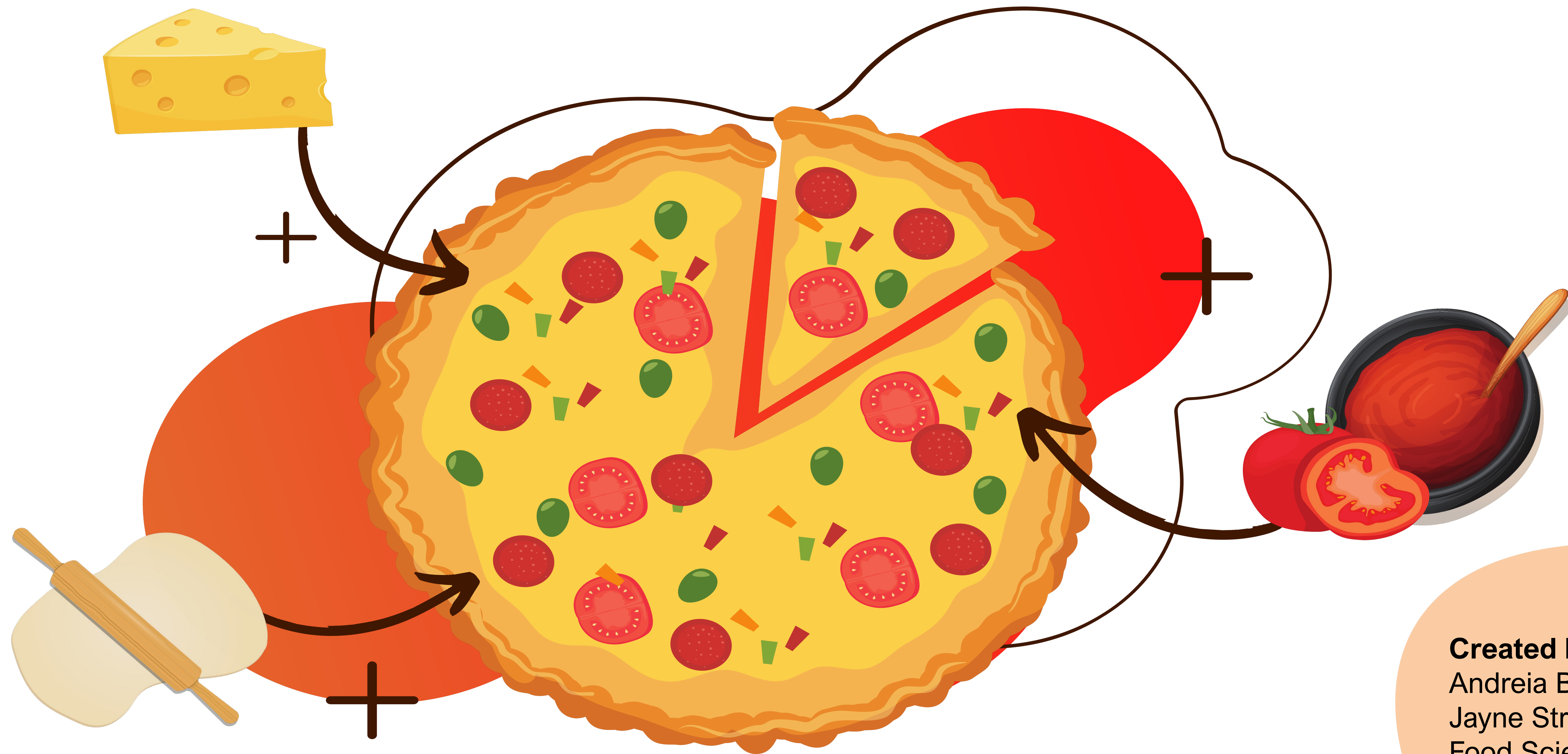


THE SCIENCE OF PIZZA

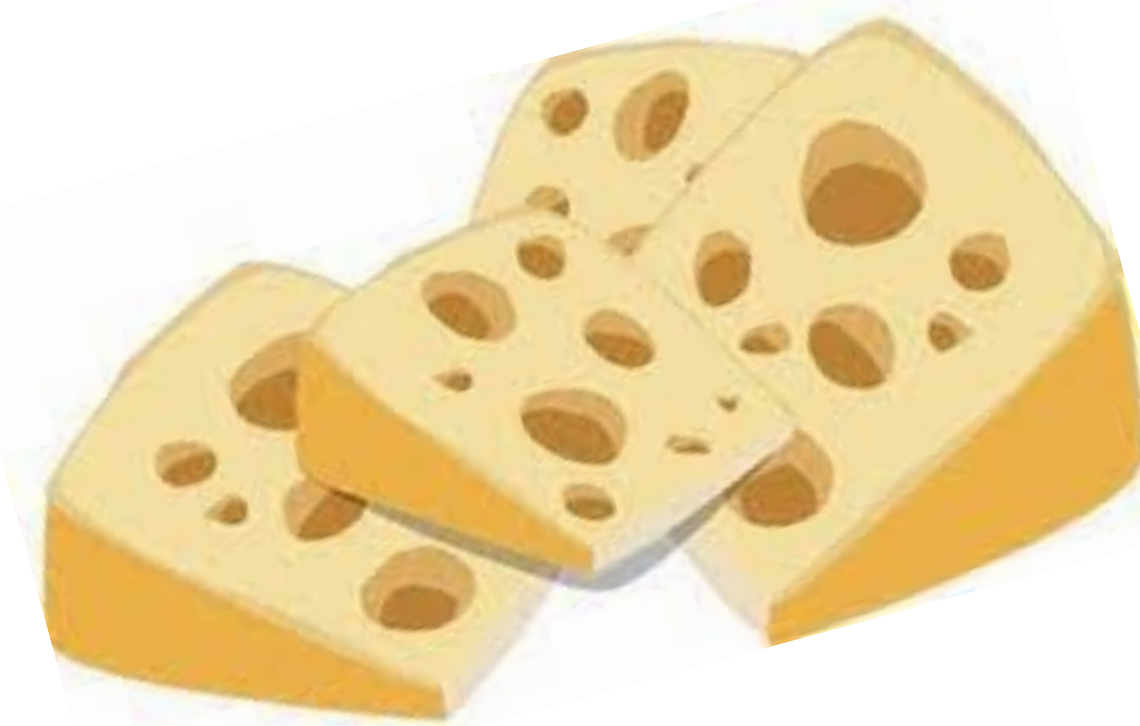
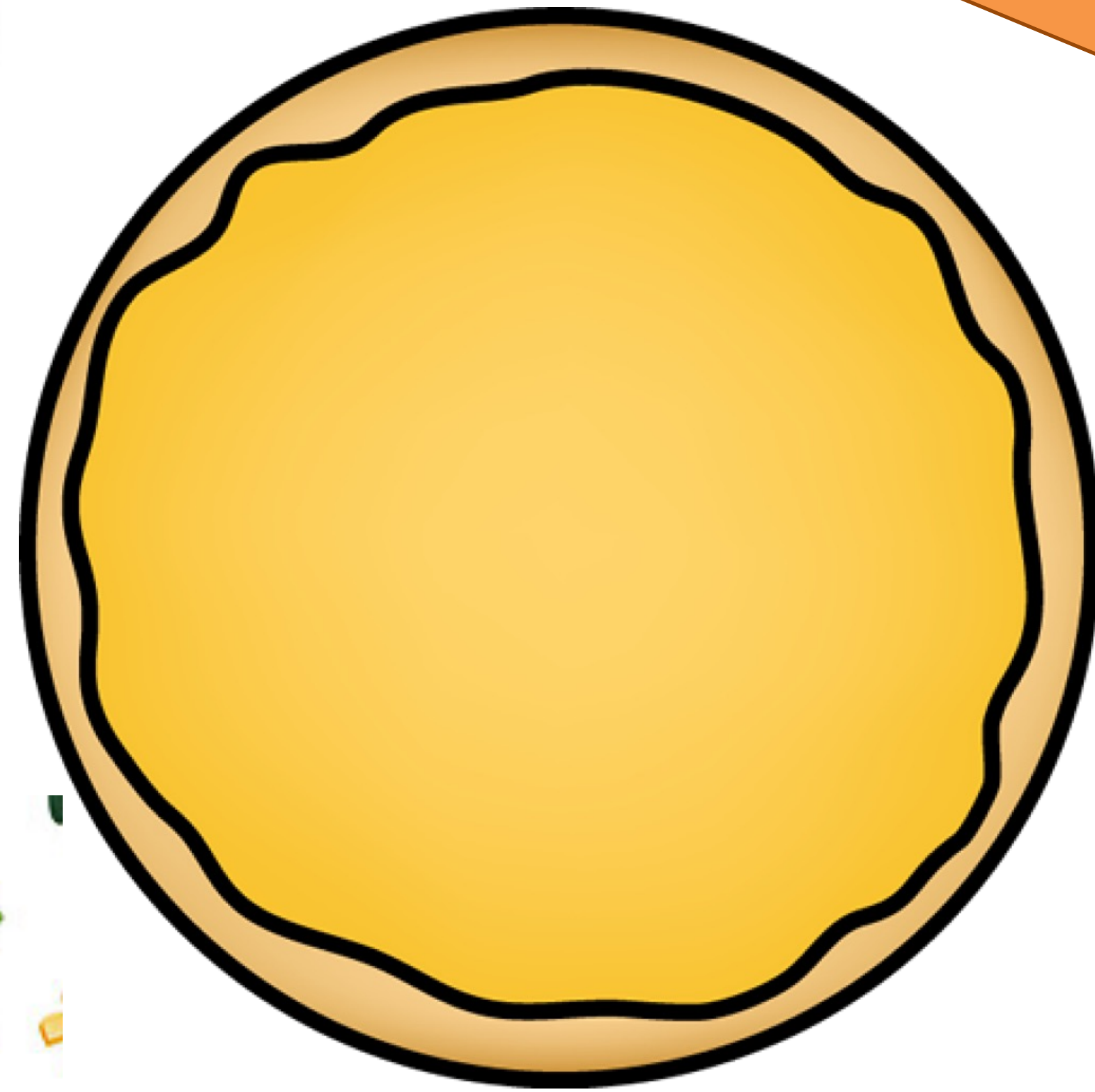
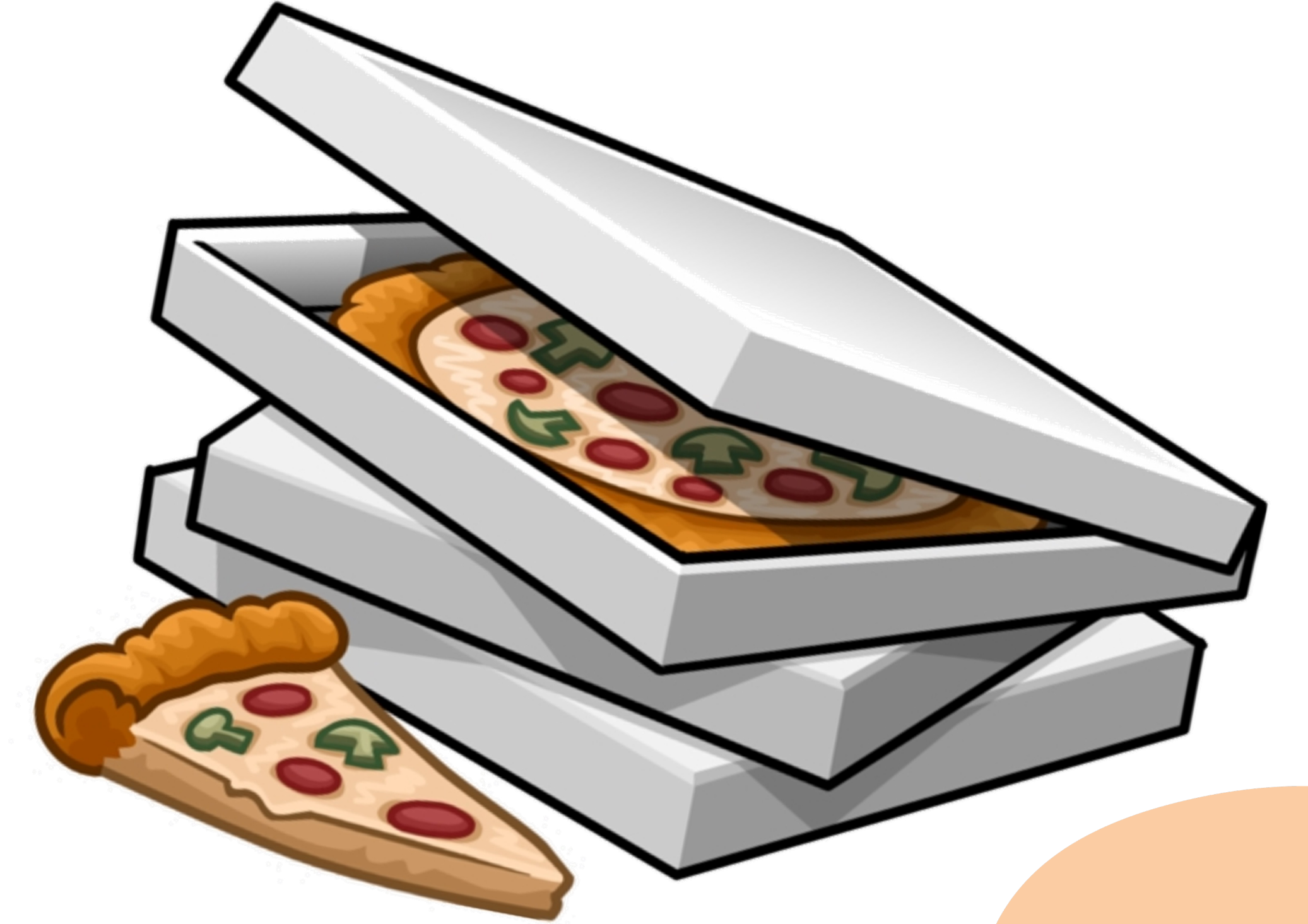


