Baking Study Guide: Fats & Oils, Milk Products, Chocolate & Cocoa

Based on your notes from Gerardo's School of Culinary Arts. Each section starts with the big idea, then the details, then a memory trick and a self-quiz.

PART 1: FATS AND OILS

The big idea

Fats make baked goods **tender, moist, rich, flavorful, and light**. Different fats behave differently, so choosing the right one is a core baking skill.

1. What are fats?

- Lipid substances that are **insoluble in water**.
- **Solid or semi-solid at room temperature** (oils are the liquid ones).
- Used in baking for **tenderness, flavor, moisture, and structure**.

2. Functions of fats (what fat does in a recipe)

1. Tenderizes and softens texture
2. Adds moisture and richness
3. Increases keeping quality (shelf life)
4. Adds flavor
5. Helps leavening through **creaming** (air is beaten into the fat)
6. Creates **flakiness** in puff pastry, pie dough, and similar products

Memory trick: T-M-K-F-L-F: Tender, Moist, Keeping, Flavor, Leavening, Flaky.

3. Selecting a fat

Consider: **melting point, softness/hardness at different temperatures, flavor, and ability to form emulsions.**

4. Fat emulsions

An **emulsion** is a uniform mixture of two substances that normally don't mix, like fat and water.

- Everyday example: **mayonnaise** (oil + vinegar).
- Bakeshop example: **creaming shortening and sugar** traps air in the fat, giving cakes lightness.

5. Shortenings

Why "shortening"? Any fat can act as a shortening because it **shortens gluten strands** (makes them short so the product is tender, not chewy).

However, the word *shortening* usually means a group of **solid fats, usually white and tasteless, made for baking, nearly 100% fat.**

Made from vegetable oils, animal fats, or both. During manufacturing the fats are **hydrogenated**, which turns liquid oils into solid fats.

Two types of shortening

	Regular shortening	Emulsified shortening
Texture	Fairly tough, waxy	Soft, spreads easily
Particles	Small fat particles hold their shape in dough or batter	Quickly coats particles of sugar and flour
Creaming ability	**Good**: holds lots of air, giving lightness and leavening	**Does NOT cream well**
Special trait	None	Contains emulsifying agents, so it holds **more liquid and sugar** than regular shortening
Use when	The recipe says "cream the shortening and sugar"	High-ratio cakes that need extra liquid and sugar

Rule to remember: If the recipe says *cream shortening and sugar*, use **regular** shortening, not emulsified.

6. Butter

Composition

- About **80% fat, 15% water, 5% milk solids**.

Types of butter

- **Unsalted**: more perishable, but fresher and sweeter tasting. **Preferred in baking.**
- **Salted**: up to **2.5% salt**. Salt changes the flavor and extends keeping quality. If you use it, **reduce the salt in the formula.**
- **European-style / cultured**: more milkfat (**82 to 86%**), very little or no salt. Often churned from cultured cream, so the flavor is more intense and buttery.
- **Whipped**: air is incorporated. More volume and spreadability, but it **turns rancid faster**.
- **Clarified**: water and milk solids are removed by **clarification**.

Handling properties

- Shortenings are manufactured to have certain textures and hardness.
- Butter is **natural**, so it doesn't have this advantage: **hard and brittle when cold, very soft at room temperature, melts easily.** Doughs made with butter are harder to handle.

Two major advantages of butter

1. **Flavor**: shortenings are flavorless, butter has a highly desirable flavor.
2. **Melting qualities**: butter melts in the mouth. Shortening doesn't, and can leave an unpleasant film coating the mouth.

Butter storage

- Wrap well, store at **32 to 35°F (0 to 2°C)**.
- Unsalted butter is best kept **frozen** until needed.
- Well-wrapped frozen butter lasts up to **9 months at 0°F (-18°C)**.

Blending butter and shortening

Bakers feel butter's advantages outweigh its disadvantages for many uses. Shortening isn't often used in fine French pastry. A common compromise is **50% butter + 50% shortening**, which gives **butter's flavor and shortening's handling qualities.**

7. Lard

- **Rendered pork fat**, solid white, almost 100% pure fat with a little water.
- Gives **flaky, flavorful pastries** (like pie crusts).
- Downside: **highly prone to rancidity.**

8. Margarine

- Made from **animal or vegetable fats** (or a combination).
- Flavorings, colorings, emulsifiers, preservatives, and vitamins are added.
- Firmed up by **hydrogenation** (hydrogen gas at very high temperatures).
- Like butter: about **80% fat, 16% water**. Even the best margarine can't match butter's flavor.
- Melts at a **slightly higher temperature than butter**, so it's useful for some **rolled-in doughs** (puff pastry, Danish).

