FACT SHEET: FUNCTIONS OF INGREDIENTS AND PRINCIPLES OF FOOD SCIENCE IN BAKING, COOKING, AND GRILLING

Baking Ingredients & Their Functions

- **Flour** Provides structure through gluten or starch.
- **Sugar** Sweetens, tenderizes, aids in browning (Maillard reaction).
- **Brown Sugar** Adds moisture and a deeper flavor due to molasses content.
- **Eggs** Bind, leaven, emulsify, and add moisture and richness.
- **Butter** Adds flavor, richness, and tenderness.
- **Oil** Moistens and tenderizes; used in cakes and quick breads.
- **Baking Powder** Chemical leavening agent (acid + base) for rise.
- **Baking Soda** Needs acid to activate; helps with browning and leavening.
- **Milk/Buttermilk** Adds moisture, activates leavening agents, and tenderizes.
- **Salt** Enhances flavor and strengthens gluten.
- **Yeast** Biological leavening; ferments sugars to produce CO2.
- **Cornstarch** Lightens flour mixtures, thickens fillings.
- **Gelatin** Stabilizes and thickens desserts like mousse or marshmallows.
- **Vinegar/Lemon Juice** Acidic agents that react with baking soda for leavening.
- **Cocoa Powder** Adds chocolate flavor and color; can be acidic or neutral.
- **Cream of Tartar** Stabilizes egg whites and activates baking soda.
- **Vanilla/Flavor Extracts** Add aroma and depth of flavor.

Cooking Ingredients & Their Functions

- **Oil/Fat (olive, canola, etc.)** Transfers heat, adds flavor, and prevents sticking.
- **Salt** Enhances and balances flavor.
- **Pepper** Adds heat and complexity.
- **Acids (vinegar, citrus)** Brighten flavors, tenderize proteins, balance richness.
- **Herbs (fresh/dried)** Add freshness, aroma, and complexity.
- **Spices (cumin, paprika, etc.)** Add flavor, aroma, color, and regional character
- **Onions/Garlic/Shallots** Aromatics that build foundational flavor.
- **Tomatoes (fresh, paste, canned)**Provide acidity, umami, and color.
- **Broth/Stock** Adds moisture and a savory base.
- **Wine/Beer** Adds acidity and depth; used in deglazing and braising.
- **Soy Sauce/Fish Sauce** Adds umami and saltiness.
- **Butter/Cream** Adds richness and smooth texture.
- **Starches (rice, pasta, potatoes)** Provide bulk, texture, and energy.
- **Flour/Cornstarch** Used for thickening sauces and soups.
- **Honey/Maple Syrup** Sweeteners that also aid in browning and flavor.

Grilling Ingredients & Their Functions

- **Marinades** Tenderize and flavor meats using acids, oils, and seasonings.
- **Dry Rubs** Add crust, flavor, and texture.
- **Oil** Prevents sticking and promotes browning.
- **Salt** Enhances flavor and helps form crust.
- **Sugar (in rubs/marinades)** Aids caramelization and browning.
- **Mustard** Acts as a binder for rubs and adds tang.
- **Worcestershire Sauce** Adds umami and depth to marinades.
- **Chili Powder/Smoked Paprika** Adds heat and smoky flavor.
- **Wood Chips/Charcoal** Impart smoky flavor and heat.
- **Vegetables (peppers, onions, corn)** Add variety, texture, and flavor when grilled.
- **Citrus Zest/Juice** Brightens grilled dishes and balances richness.

Boiling

- **Salt** Enhances flavor and raises boiling point slightly.
- **Water/Broth** Acts as the cooking medium; broth adds flavor.
- **Acid (vinegar, lemon)** Helps retain color in vegetables and firm texture in proteins.
- **Aromatics (onion, garlic, herbs)** Infuse flavor into the boiling liquid.
- **Starch (pasta, rice, potatoes)** Absorbs water and softens during cooking.