Department of Food Science and Technology
University of Nebraska-Lincoln (2023)

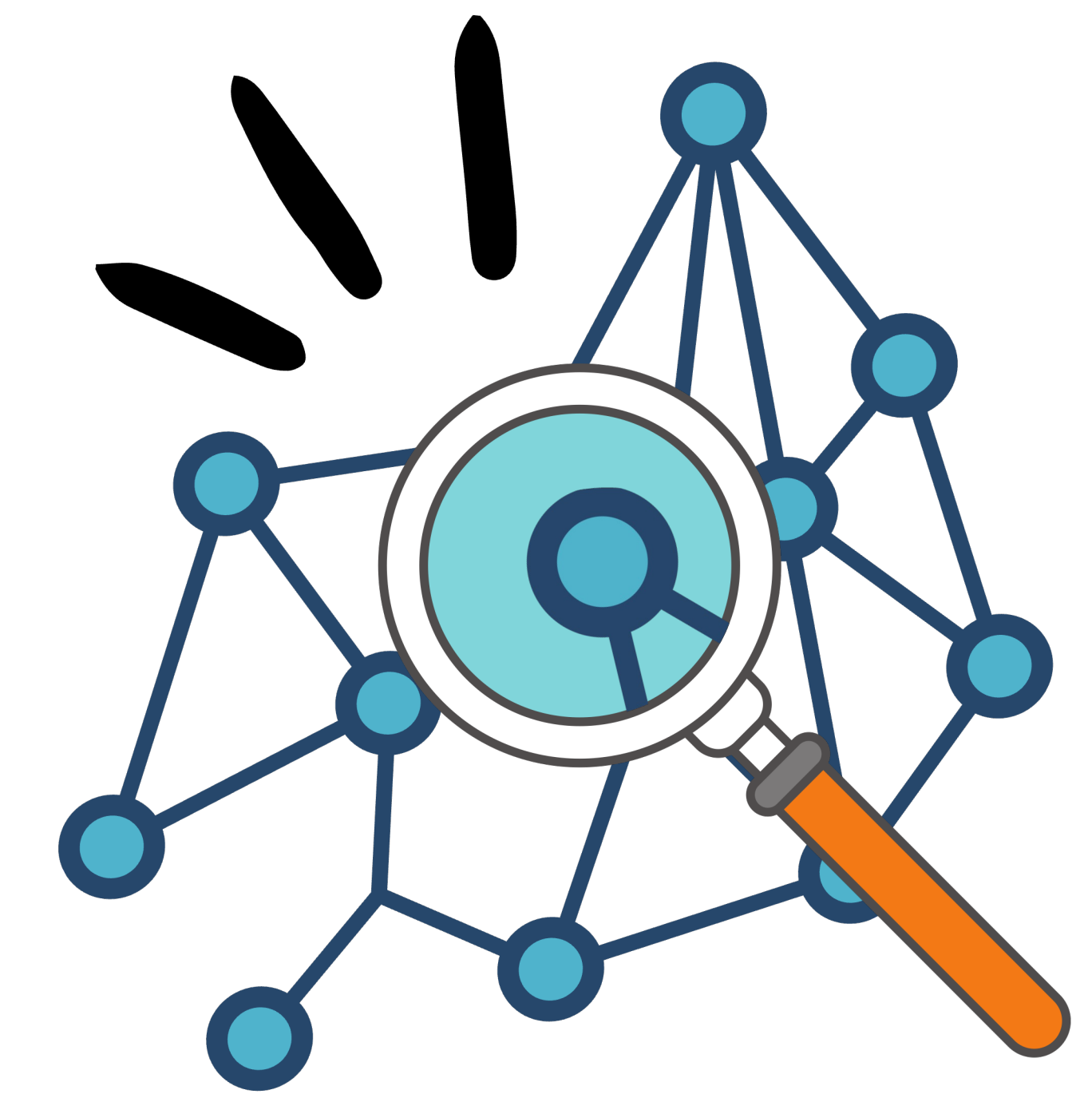
Created by:
Andreia Bianchini, PhD
Jayne Stratton, PhD
Food Science and Technology
University of Nebraska – Lincoln



PIZZA ANYONE???

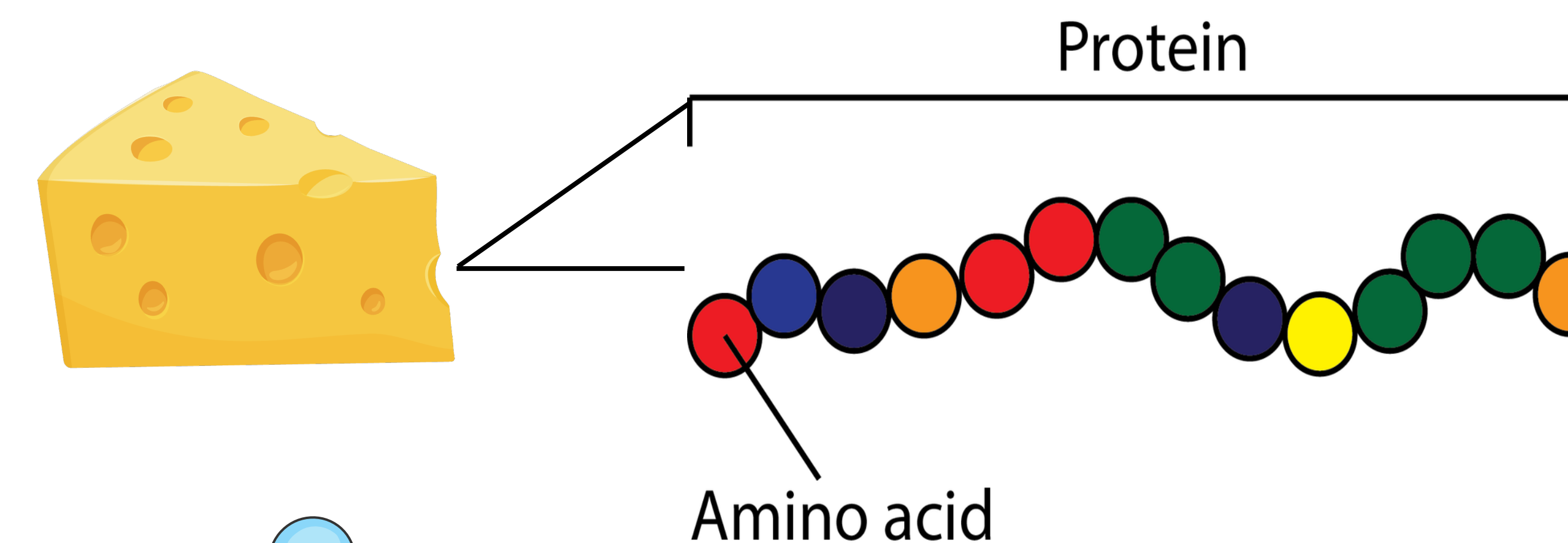
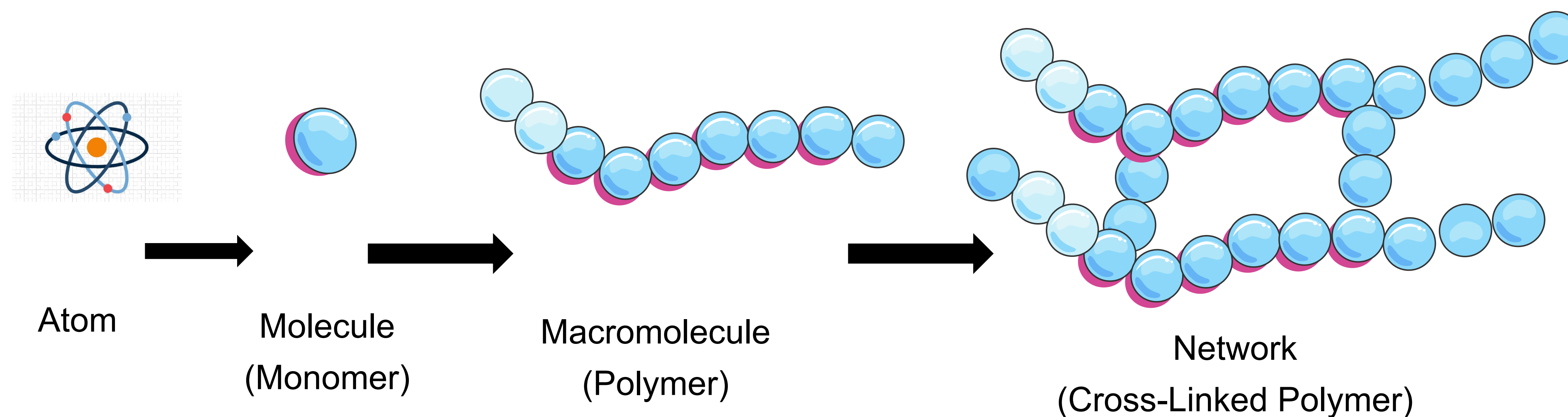


