

Vegetables

COOKING WITH CHEMISTRY

Did you know vegetables can change color?

A vegetable's color depends upon **pigments**. The substance that provides color in plant and animal cells is called a pigment. For example, **melanin** is the pigment that provides color to your hair and skin. This pigment is important because it protects our bodies from the sun.

There are five types of pigments in vegetables: Chlorophyll, Carotenoids, Anthocyanins, Anthoxanthins, and Betalins.



Pigment	Chlorophyll	Carotenoids	Anthocyanins	Anthoxanthins	Betalins
Vegetables	Broccoli Asparagus Celery	Carrots Sweet Potatoes	Eggplants Red Beans	Onions Turnips Cauliflower	Beets Swiss Chard

Certain vegetable pigments change color when cooked. Heat alone will cause changes to occur for each of the vegetable pigments. However, the addition of an acid or base will cause different reactions, or changes to occur for each of these pigments.

Chemical changes occur when one substance changes into another substance. **Physical changes** occur when a substance changes form,

but not its chemical structure. Melting butter, for example, is a physical change because it can be transformed back to a solid state. When heated, the red anthocyanin pigment in red cabbage will irreversibly break down as a result of a chemical change.

This chemical change causes the solution to become more basic. If an acid is added to the solution, it will physically transform the pigment



Note the difference in color between raw broccoli (left) and cooked broccoli (right).

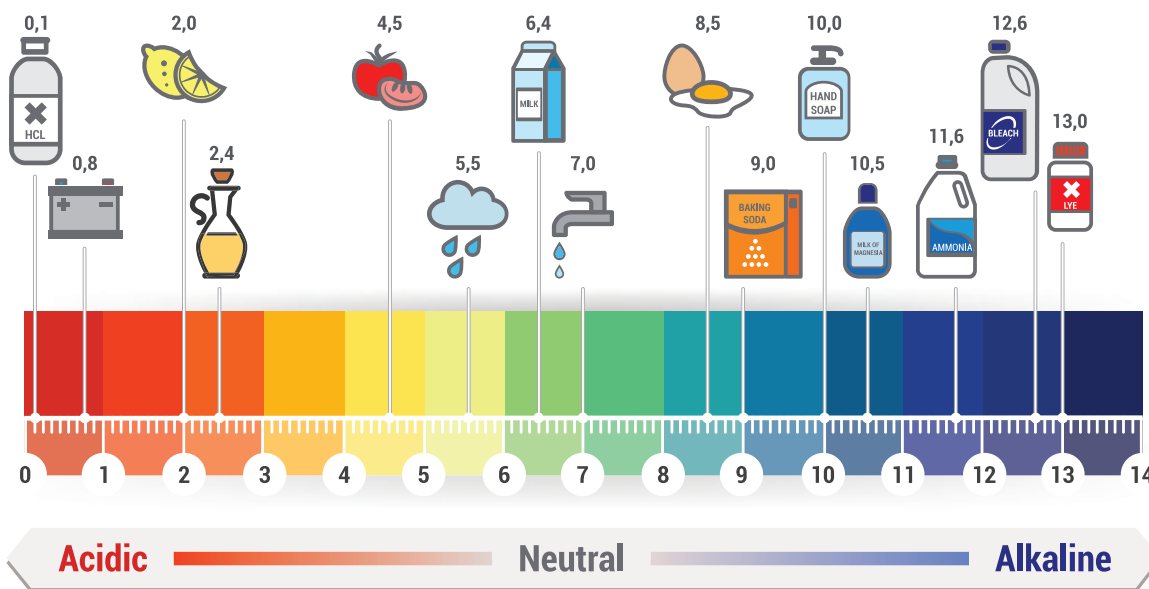
back to its original color. The addition of a base, such as baking soda, will cause the pigment to completely change color. Because the solution can change color with the addition of acid or base, it is considered a physical change that is reversible. You will observe these types of physical and chemical changes in *Food Lab Explorations Lab I* of this chapter.

The structure of a vegetable can also change when it is heated. Asparagus, for example, will become brighter green and softer because the heat causes tiny air pockets to explode. You will observe these types of chemical changes in *Food Lab Explorations Lab II* of this chapter

Acids cause a sour flavor in foods. **Bases** are used to neutralize those acids. Chemistry explains this relationship simply by the gain and loss of hydrogen ions. Acids want to lose a hydrogen ion, while bases want to gain a hydrogen ion. This makes for a great collaborative relationship! Acids and bases are categorized based on a **pH scale** ranging from 0-14. An item with a pH of 7 is considered neutral. If the pH is below 7, it is considered an acid and, if it is above 7, it is considered a base.

Acids, such as vinegar and lemon juice, are often used in cooking. The most common base used in cooking is **baking soda**. Baking soda is used for a variety of purposes. However, its primary function in cooking is to raise baked products. When vegetables are cooked in an acid or a base, their color and/or structure may be affected. The **cell wall** of a plant cell gives the plant its shape. The cell wall contains **cellulose**. Cellulose is a type of fiber necessary in our diets for intestinal health.

Cooking is simply a combination of chemical reactions. Recipes wouldn't be the same without an understanding of the chemical reactions that allow them to blend together properly. Experiment with food and become a chemist!



Think About It

Food Explorations Lab I

1. What pigment is found in red cabbage? anthocyanin
2. When red cabbage is heated a chemical (physical or chemical) change occurs.
3. If the chemical structure of a substance is changed, it is a chemical (physical or chemical) change.

Food Explorations Lab II

1. What can happen to vegetables visual appearance and texture when they are heated?

They can become brighter and softer

2. Name an example of an acid used in cooking. cream of tartar, lemon juice, vinegar

3. Name an example of a base used in cooking. baking soda