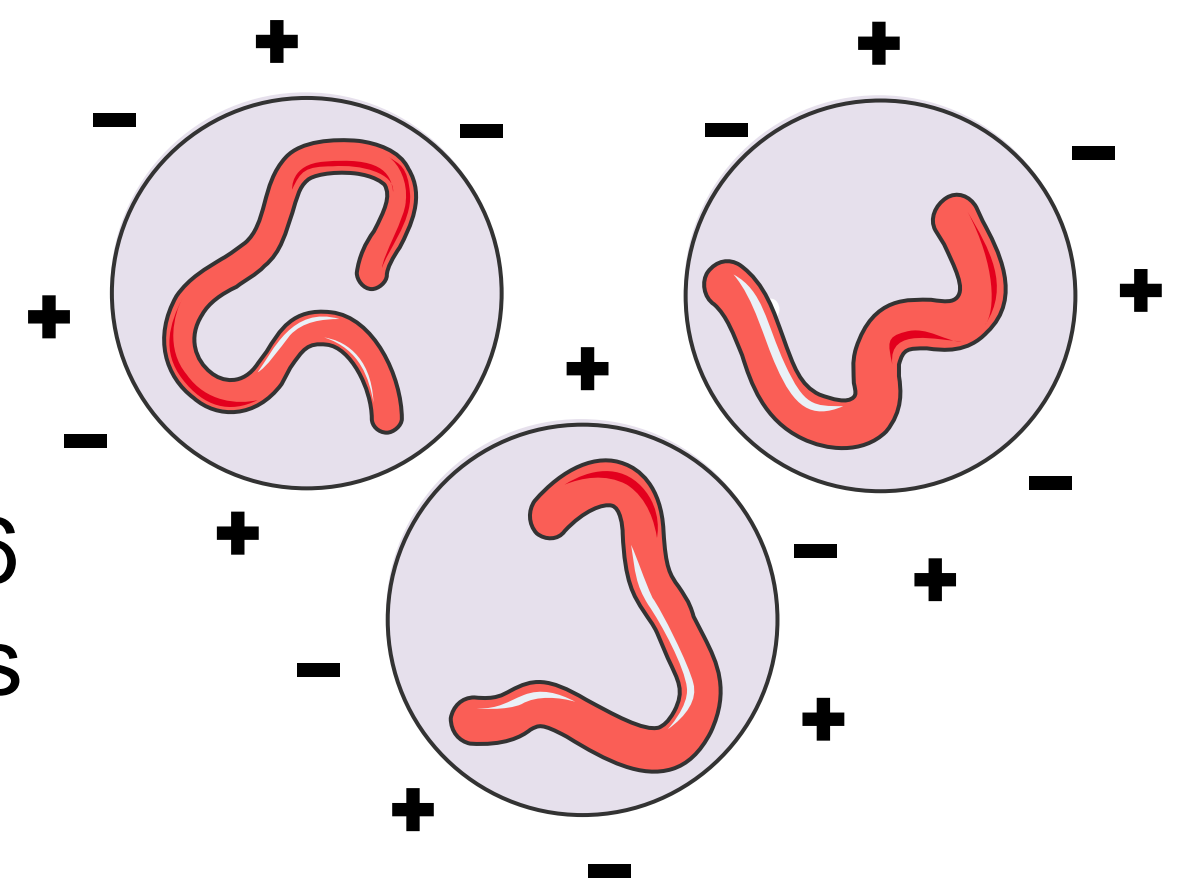
Protein molecule
at pH 6.6

THE SCIENCE OF CHEESE



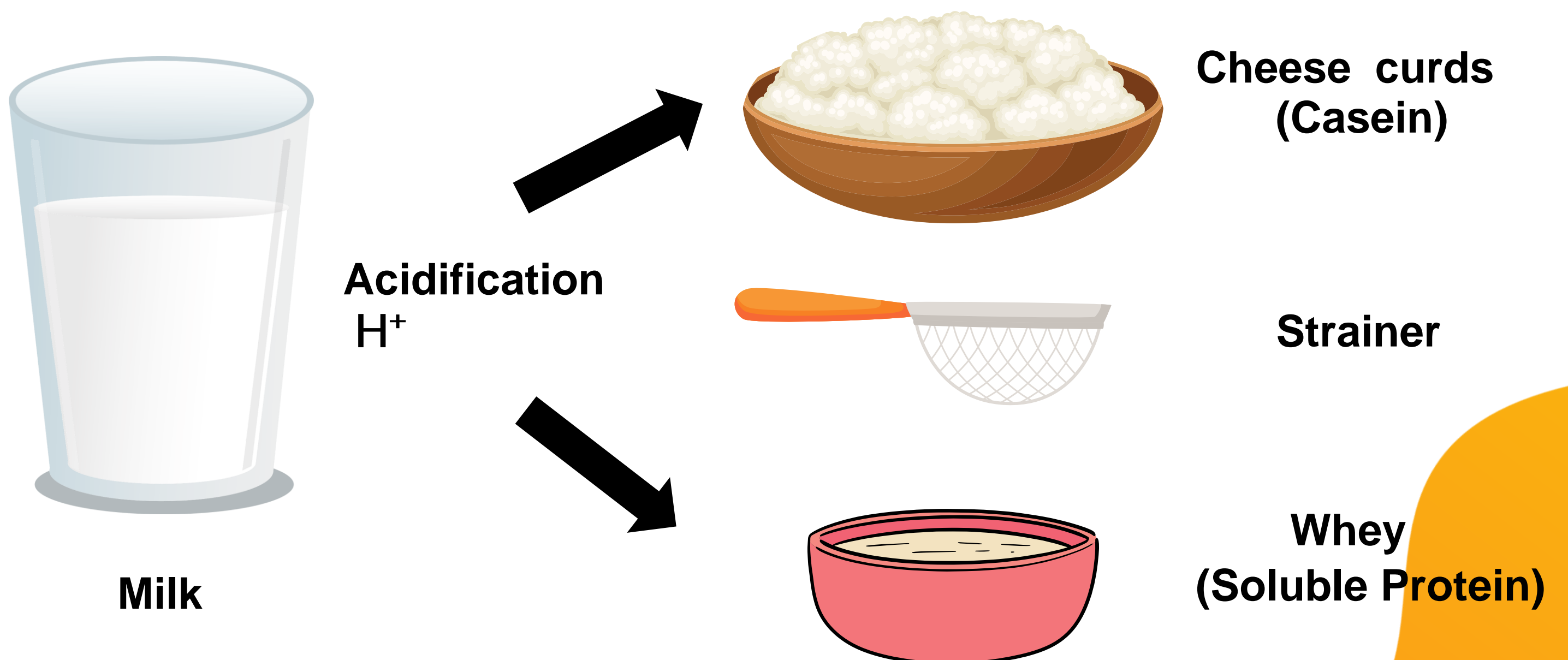
Acid Precipitation

- When the pH of milk is changed by addition of an acid (i.e., vinegar) the charge distribution of the proteins is also changed.
- When the milk pH is lowered to pH=4.6 the total charge of the protein becomes zero, and molecules no longer repel each other. The acidification causes the protein to precipitate from the solution.
- The pH at which this happens is called the isoelectric point of the protein.