THE SCIENCE OF CROSS-LINKING

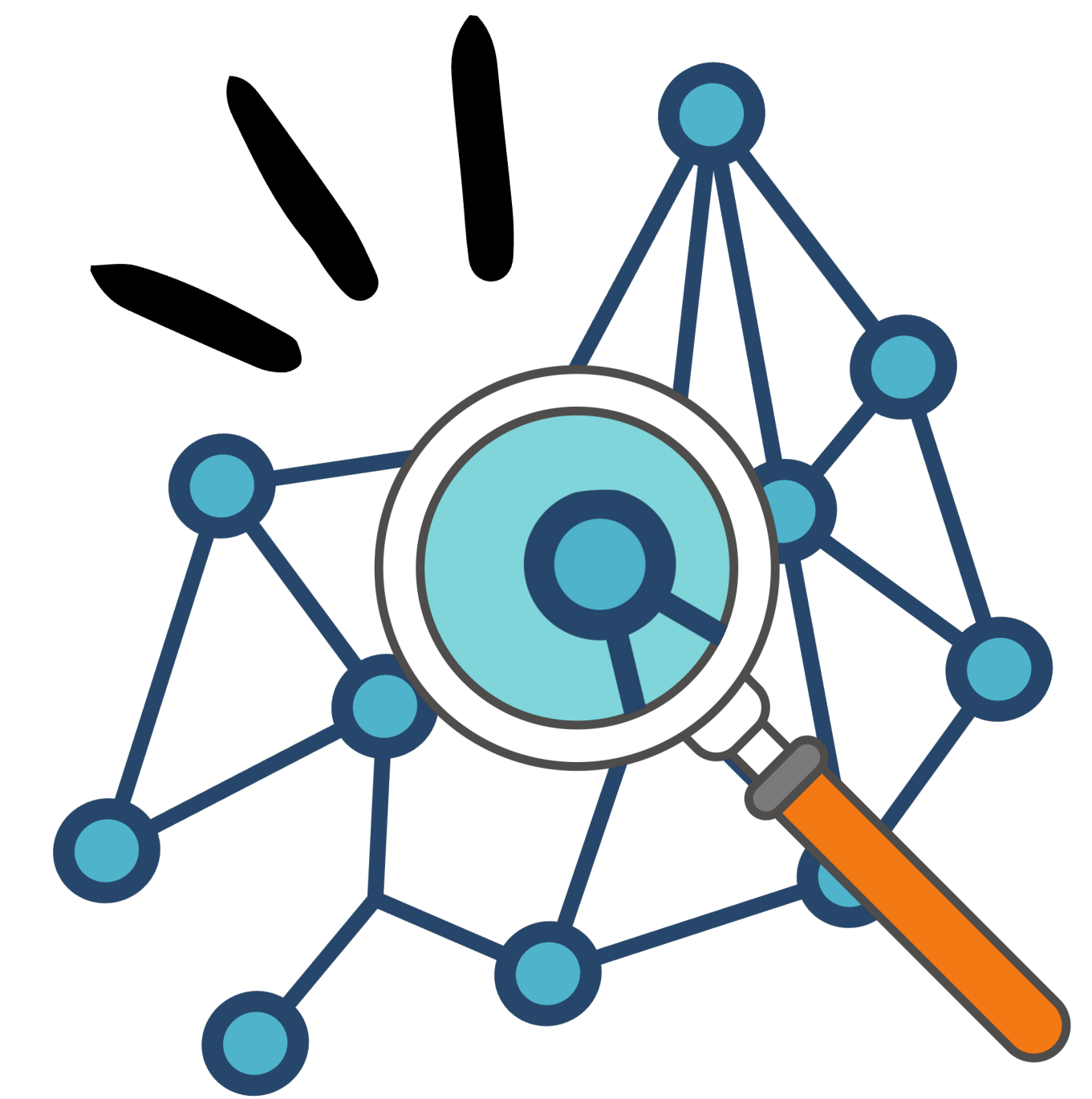


- Foods are made of ingredients. The major ingredients of pizza - tomatoes, cheese, and bread - are networks of macromolecules that are either linked together or in association with each other to form the food matrix.
- Macromolecules are made of single subunits or building blocks that are linked together.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