Two categories of margarine

Cake / Baker's margarine	Pastry margarine
Soft, good creaming ability	Tougher, more elastic, waxy texture
Used in cakes and a wide variety of products	Made for doughs with fat layers: **Danish dough, puff pastry**

9. Oils

Production and storage

- Made by **pressing** high-oil foods: olives, nuts, corn, avocados, soybeans.
- May then be **filtered, clarified, or hydrogenated**, depending on use.

- Store oils and shortenings in a **dry place away from light and extreme heat.**

Flavors

- Vegetable oils are **virtually odorless with a neutral flavor**, and are **cholesterol-free** (no animal products).
- Nut oils (walnut, hazelnut) are prized for their **distinctive flavors**.

Oils in baking

- Oil **blends thoroughly** throughout a mixture, so it coats more of the proteins. Gluten strands come out **much shorter**, which gives **fine-textured products** like muffins and chiffon cakes.
- Use a **neutral oil** unless you want a specific flavor (like olive oil in some breads).
- **Never substitute oil in a formula that requires a solid shortening.**

10. Melting points of fats

Fat	°F	°C
Butter	90	32
Emulsified shortening	100	38
Lard	110	43
Shortening	115	46

Memory trick: Butter melts lowest, which is why it melts in your mouth (body temperature is about 98.6°F / 37°C) and why butter doughs get sticky fast.

Self-quiz: Fats and Oils

1. Why can any fat be called a "shortening"?
2. Which shortening should you use for creaming, and why?
3. What are butter's three components and percentages?
4. Why is unsalted butter preferred in baking?
5. Which fat has the highest melting point? Lowest?

6. Why is oil good for muffins and chiffon cakes?
7. What does hydrogenation do?

PART 2: MILK AND MILK PRODUCTS

The big idea

Next to water, **milk is the most important liquid in the bakeshop.** Water develops gluten, and fresh milk is **88 to 91% water**, so it does that job. Milk also adds **texture, flavor, crust color, keeping quality, and nutrition.**

1. Whole milk

Fresh milk as it comes from the cow, nothing removed or added (except vitamin D fortification).

- **3.5% fat** (milkfat or butterfat)
- **8.5% nonfat milk solids**
- **88% water**

2. Forms of fresh whole milk

- **Pasteurized**: heated to kill disease-causing bacteria, then cooled. Most milk and cream on the market is pasteurized.
- **Raw**: not pasteurized. Generally not allowed to be sold.
- **Certified**: from disease-free herds under strict sanitary conditions. May be raw or pasteurized.
- **Homogenized**: processed so the cream doesn't separate.

3. Processing terms (a favorite exam topic)

Pasteurization

Heating to a high enough temperature for long enough to destroy **pathogenic (disease-causing) bacteria.**

- Typical: **161°F (72°C) for 15 seconds.**

- Also destroys spoilage enzymes, so **shelf life increases**. Nutrition is not significantly affected.

Ultra-pasteurization

- **275°F (135°C) for 2 to 4 seconds**, destroying virtually all bacteria.
- Most often used for **whipping cream and individual creamers.**
- Trade-off: may reduce cream's **whipping properties**, but shelf life is extended dramatically.

UHT (ultra-high-temperature)

- A form of ultra-pasteurization: **280 to 300°F (138 to 149°C) for 2 to 6 seconds.**
- Packed in **sterile containers**, aseptically sealed.
- **Unopened UHT milk keeps without refrigeration for at least 3 months.**

Homogenization

- Fat globules are **reduced in size and permanently dispersed** (forced through tiny holes).
- Prevents fat clumping and rising as a layer of cream.
- Not required, but commercial milk is usually homogenized for **uniform consistency, whiter color, richer taste.**

Memory trick for the three heat treatments: the temperatures go up while the times stay short: 161°F/15 sec, then 275°F/2 to 4 sec, then 280 to 300°F/2 to 6 sec.

4. Removing milkfat

Whole milk processed in a **centrifuge** to remove some or all milkfat.

Type	Milkfat
Whole	3.5%
Reduced-fat / less-fat	2%
Low-fat / little-fat	1%
Skim / nonfat	0.5% or less

Note: your notes also say low-fat milk can range **0.5 to 3%** in retail and food service, so a range is acceptable. Skim, low-fat, fortified and flavored milks are generally **not used in bakeshops**.