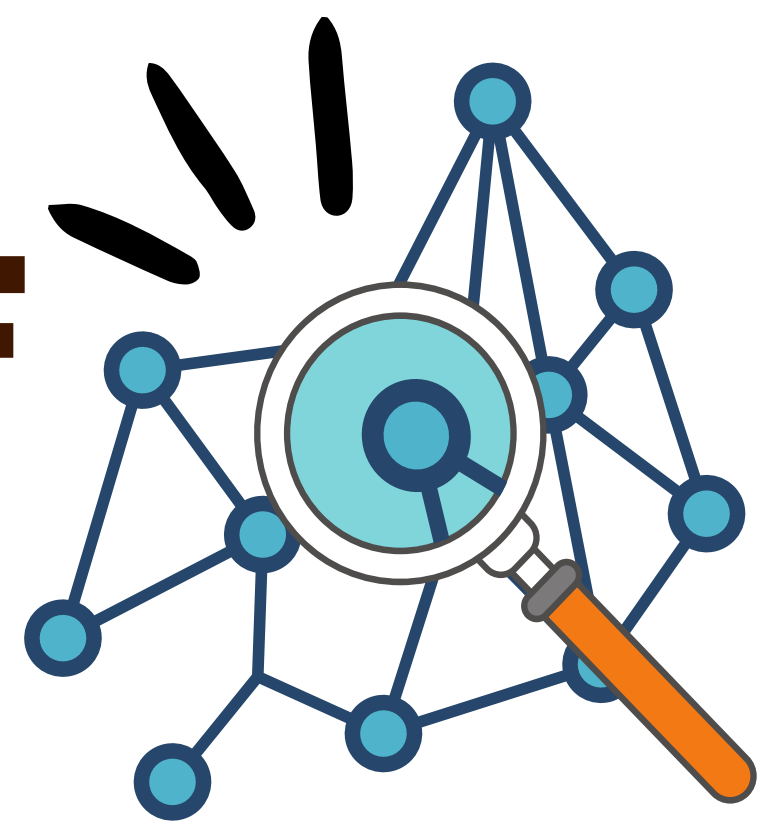


Protein molecule at pH 4.6

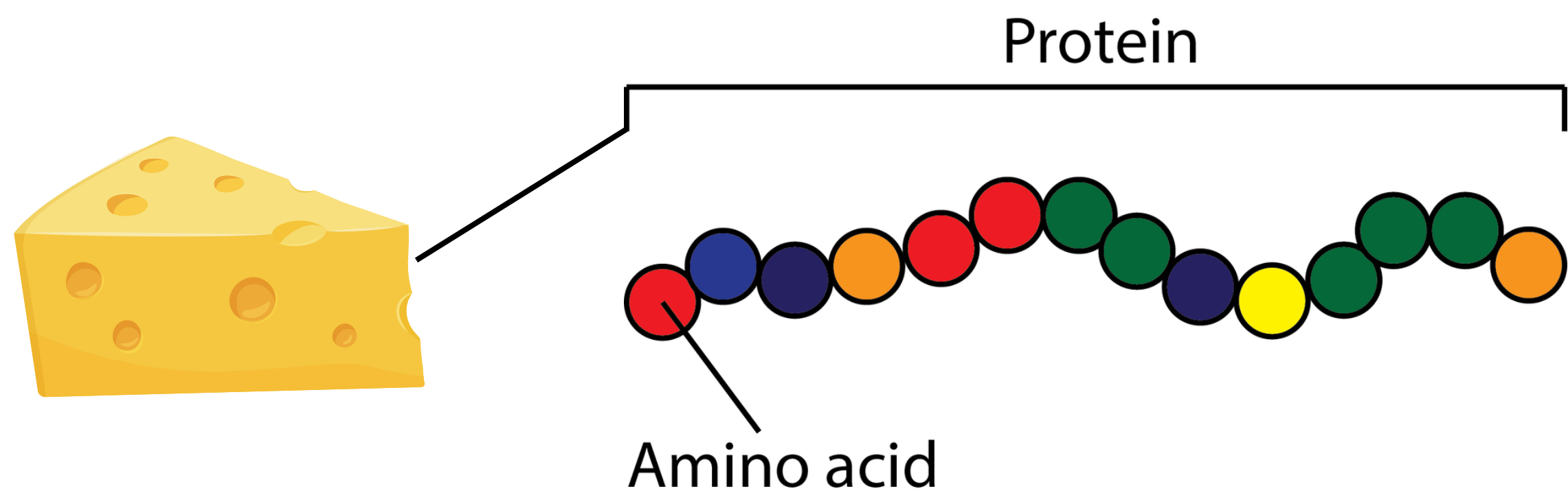
From Milk to Cheese



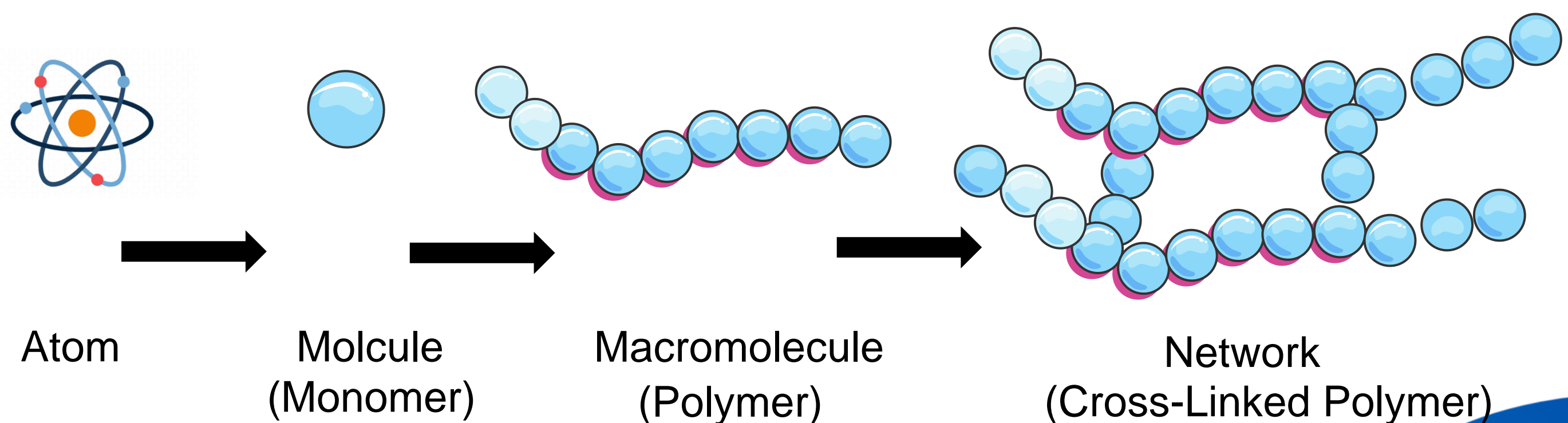
THE SCIENCE OF CROSS-LINKING



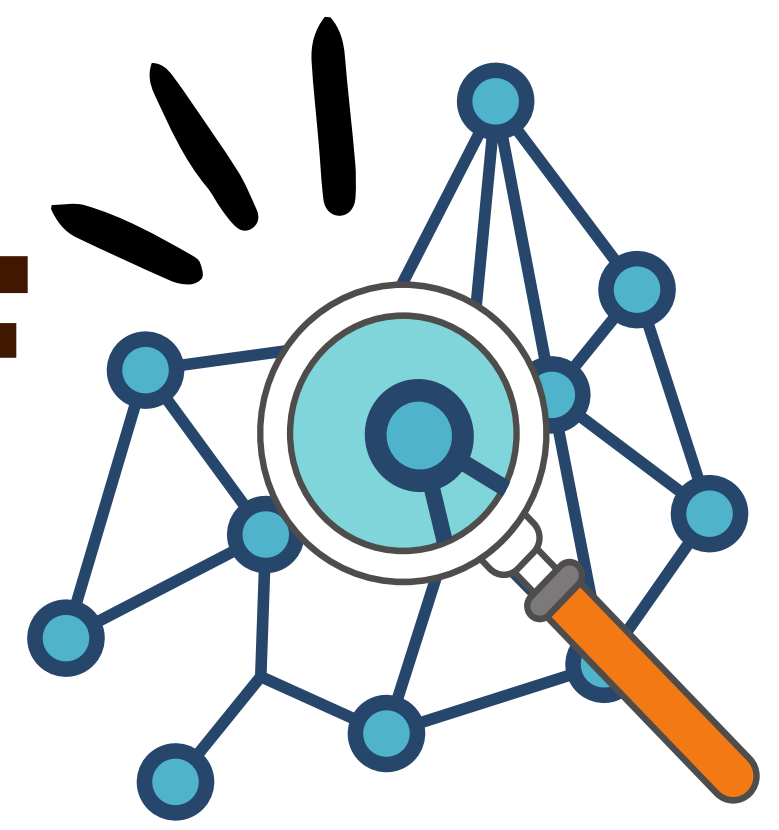
- Foods are made of ingredients. The major ingredients of pizza-tomatoes, cheese, and bread-are networks of molecules that are linked together or in association with each other to form the food matrix.
- Macromolecules are made of single subunits or building blocks that are linked together. One example is protein, which is made of a chain of amino acids.