Atoms to Molecules to Macromolecules to Networks

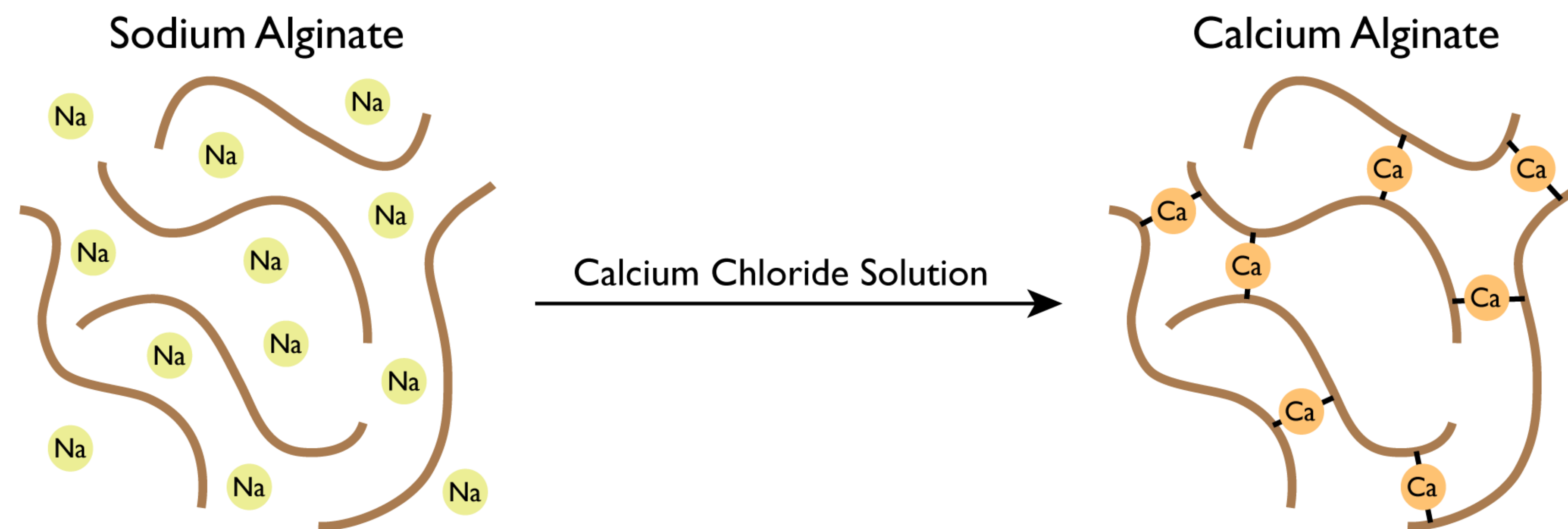


THE SCIENCE OF CROSS-LINKING



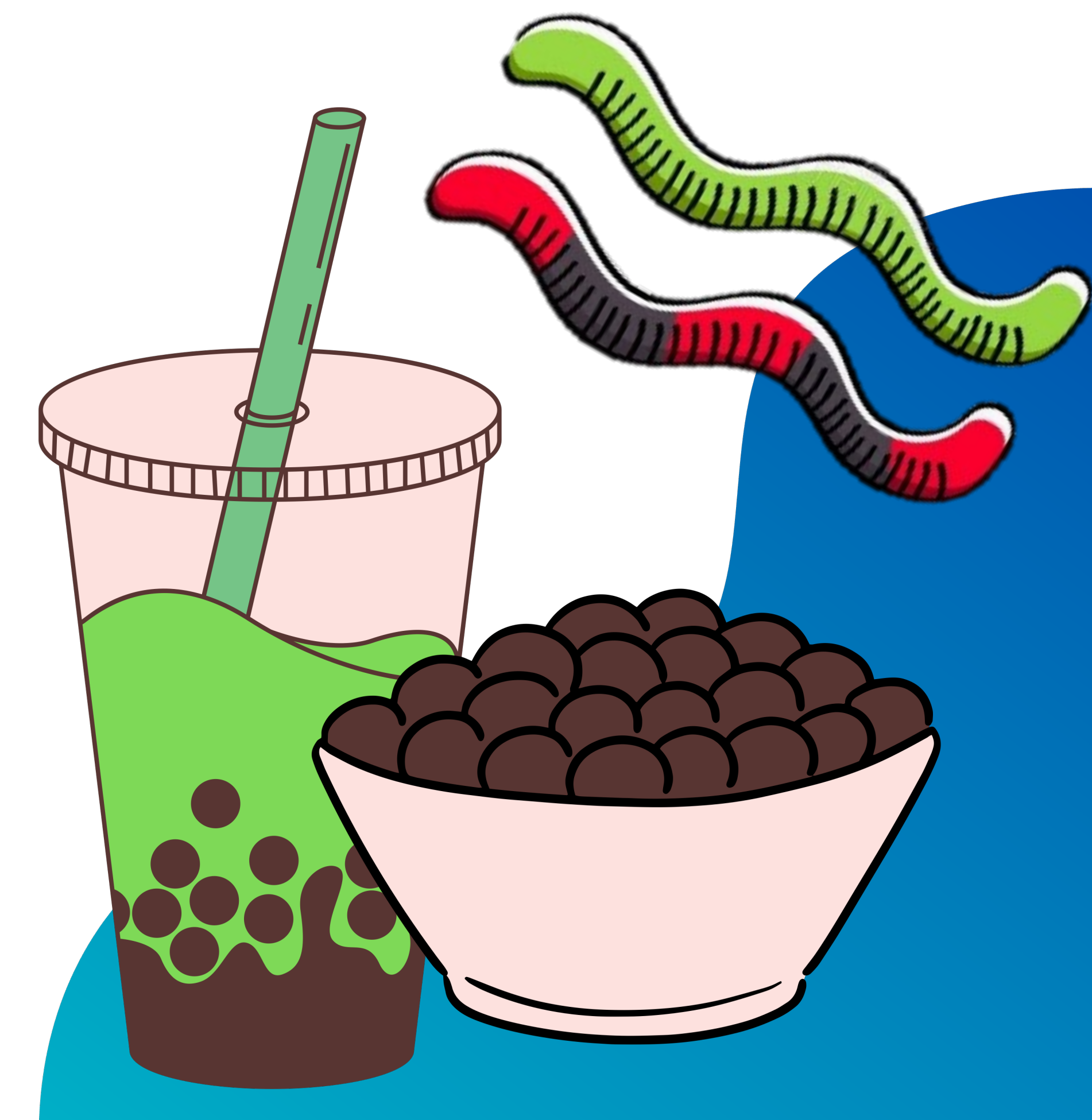
The Reaction

- Sodium alginate is a polysaccharide made of alginate linked to sodium ions. When mixed with water, the sodium (Na^+) ions dissociate giving an opportunity for 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 an intertwining network that has a variety of applications in food science.



Applications

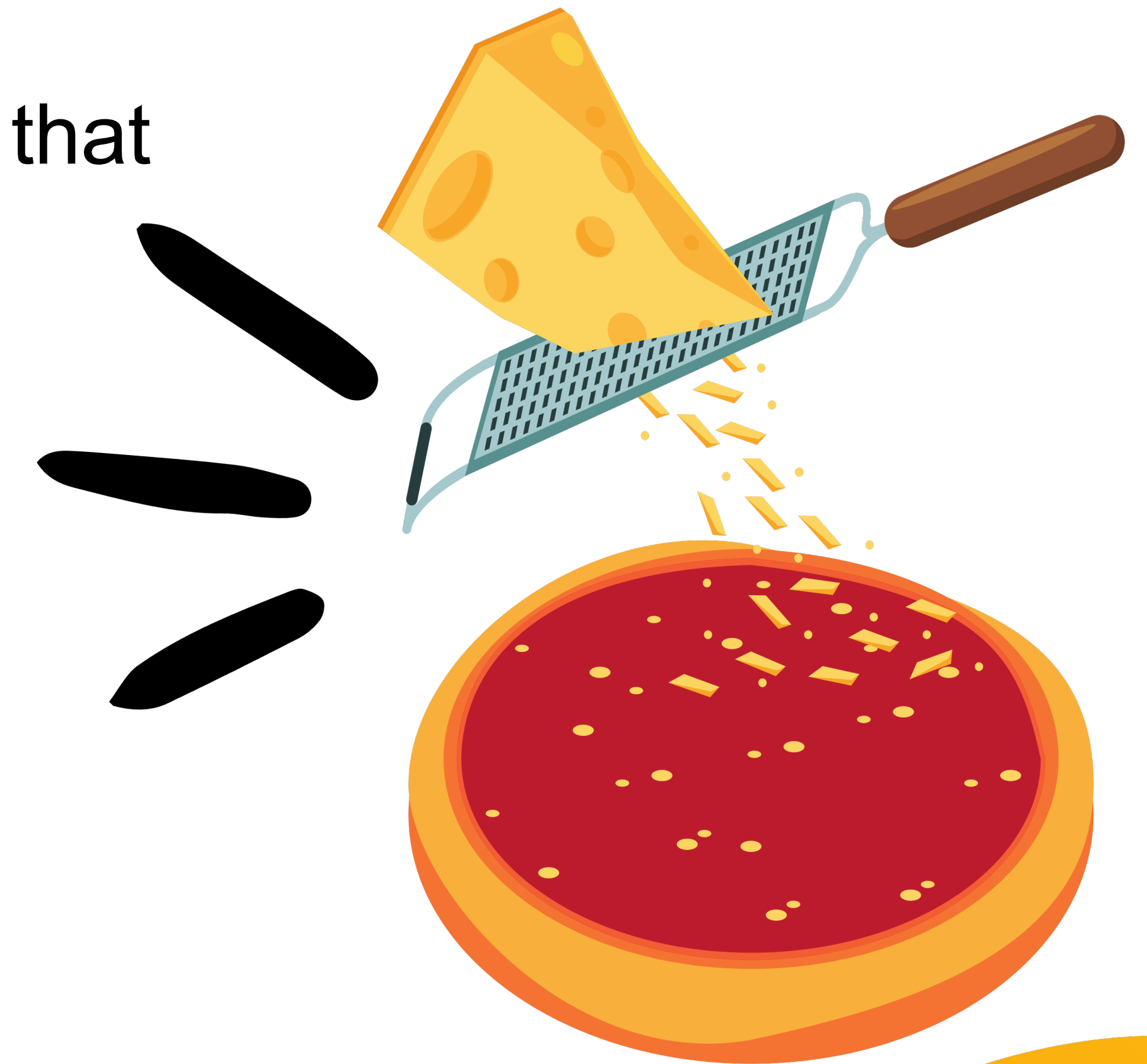
- Gummy worms can be made by mixing sodium alginate, water, and flavoring to form a mixture. This mixture is later added as a continuous stream to a calcium chloride solution forming a gel that can be further cut/formed into different candies.
- Spheres, such as the pearls found in bubble tea are also 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 CHEESE

- All cheeses start as milk. Studying the label of a milk container reveals that there are many components in milk; including fat, protein, and carbohydrates.

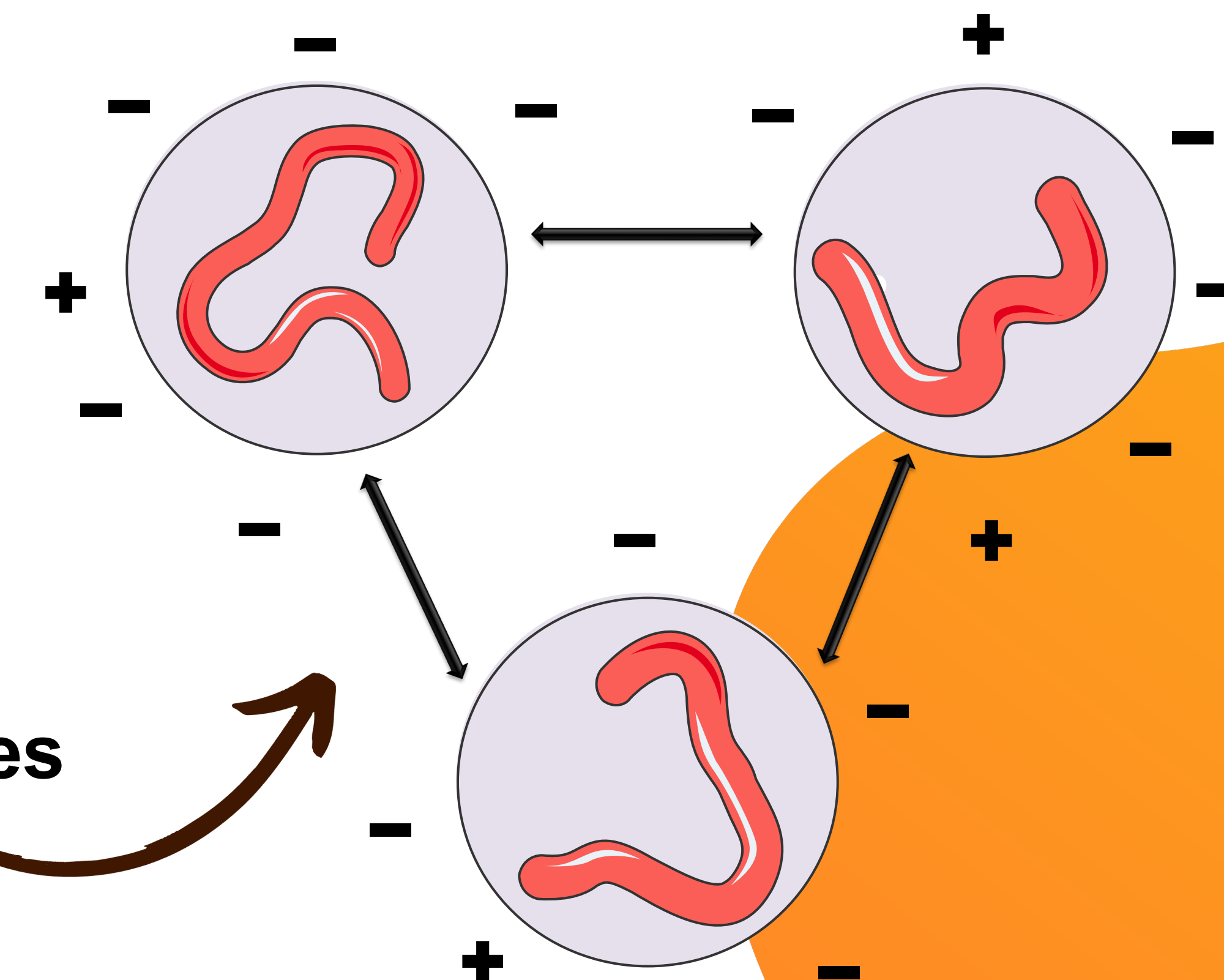
- To make cheese, the proteins in milk need to coagulate or curdle. Coagulation occurs by acidifying milk, by heating it up, adding an enzyme called Rennet, or by adding good bacteria.



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 6.6. At this pH protein molecules remain in solution and separated because they have a net negative charge.