Roasting

- **Oil/Fat** Promotes browning and prevents sticking.
- **Salt** Draws out moisture and enhances flavor.
- **Herbs/Spices** Infuse flavor during dry heat cooking.
- **Vegetables/Meats** Caramelize and develop deep flavors through Maillard reaction.
- **Acid (lemon, vinegar)** Balances richness and brightens flavor.

Air Frying

- **Oil Spray** Aids in browning and crisping with minimal fat.
- **Breading/Coating** Creates a crispy texture similar to deep frying.
- **Spices/Seasonings** Enhance flavor and aroma.
- **Starch (cornstarch, flour)** Helps achieve a golden, crunchy exterior.
- **Marinades** Add flavor and moisture before air frying.

Frying

- **Oil (high smoke point)** Transfers heat quickly and evenly; creates crisp texture.
- **Flour/Breading** Forms a crust and protects food from direct oil contact.
- **Eggs (in batter)** Bind breading and add richness.
- **Salt/Spices** Enhance flavor and contribute to crust formation.
- **Cornstarch** Adds extra crispiness to coatings.

Steaming

- **Water/Broth** Generates steam for gentle cooking.
- **Aromatics (herbs, citrus, ginger)** Infuse subtle flavor into food.
- **Vegetables/Seafood** Retain nutrients, color, and texture.
- **Soy Sauce/Sesame Oil (post-steaming)** Add flavor without overpowering delicate foods.

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Principles of Food Science

Cooking is both an art and a science. While creativity and personal taste make food fun, there's also a lot happening behind the scenes every time you cook. This guide is designed to help you understand the basic food science principles at work in your kitchen, such as the chemical and physical changes that happen when ingredients are mixed, heated, cooled, or stored. These reactions play an important role in a food's final flavor, texture, and appearance, and learning about them can help you become a more confident, curious, and creative cook.

Principle	The Big Idea	Examples At Home	Why it Matters
Maillard Reaction	When heat meets protein and sugar, a chemical reaction occurs that develops complex flavors and brown colors in foods.	Searing meat Golden crust of baked goods such as cookies or breads	Develops complex flavors and brown colors in many foods
Caramelization	When sugar is heated, it's molecules break down and reform into other flavor molecules.	Caramel sauces and candies Caramelized Onion Toasted Marshmallow	Creates complex flavors
Emulsions	Suspension of 2 liquids that would not normally mix (ie: oil and water)	Mayonnaise Salad Dressing Cheese Sauces	Creates stable, smooth creamy textures.
Emulsifier	Ingredients that help suspend 2 liquids that would not normally mix in order to create an emulsion	Egg yolk Mustard Lecithin	Maintains the stability of the emulsion.
Protein Denaturation	Heat, Acids, and Mechanical Force can change proteins, creating foods to change forms	Eggs turning solid Meat cooking and turning red to brown Milk curdling Kneading Dough	Transforms food's texture, flavor, and digestibility
Gelatinization	When carbohydrates are combined with liquid and heat, they begin to swell	Jellies/Jams Pudding Thickening sauces (gravies) Marshmallows	Provides desirable textures and mouthfeels
Acidification	Adding an acid to food to lower the pH	Lemon Juice Vinegar Lactic Acid Buttermilk	Acid changes taste, color, and safety of foods.
Leavening	When gases are formed creating bubbles making food rise.	Baking soda Baking Powder Yeast	Makes foods light and fluffy, rather than dense.
Foaming	When proteins unfold and trap air, a foam is created	Whipped cream Meringue Angel Food Cake Souffle	Creates creamy and airy textures.
Water Activity	Water can either be: Bound= stuck to sugar, salt, or protein Free= not bound to anything meaning it is available for microbes The lower the water activity, the less likely microbial spoilage is to occur.	Fresh Fruit: high water activity and can spoil quickly Bread: moderate water activity and can spoil within a few days Jam: low water activity and can last longer Dry pasta: very low water activity and can last a very long time	Foods with more free water spoil faster

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