Atoms to Molecules to Macromolecules to Networks

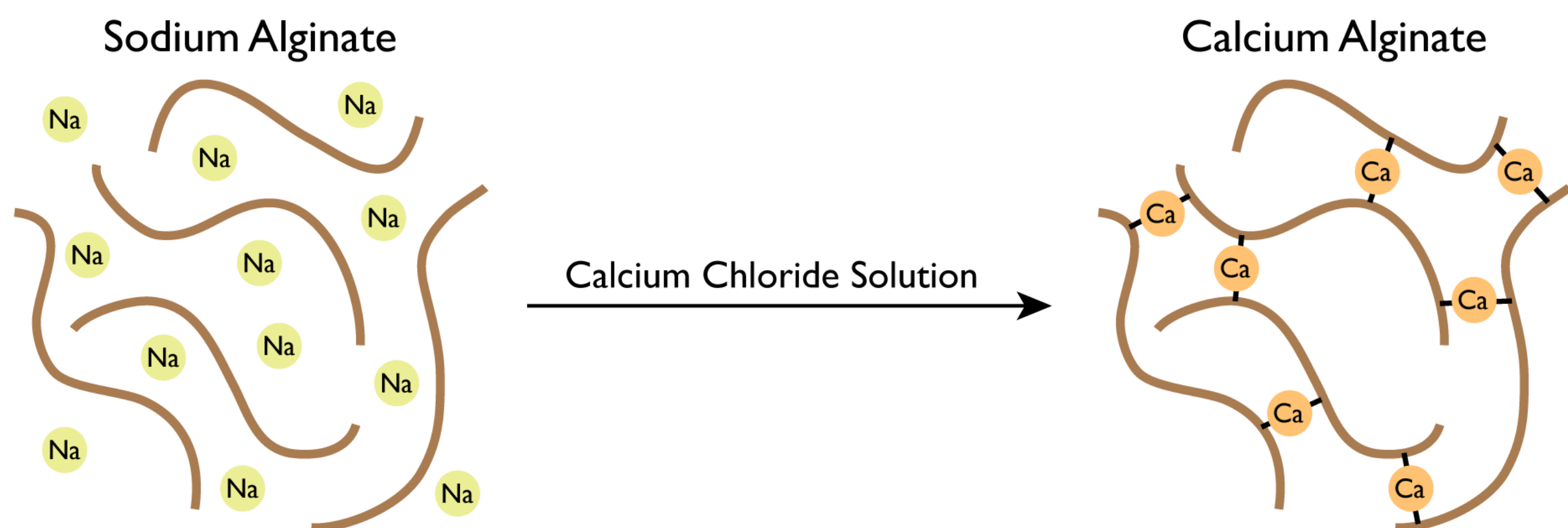


THE SCIENCE OF CROSS-LINKING



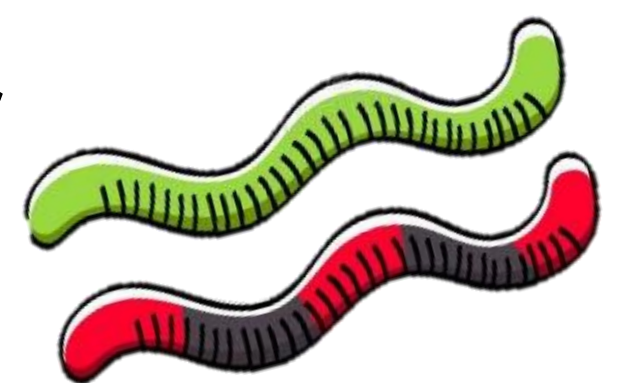
The Reaction

- Sodium alginate is a polysaccharide made of alginate linked to sodium ions. When mixed with water, the sodium (Na^+) ions dissociate giving the opportunity to other ions to interact with the alginate chains.
- In the presence of calcium (Ca^{2+}) ions, the alginate chains are cross-linked together. The result is a tangling network that has a variety of applications in food science.

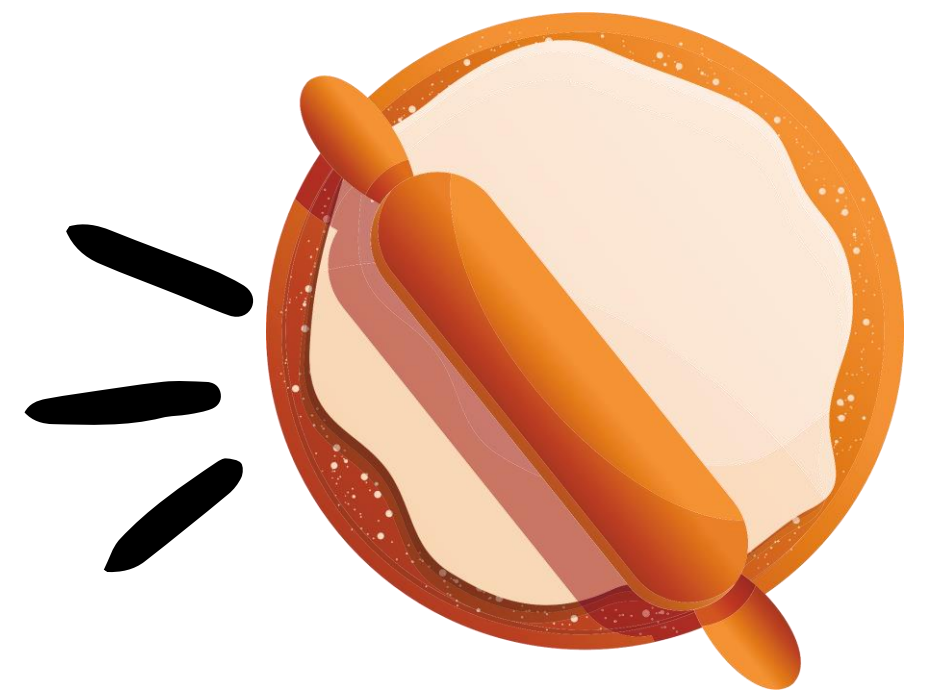


Application

- Gummy worms can be made by mixing sodium alginate, water, and flavoring to form a mixture. This mixture is later added as a continuous stream to a calcium chloride solution forming a gel that can be further cut/formed into different candies.
- Spheres, such as the pearls found in bubble tea are also made by combining alginate and calcium ions. However, in this process known as spherification the flavored alginate is “dropped” into a bath of calcium chloride solution.