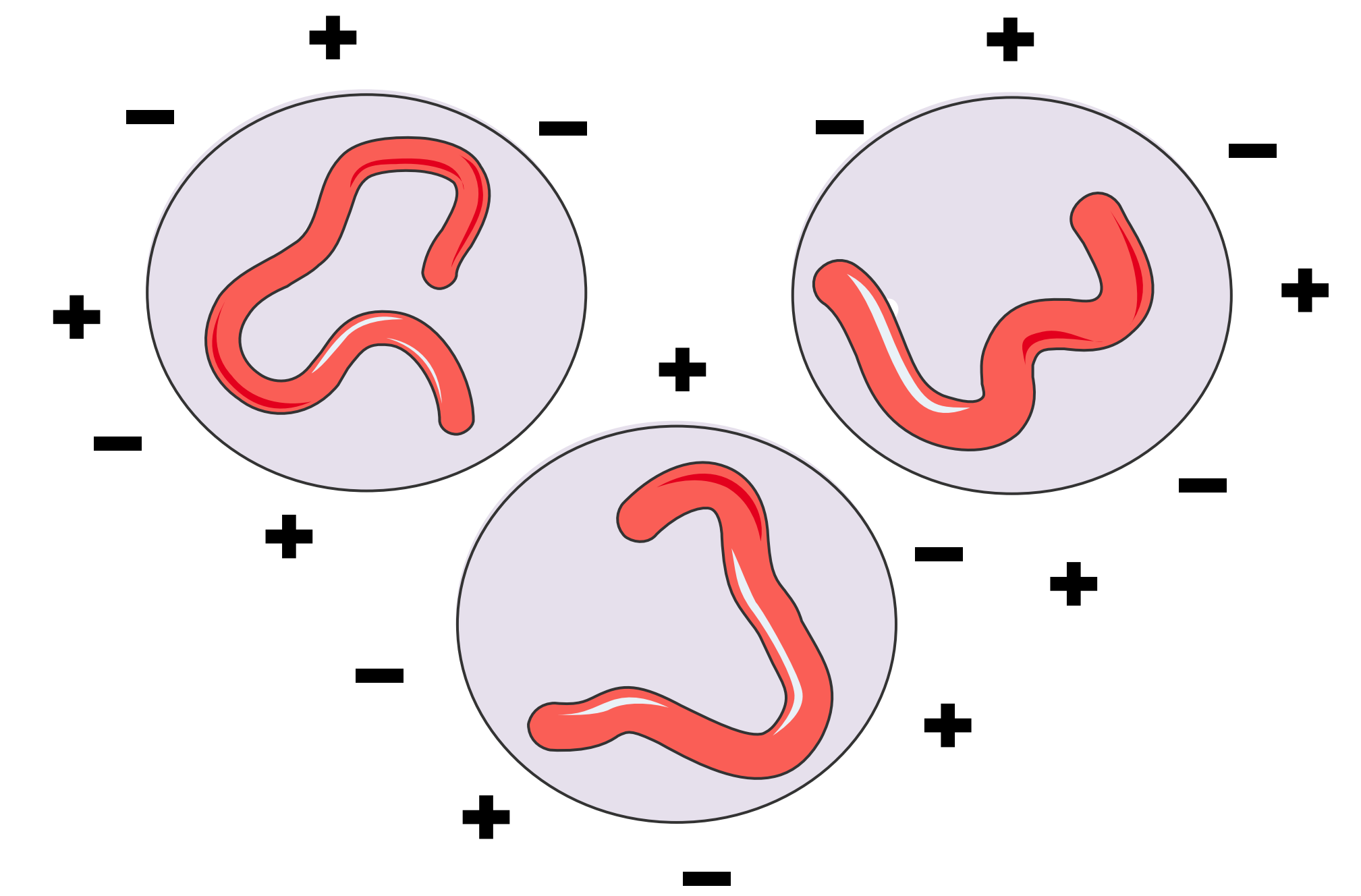
Protein Molecules
at pH 6.6



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.



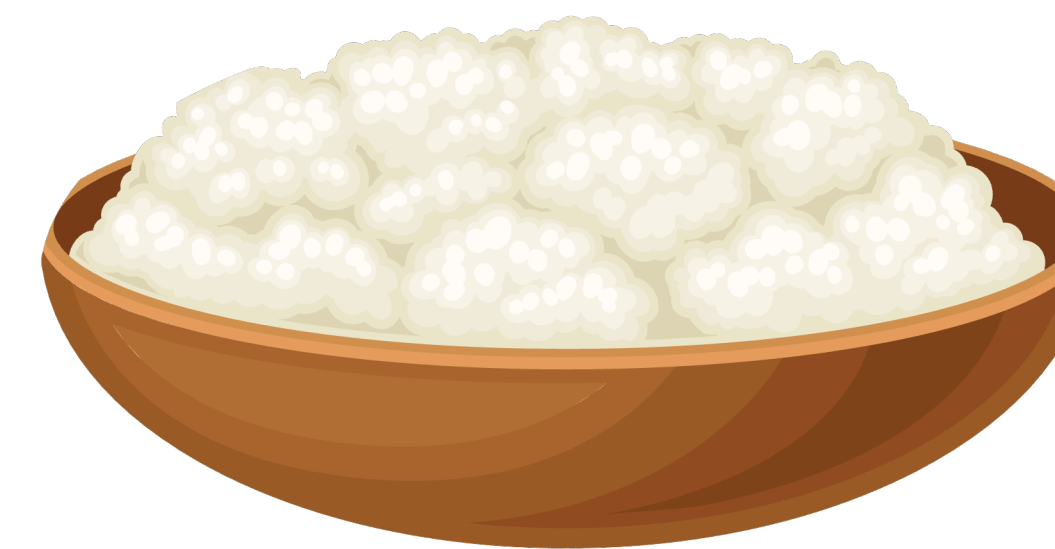
Protein Molecules
at pH 4.6

From Milk to Cheese

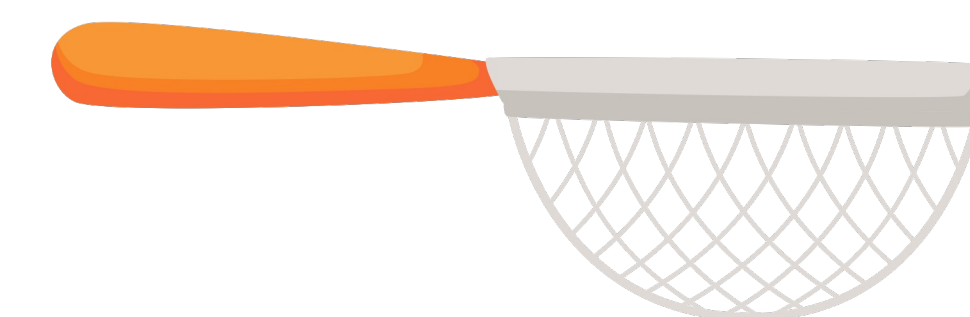


Milk

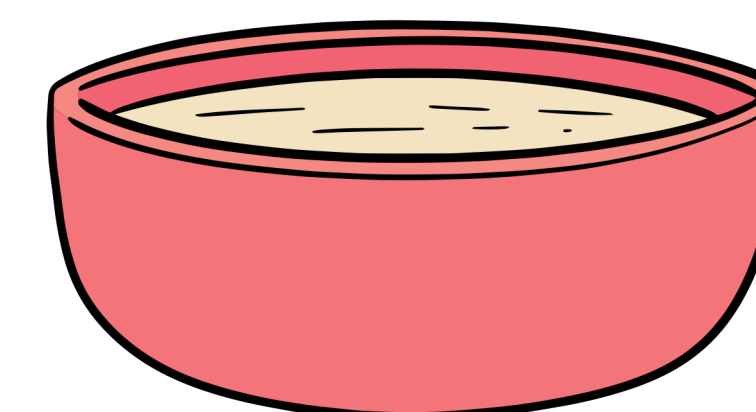
Acidification
 H^+



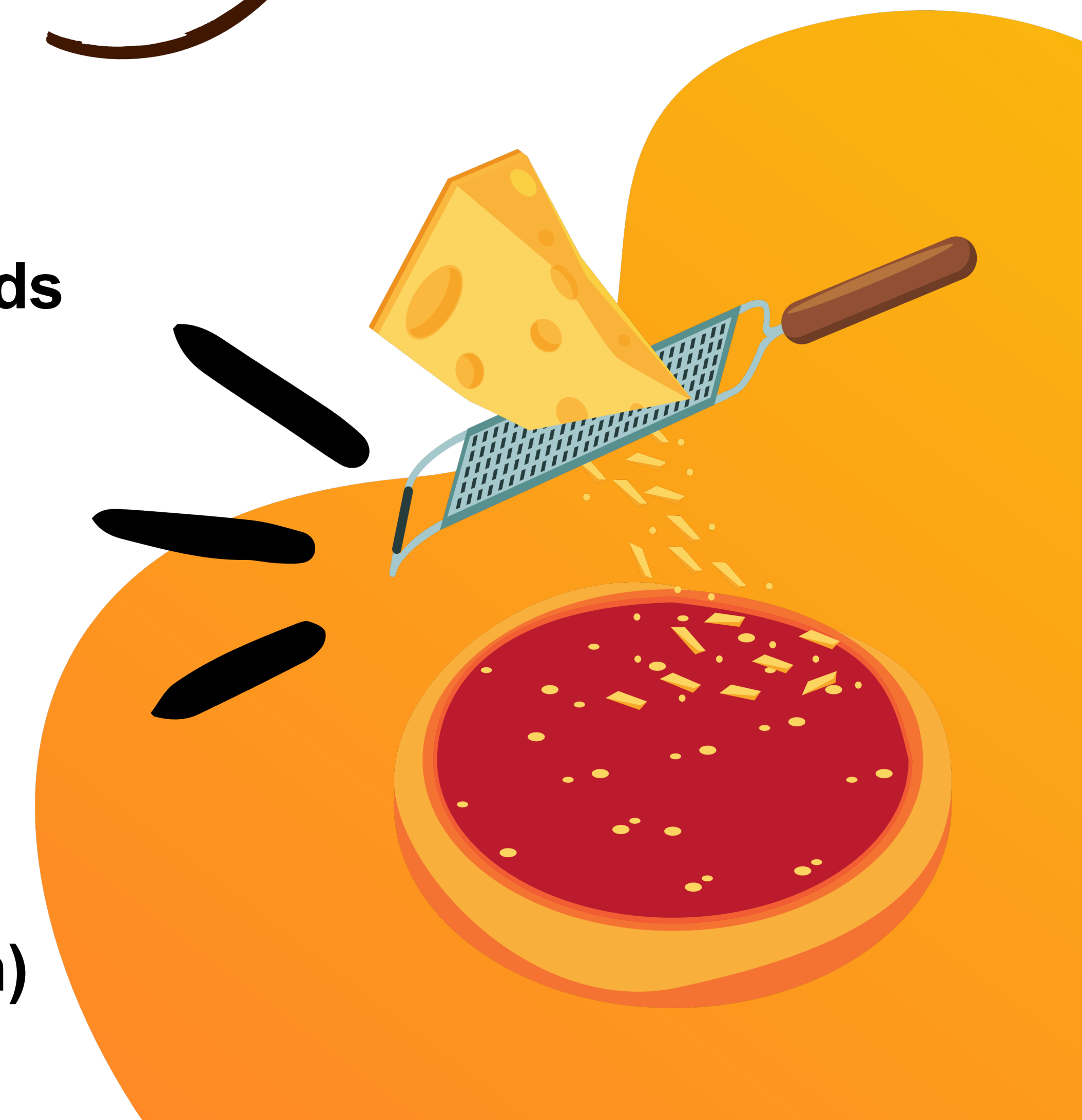
Cheese Curds
(Casein)