5. Concentrated (condensed) milk products

Made by using a **vacuum** to remove all or part of the water. Result: high concentration of milkfat and solids, **extended shelf life.**

	Evaporated milk	Sweetened condensed milk
Water removed	About **60%**	About **60%**
Sugar	None added	**40 to 45%** sugar
Process	Canned and heat-sterilized: cooked flavor, darker color	Canned; the process **darkens color and adds caramel flavor**
Substitution	Can be reconstituted with an **equal amount of water** and used like whole milk	**Cannot** replace whole or evaporated milk because of the sugar
Uses	Cooking or drinking	Puddings, fudge, confections

Evaporated **skim** milk (0.5% milkfat) also exists. A sealed can needs no refrigeration, but store it cool.

6. Dry milk powder

- Made by removing **virtually all moisture** from pasteurized milk. Available as whole, nonfat, and buttermilk powder.
- No moisture means **no microorganism growth**, so it stores a long time without refrigeration.
- Can be **reconstituted with water** and used like fresh milk.
- Can also be added **directly to foods** (with extra liquid in the recipe). Typical in **bread making** and doesn't change the milk's function or flavor.

7. Cream

A rich liquid milk product with **at least 18% fat.** Must be pasteurized or ultra-pasteurized, may be homogenized. Slight yellow/ivory color, more viscous than milk.

Cream types: know the fat percentages

Cream	Milkfat	Key facts
Half-and-half	10 to 18%	Whole milk + cream. **Too little fat to whip.** Cereal and coffee.
Light / coffee / table cream	18 to 30%	Baked goods, soups, coffee, fruit
Light whipping cream	30 to 36%	Thickening sauces, ice cream. Can be whipped into a foam.
Heavy whipping cream	**36% or more**	Whips easily and **holds its whip longest**. Must be pasteurized, rarely homogenized. Ultra-pasteurized version lasts longer but whips less easily.
Clotted cream	55%	Thick, spreadable, from **unpasteurized** whole milk. Milk is heated, cream clumps and floats as it cools, then is removed. Spread or filling for scones and pastries.

Memory trick: 10, 18, 30, 36 are the key stair-steps. Cream starts at 18, whips at 30, and holds best at 36.

Cream storage

- Ultra-pasteurized cream keeps **6 to 8 weeks** at or below **40°F (4°C)**.
- **Do not freeze unwhipped cream.**
- Keep away from strong odors and bright light (they harm flavor).

8. Cultured dairy products

Yogurt, buttermilk, sour cream are made by adding **specific bacterial cultures** to fluid dairy products.

- Bacteria convert **lactose (milk sugar) into lactic acid**.
- Lactic acid makes proteins **coagulate**, giving **body and tangy flavor.**
- The acid also **slows growth of unwanted microorganisms**, so cultured foods have preserved milk for centuries.

Buttermilk and sour cream

- **Buttermilk**: originally the liquid left after churning butter. Today it's made by adding lactic acid bacteria (*Streptococcus lactis*) to fresh pasteurized **skim or low-fat milk**. Tart and thick.
- **Sour cream**: lactic acid bacteria added to pasteurized, homogenized **light cream**. White, tangy gel. Must have **at least 18% milkfat.**

Creme fraiche and yogurt

- **Creme fraiche**: cultured cream popular in French cooking. **Thinner and richer** than sour cream, with similar tang.
- **Yogurt**: thick, tart, made from milk cultured with ***Lactobacillus bulgaricus*** **and** ***Streptococcus thermophilus***. Despite its "diet food" image, it has the **same milkfat as the milk it came from.**

Greek yogurt and skyr

- **Greek yogurt**: creamier and denser because **more whey is strained out.**
- **Skyr** (marketed as Icelandic yogurt): actually a **fresh, fat-free cheese** from very well-strained cow's milk. Texture and flavor like yogurt but with **more protein and calcium.** Can replace yogurt or sour cream.

Cultured dairy storage

- Potentially hazardous foods. Refrigerate at or below **40°F (4°C).**
- Sour cream: up to **4 weeks**. Yogurt: up to **3 weeks**. Buttermilk: up to **2 weeks.**
- Don't freeze the products themselves, but **dishes made with them can generally be frozen.**

9. Cheese

How cheese is made

1. Start with a mammal's milk (cow, goat, sheep).
2. **Casein** (the milk proteins) is coagulated by an enzyme, usually **rennet** (found in calves' stomachs).
3. Milk separates into **solid curds and liquid whey.**
4. Drain the whey. Then either:
    - Curds become **fresh cheese** (ricotta, cottage cheese), or
    - Curds are cut, kneaded, and cooked into **"green cheese"**, then packed into molds to drain.
5. Salt or special bacteria may be added. The cheese is **aged/ripened** under controlled conditions to develop texture, color, and flavor.