THE SCIENCE OF BREAD

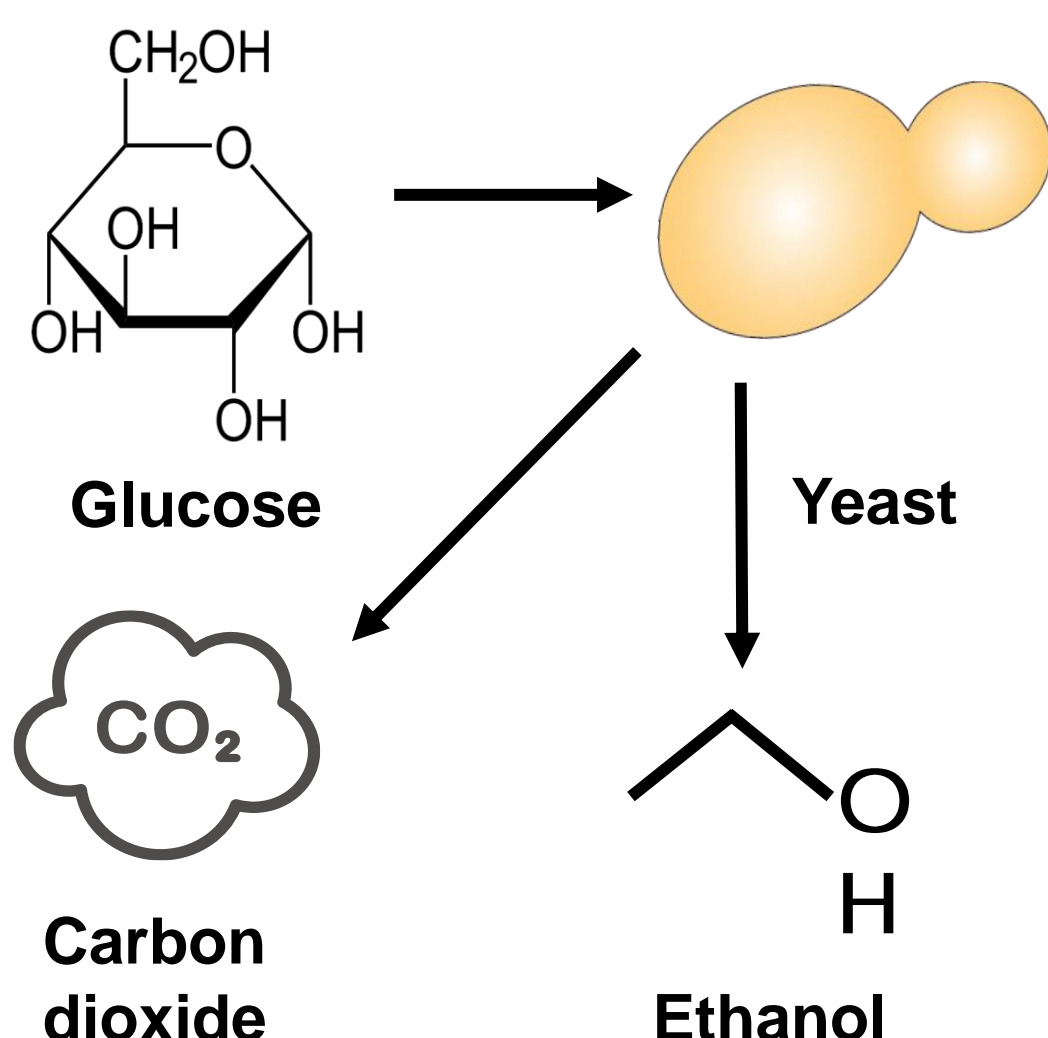
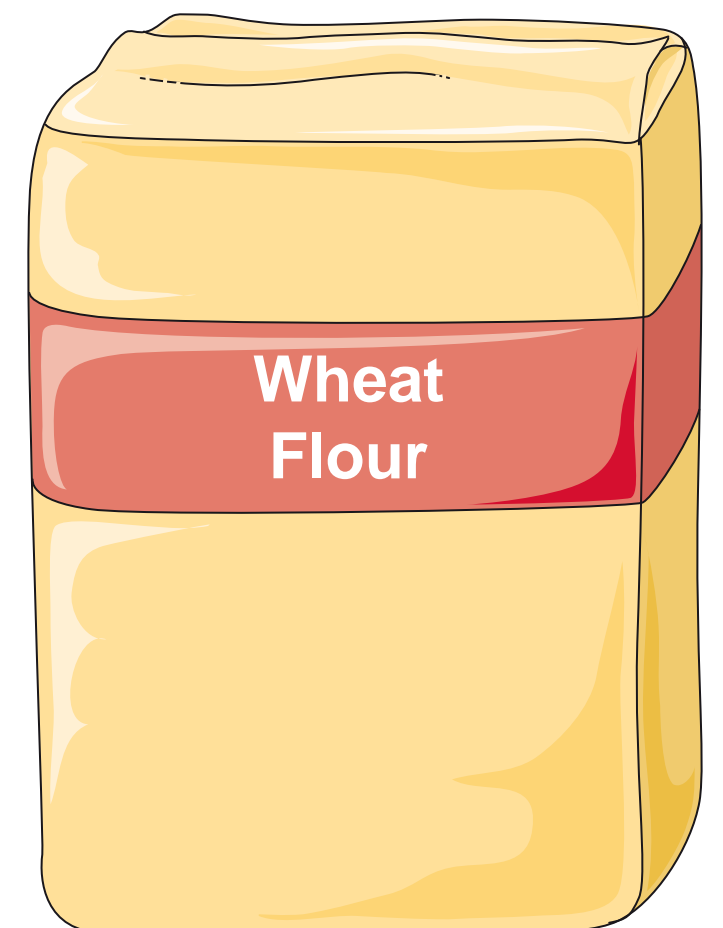


- Bread is a common staple food throughout the world ranging from bagels to rye bread to pizza dough. All bread products derive from flour, which the major components are proteins and carbohydrates.



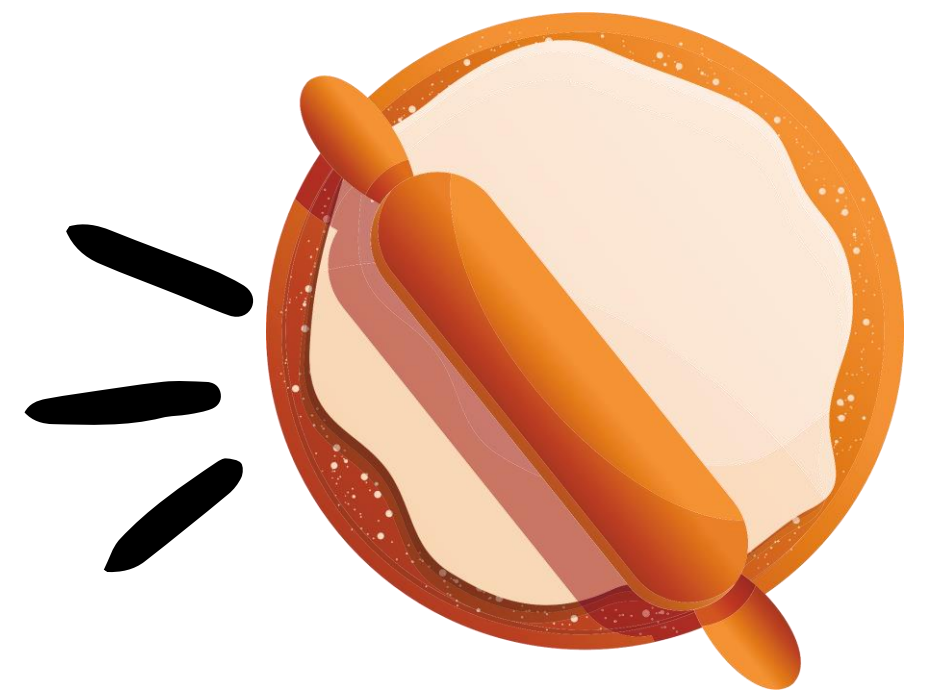
- Proteins in bread include glutenins and gliadins, which are large molecules built up of a large number of amino acids. These are collectively referred to as gluten. When water is added, the proteins form a network held together by hydrogen bonds and disulfide cross-links.