Strainer



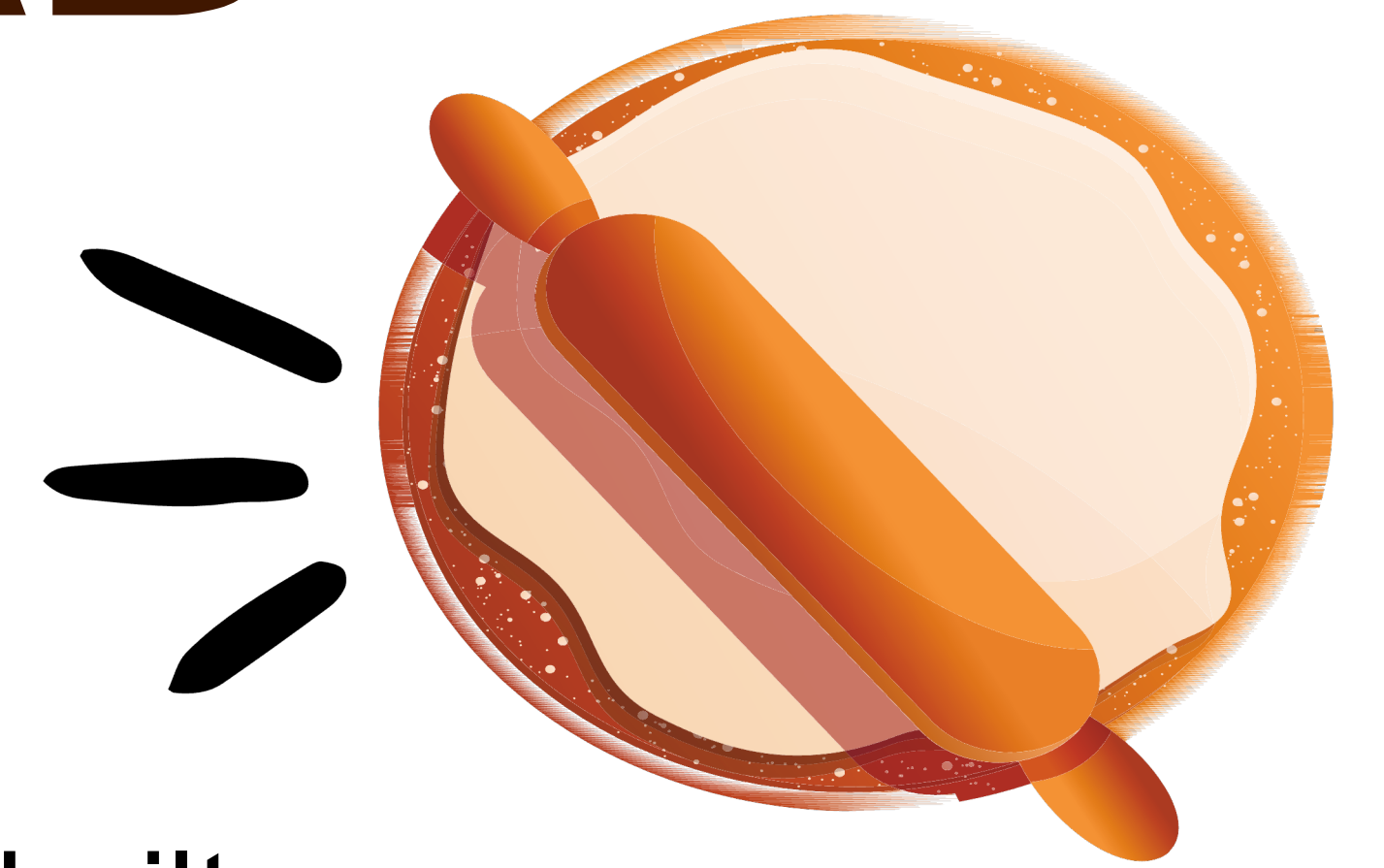
Whey
(Soluble Protein)



THE SCIENCE OF BREAD

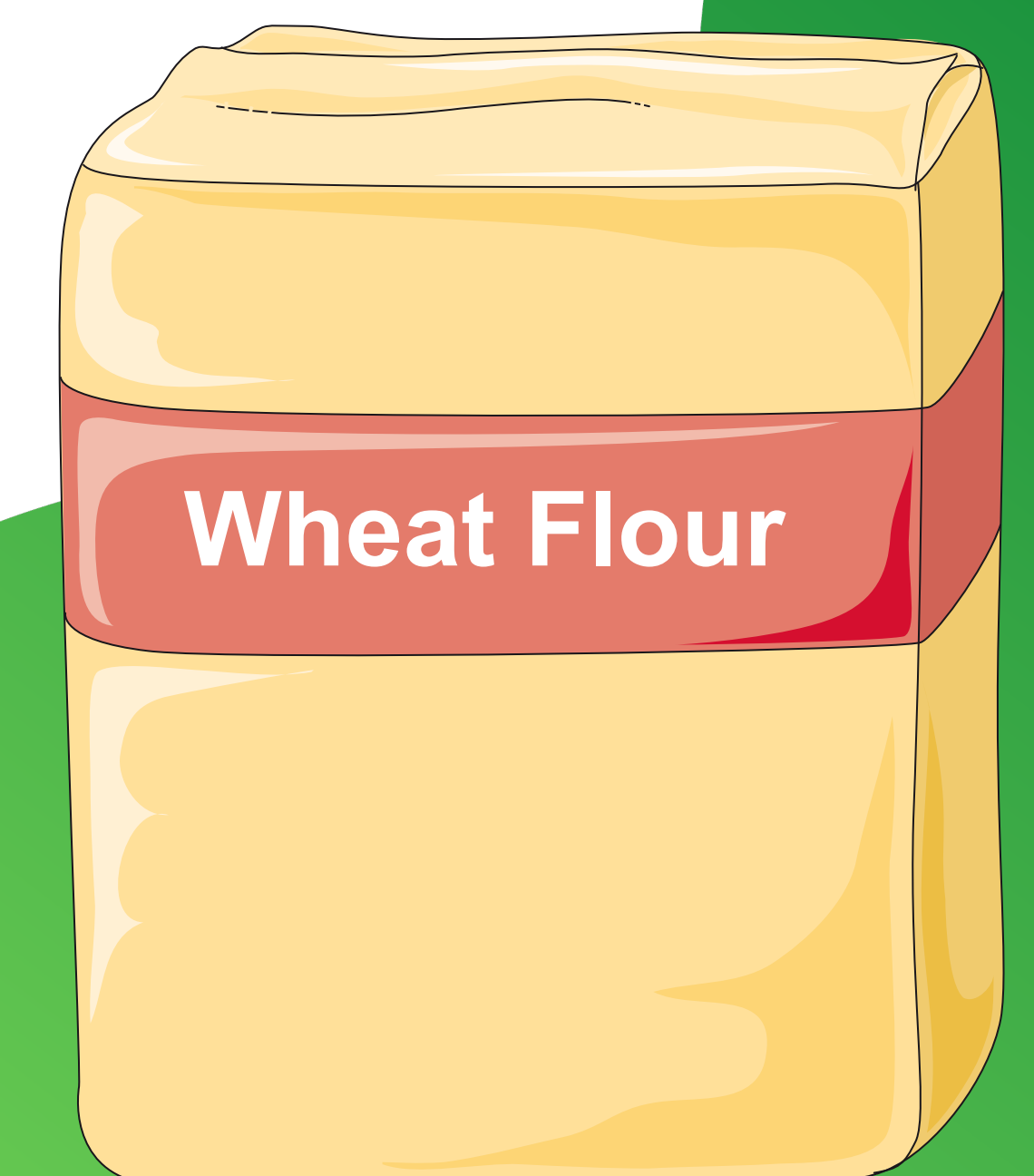
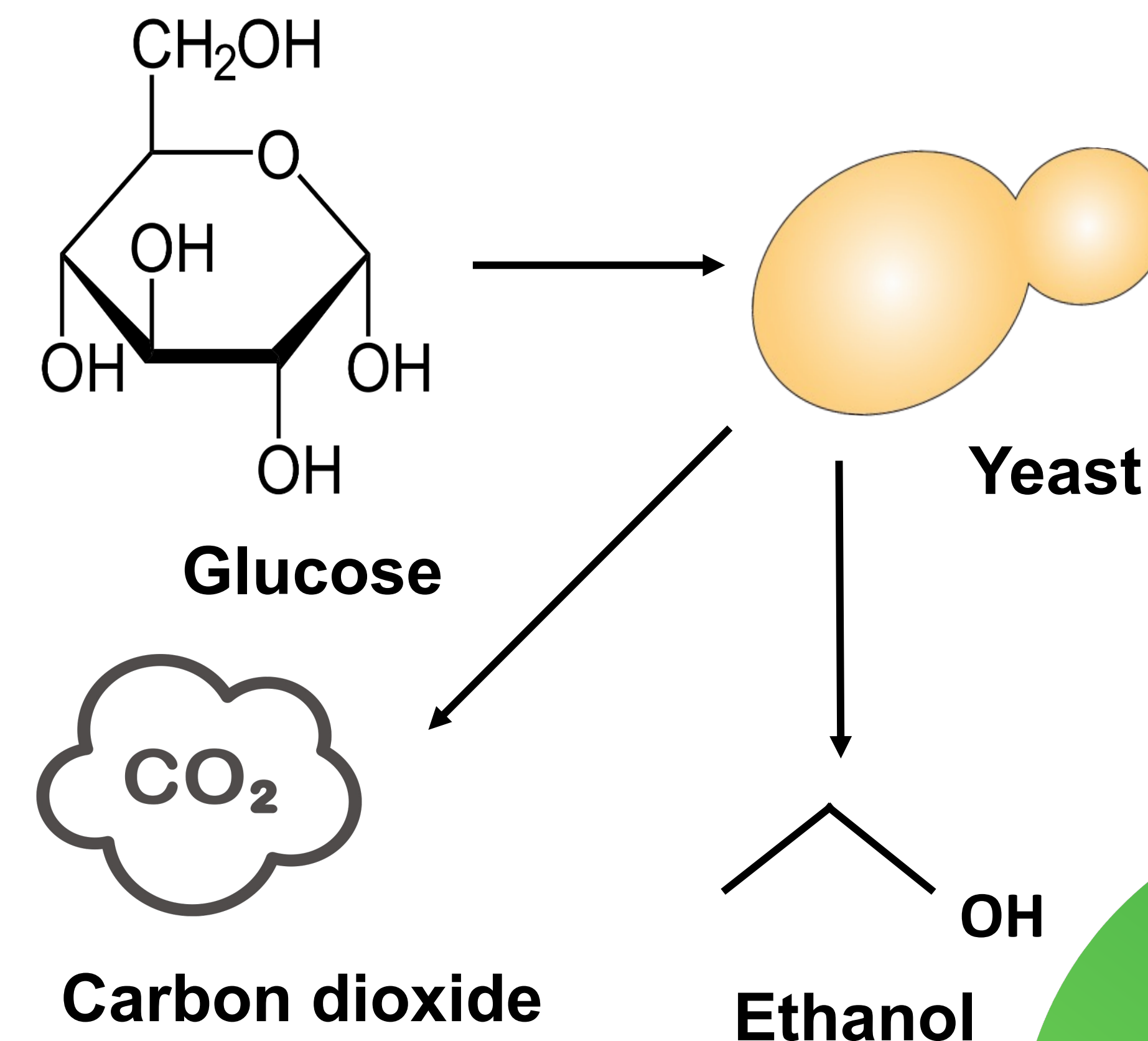