Cheeses to know

Cheese	Fat	Key facts and uses
Cream cheese	~35%	Soft cow's-milk cheese. Blocks or whipped. Cheesecakes, fillings, icings. **Soften gently first**: blend on **low speed with a paddle** to remove lumps **before** adding sugar, eggs, or liquids.
Farmer's cheese, baker's cheese, quark	Light	Fresh soft cow's-milk cheeses, interchangeable. **Quark** is German for "curd," a cross between mild cream and cream cheese. If no quark: use equal amounts of farmer's cheese, baker's cheese, or cream cheese, adding **milk to loosen to a yogurt-like consistency.** Yogurt can also replace quark.
Mascarpone	70 to 75%	Soft cow's-milk cheese from **Italy's Lombard region.** Extremely smooth and creamy, pale ivory, rich and sweet. **Highly perishable.** Sweet sauces, ice cream, fillings.

Cheese	Fat	Key facts and uses
Ricotta	4 to 10%	Soft Italian cheese, like cottage cheese, made from the **whey** left from other cow's-milk cheeses. White or ivory, fluffy, small grain, sweet. **Italian cheesecake and cannoli filling.**

Memory trick: Mascarpone is the richest (70 to 75%), ricotta the leanest (4 to 10%). Ricotta = *re-cooked whey*, which is why it's low in fat.

Cheese storage

- Refrigerate, **well wrapped** (keeps odors out, moisture in).
- Firm/hard cheeses: **several weeks.**
- Fresh cheeses: **7 to 10 days** (high moisture).
- Hard or dry cheeses can still be **grated** for cooking or baking.

Self-quiz: Milk Products

1. Why is milk the second most important bakeshop liquid?
2. Give the composition of whole milk.
3. Compare pasteurization, ultra-pasteurization, and UHT (temp and time).
4. What's the minimum fat in heavy cream? In cream in general?
5. Why can't half-and-half be whipped?
6. Evaporated vs. sweetened condensed: what's the difference, and can they be swapped?
7. How do cultured dairy products work chemically?
8. Which is richest: mascarpone, ricotta, or cream cheese?
9. What is skyr, really?

PART 3: CHOCOLATE AND COCOA

The big idea

Chocolate comes from the **cacao tree** (*Theobroma cacao*). Understanding **how it's made** and **how much cocoa butter vs. cocoa solids** each product has tells you how to use it.

1. Origins and history (timeline)

- *Theobroma* means **"food of the gods."** Originally a **bitter, spiced, frothy, cold drink**, not a bar.
- **Olmec (c. 1500 to 400 BCE)**: earliest known cacao use, southern Mexico.
- **Maya (c. 250 to 900 CE)**: drank cacao at feasts, weddings, rituals. A gift from the gods and status symbol.
- **Aztec (c. 1300 to 1521 CE)**: beans used as **currency**. Drink reserved for nobility, warriors, priests. Flavored with chili, vanilla, flowers.
- **1500s**: Spanish conquistadors bring cacao to Spain, first as a medicinal drink for the elite. Sugar, cinnamon, and milk gradually make it sweeter.
- **1600 to 1700s**: spreads to France, Italy, England, and the Philippines, still mostly an upper-class drink.
- **1815**: Casparus van Houten sets up a cocoa operation in Amsterdam.
- **1828**: Van Houten patents a **hydraulic cocoa press** that presses out cocoa butter (cutting fat from about 50% to much lower). The remaining cake is ground into **cocoa powder.** He also introduces **"Dutching"** (alkali treatment): less bitter, darker, more soluble.
- **1847**: **Joseph Fry** (England) blends cocoa powder + sugar + melted cocoa butter into a stable, moldable mixture: the **first modern chocolate bar.**
- **1875**: **Daniel Peter** (Swiss chocolatier) and **Henri Nestle** (powdered milk inventor) create the first **milk chocolate.**

Memory trick (the order of inventions): *Press (1828) -> Bar (1847) -> Milk (1875).* Van Houten pressed it, Fry molded it, Peter and Nestle made it milky.