- Flour contains starch, which is made of long chains of sugar molecules. During bread fermentation amylase, an enzyme, converts starch into maltose; then maltase, another enzyme produced by yeast converts maltose in glucose. Along with other sugars, glucose can be used by yeast for fermentation.

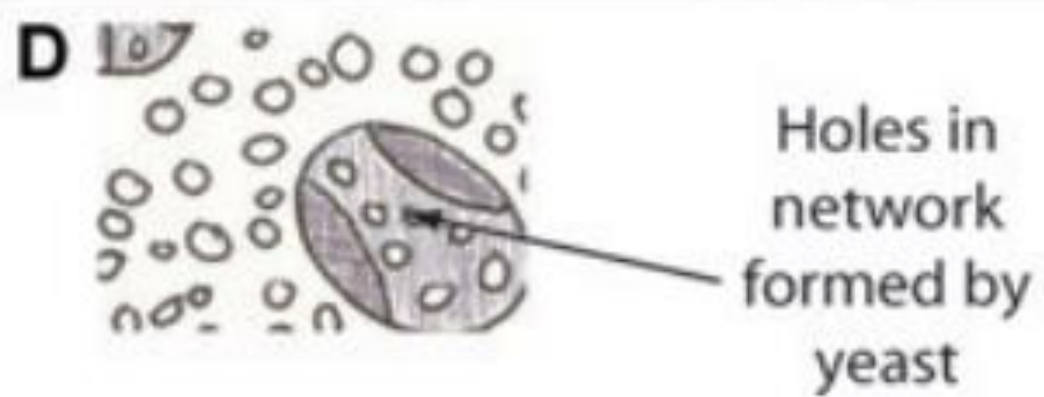
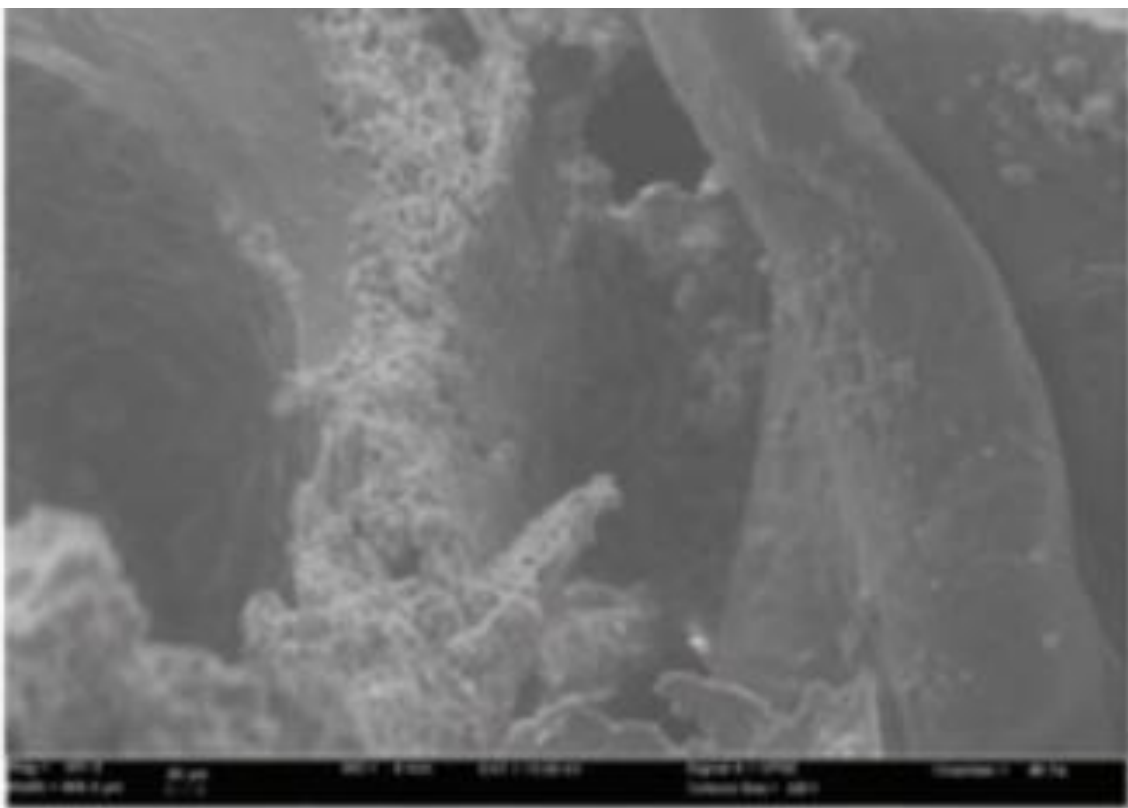
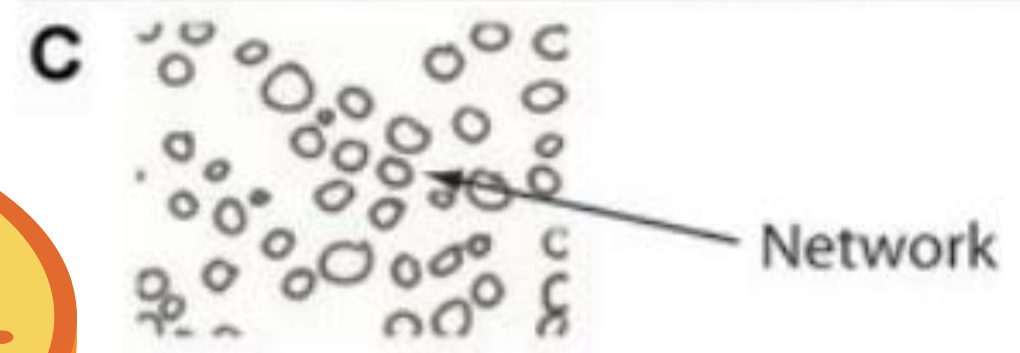
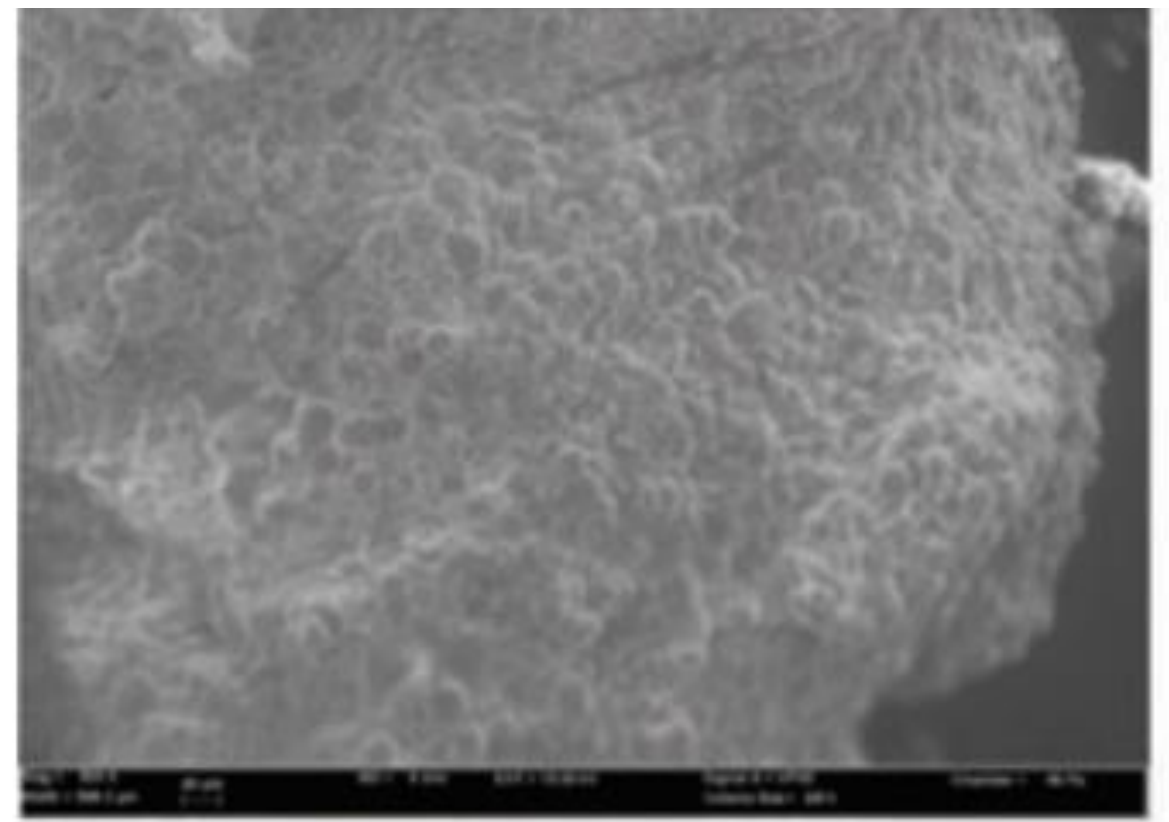