- Bread is a common staple food throughout the world ranging from bagels to rye bread to pizza dough. All bread products derive from flour, which the major components are proteins and carbohydrates.
- Proteins in bread include glutenins and gliadins, which are large molecules built up of a large number 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.



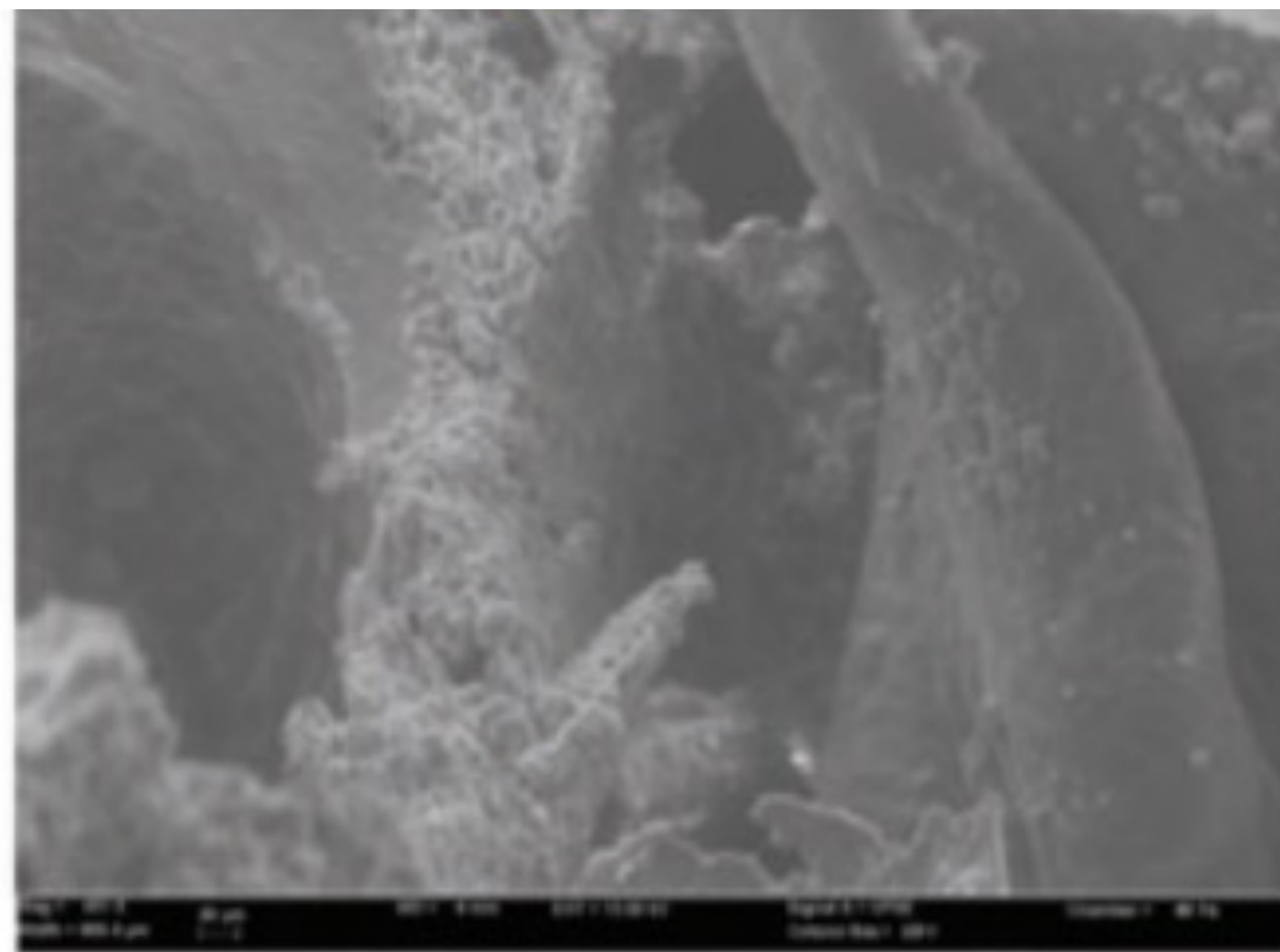
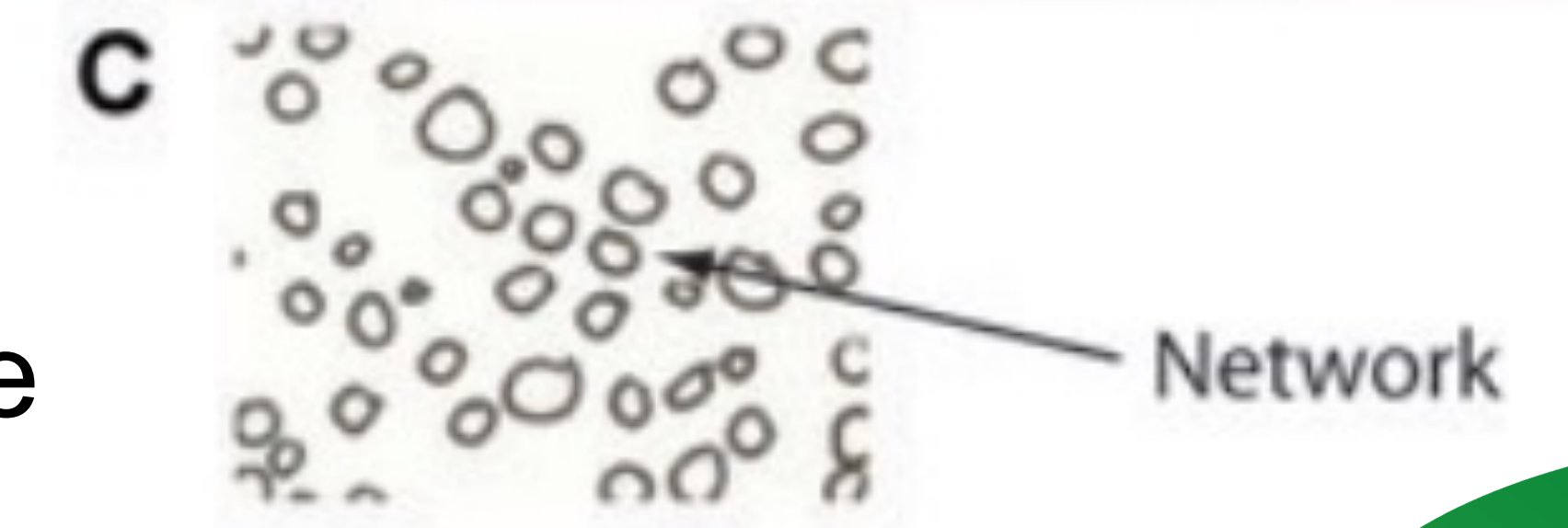
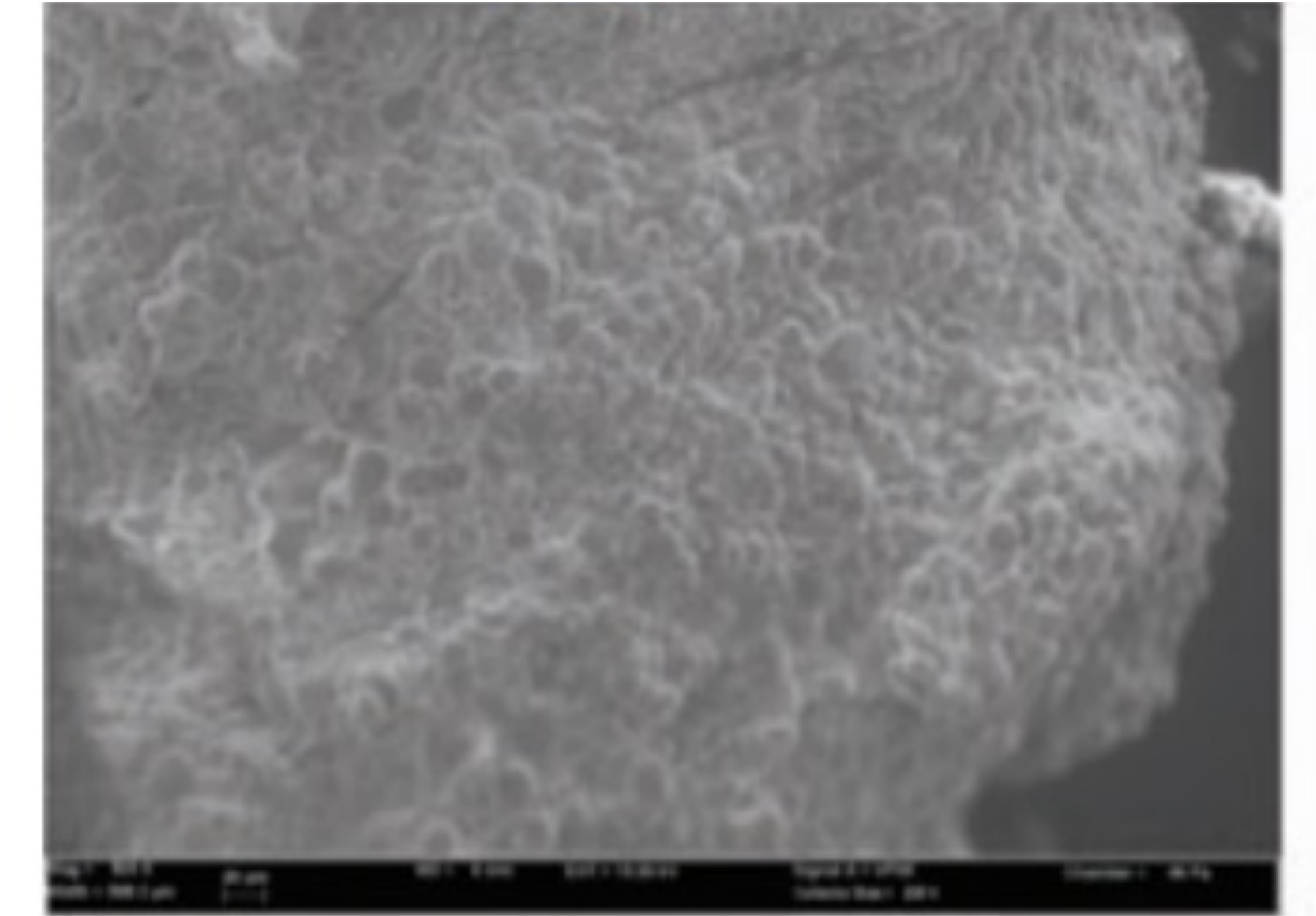
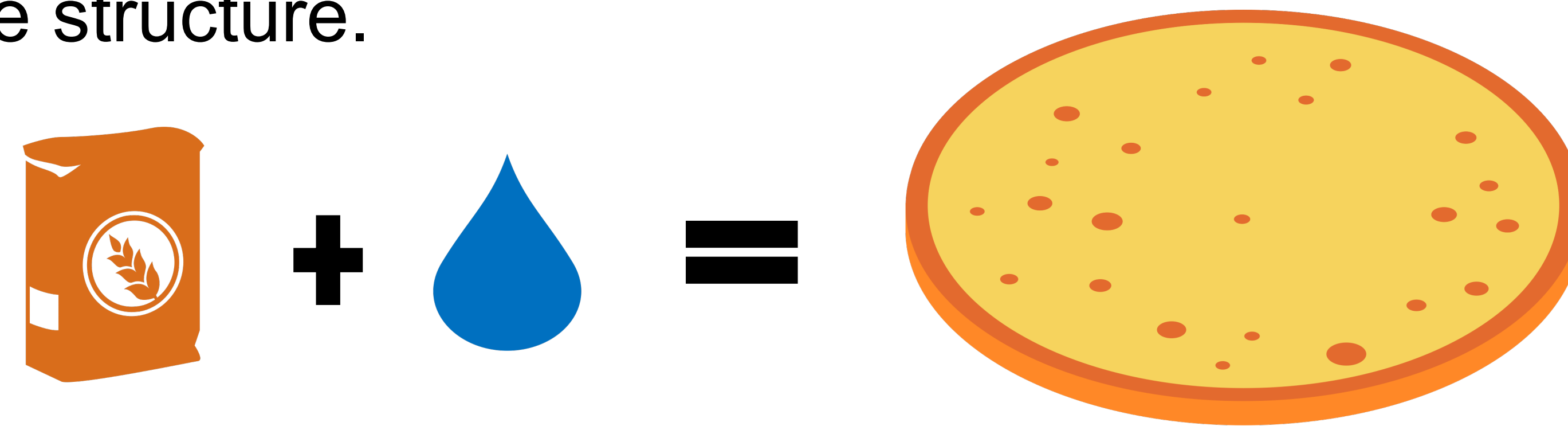
Bread Fermentation

- 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 yeasts, 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 CO_2 causes the bread to rise because the gluten protein is very elastic and allows the bread to increase in volume like a balloon.

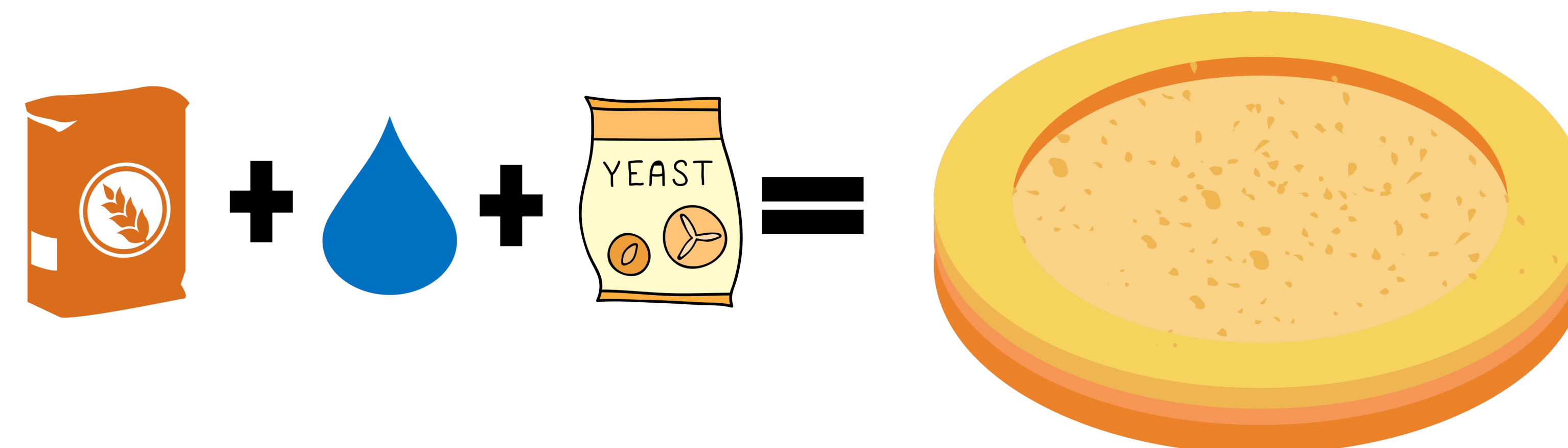
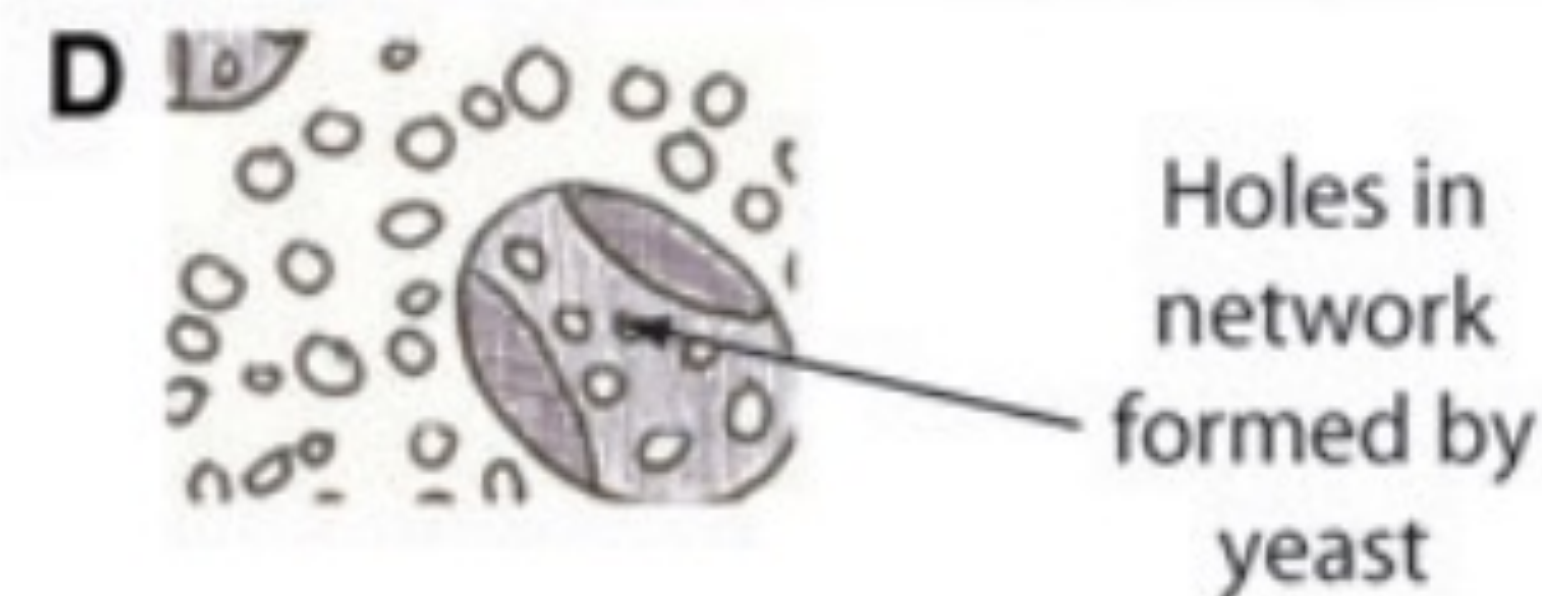


THE SCIENCE OF BREAD

- 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 produces 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.



Food Science & Technology

The background features a stylized illustration of a laboratory. On the left, a scientist with red hair and safety goggles is working at a bench with various glassware. On the right, a scientist with long blonde hair and glasses is holding a flask with red liquid. The scene includes shelves with beakers, flasks, and test tubes, as well as a table with a fish, corn, and a head of lettuce.

Main Areas of Knowledge:

- Food Chemistry
- Food Engineering
- Food Safety
- Quality Assurance
- Product Development
- Food Law

Why Food Science & Technology Matters:

- Availability of Food
- Food Safety
- Food Sustainability
- Nutrition
- Special Foods
- Convenience and Cost



FOOD SCIENTISTS TRANSFORM!





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