- Yeast are single-celled fungi that help convert sugars in the bread to carbon dioxide.
- The CO₂ causes the bread to rise because the gluten protein is very elastic and allows the bread to increase in volume like a balloon.

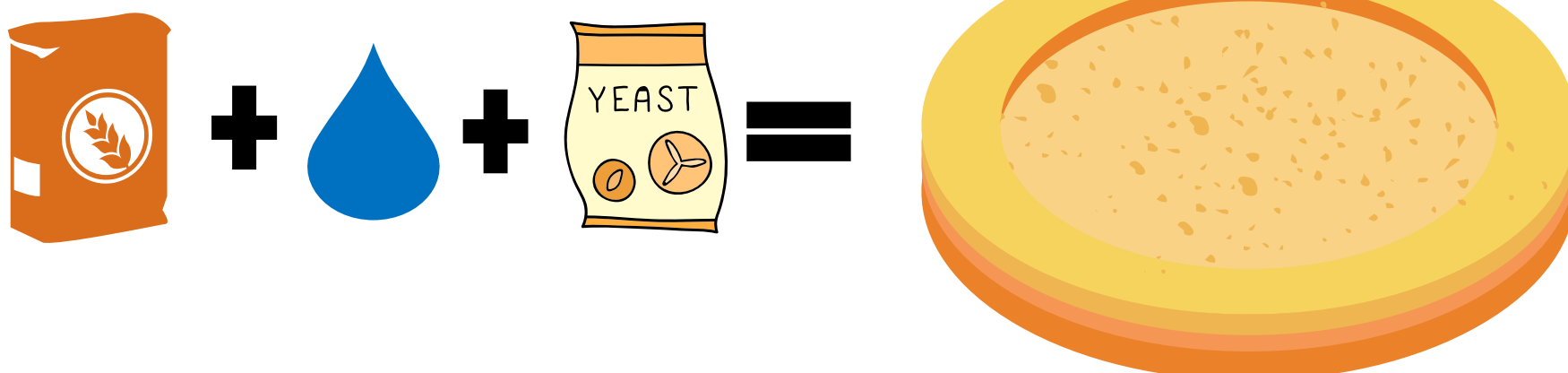
THE SCIENCE OF BREAD



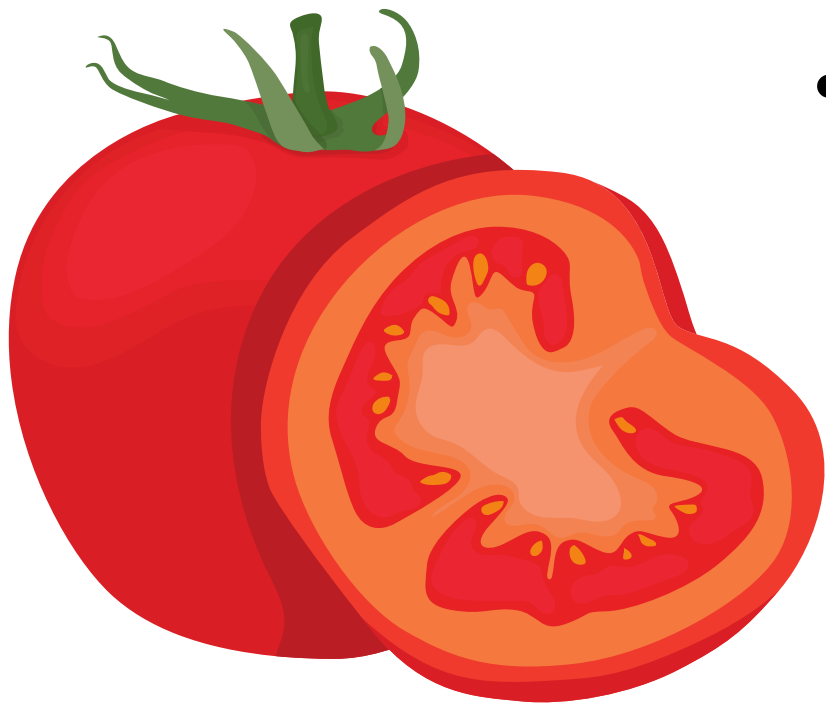
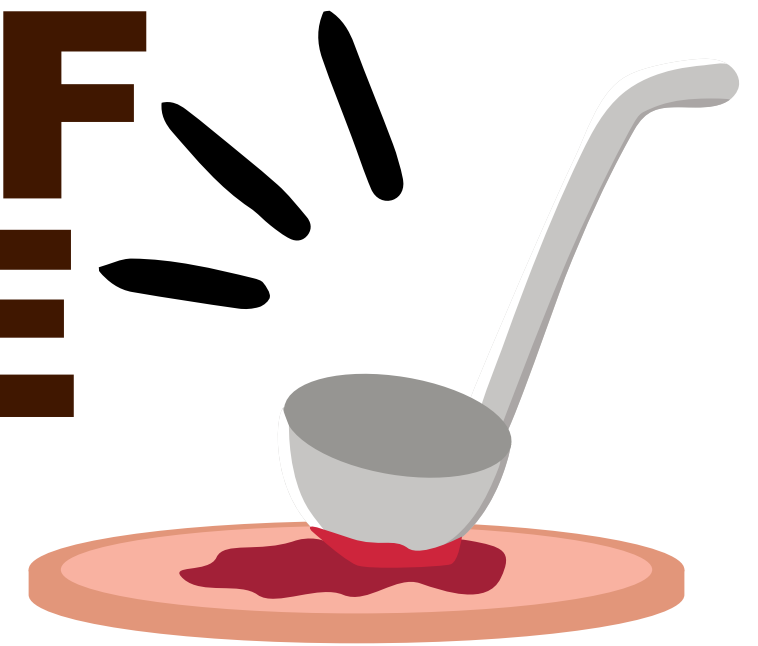
- Mixing flour and water produces a basic bread that remains flat when baked. Imaging by electron microscopy reveals aggregates of starch granules, but no holes within the structure.



- Adding yeast to this mixture yields a bread with holes, as the yeast consumes simple sugars and produce gas (CO_2).
- This image shows the starch granules in a network of flour proteins, along with holes formed by entrapped CO_2 , giving fermented bread a lighter, airy, texture.



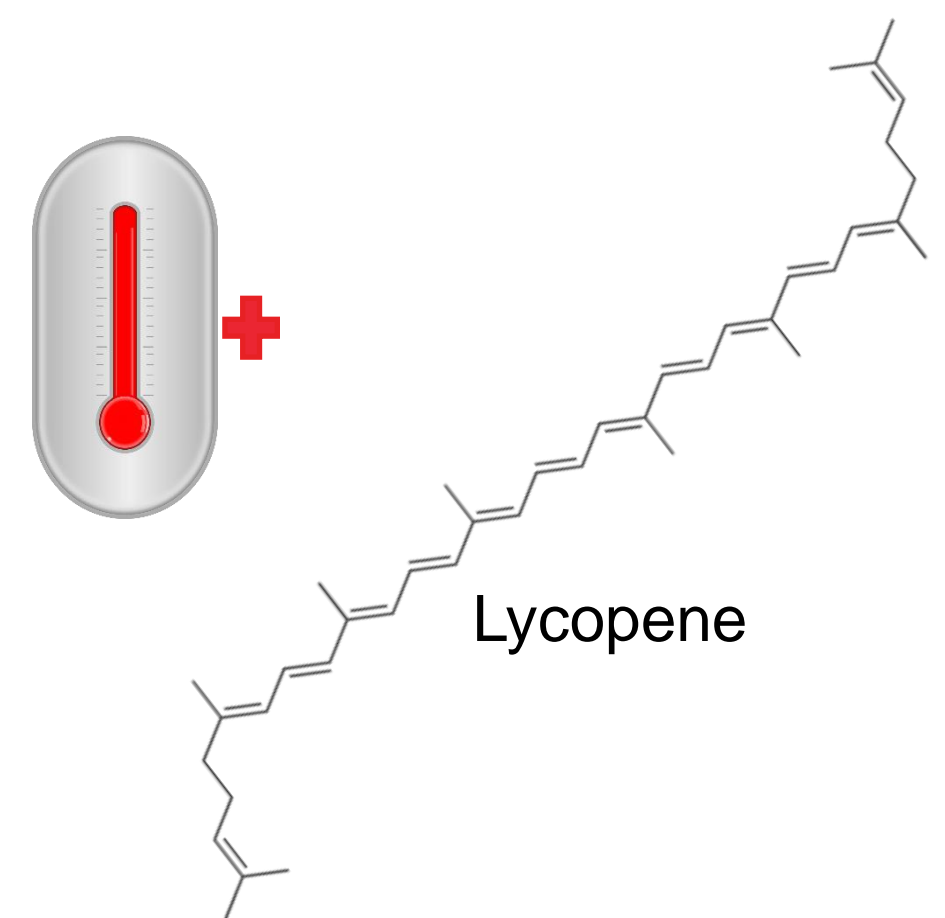
THE SCIENCE OF TOMATO SAUCE



- Tomatoes are versatile and healthy foods. They can be consumed raw in salads or as an ingredients in sauces, soups, and juices. They contain high levels of vitamin C, and pigments such as carotene and lycopene which are powerful antioxidants.

Thermal Processing: Canning

- Food processing, especially thermal processing, may improve lycopene bioavailability. Higher temperatures break down cell walls, which weakens the bonding forces between lycopene and the tissue matrix. This reaction makes lycopene more accessible.



- Temperature also contributes to the release of pectin. Pectins are polysaccharides that contribute to the texture and nutritional characteristics of foods. As a result, canned tomatoes are thicker due to the gel that is formed.
- This thermal processing leads to chemical reactions that result in physical and chemical changes in canned tomatoes; altering its color, texture, and nutritional value.