2. From cacao pod to chocolate (8 steps)

1. **Harvesting**: ripe pods cut from the tree

2. **Fermentation**: beans and pulp fermented to develop flavor
3. **Drying**: sun or dryers
4. **Roasting**: intensifies aroma
5. **Cracking and winnowing**: removes shells, separates the **nibs**
6. **Grinding**: nibs become **chocolate liquor** (cocoa solids + cocoa butter)
7. **Pressing**: liquor separated into **cocoa butter** and **cocoa solids/cake** (for cocoa powder)
8. **Refining, conching, tempering**: finished chocolate with the right texture and shine

Conching is the "polishing phase": it smooths the chocolate, drives off harsh acidic notes, and distributes cocoa butter evenly.

Memory trick: *"Happy Farmers Dry Roasted Cracked Grinding Pressed Chocolate"* gives you H-F-D-R-C-G-P-C in order.

3. Natural vs. Dutch-process cocoa

Cocoa is the dry powder left after part of the cocoa butter is removed from chocolate liquor.

	Natural cocoa	Dutch-process (dutched) cocoa
Treatment	None	Processed with an **alkali**
Acidity	Somewhat **acidic**	Neutral or slightly **alkaline**
Color/flavor	Lighter, sharper	Slightly darker, smoother, dissolves more easily
Leavening	**Reacts with baking soda** (acid + base), so baking soda can be part of the leavening	**Does not react** with baking soda, so **baking powder** is the sole leavener

Substituting dutched for natural: increase baking powder by **30 g for each 15 g of soda omitted.**

Color clues (your notes): too little soda makes the product anywhere from light to dark brown, and too much makes it **reddish brown.** Whenever you switch cocoa types, you may have to **adjust the soda.**

Memory trick: *Natural = acid = needs soda. Dutched = neutral = use powder.*

4. Three main types of chocolate

Type	Composition
Dark	More than **50% cocoa liquor** + cocoa butter + sugar + vanilla + lecithin. Premium confections.
Milk	Minimum **10% cocoa mass** + milk powder + cocoa butter + sugar + vanilla + lecithin
White	**32% cocoa butter** + milk + sugar + vanilla. **Not considered real chocolate** (no cocoa solids).

5. Market forms of chocolate

Five forms: **Couvertures, Compound chocolate, Cocoa powder, Chocolate chips, Baker's chocolate.**

Couverture

- Higher **cocoa butter (32 to 39%)** than baking or eating chocolate.
- With proper tempering: more **sheen, a firmer "snap,"** and a creamy, mellow flavor.
- Good-quality products (dark, milk, **or white**) are often called couverture, meaning **"coating"** in French.
- **Tempering**: carefully melt the chocolate without letting it get too warm, then bring the temperature back down to a set level. Requires skill. Needed when couverture coats candies or cookies.

Compound chocolate

- Cocoa + **vegetable fat** + sweeteners. A **lower-cost** alternative: cheaper hard fats (coconut oil, palm kernel oil) replace expensive cocoa butter.
- Also called "compound coating" or "chocolaty coating."
- Easier to handle, **no tempering needed**, but lacks the flavor and eating quality of real chocolate.

Coating chocolate (don't confuse with couverture!)

- Less expensive chocolates with part of the cocoa butter **replaced by other fats.**

- Sold as cookie coating, cake coating, baking chocolate.
- **Couverture and coating chocolate are entirely different**, even though couverture means "coating."

Cocoa powder

Dry powder from roasted beans with **most of the cocoa butter removed.** Rich chocolate flavor without the extra fat and sugar.

Chocolate chips

Small morsels (milk, dark, or semi-sweet) known for **keeping their shape when baked.** Cookies, muffins, pancakes.

Baking chocolate

Chocolate meant for baking, sweetened or not. Dark, milk, and white are all sold as baking chocolate.

Unsweetened (bitter) chocolate

- **Straight chocolate liquor.** No sugar, strongly bitter.
- Molded in blocks, so also called **block cocoa** or cocoa block.
- Used to flavor items that get sweetness from other sources.

Sweet, semisweet, and bittersweet

- Bitter chocolate **plus sugar and cocoa butter.**
- Semisweet = lower sugar. Bittersweet = even less sugar.
- Semisweet and bittersweet must have **at least 35% chocolate liquor**, with **35 to 50% sugar.**
- Product labeled **sweet chocolate** may have as little as **15% liquor.**
- Don't confuse sweet chocolate with milk chocolate.
- **If a recipe says "sweet chocolate,"** any sweetened chocolate may be used, though results will vary. If it says **bittersweet**, a good grade with high chocolate liquor content is essential (your handwritten notes).

Milk chocolate

- Sweet chocolate with **milk solids** added. Usually a coating chocolate and used in confections.
- Seldom melted into batters, because it has a **relatively low proportion of chocolate liquor.**

Cocoa butter

- The **fat pressed out of chocolate liquor.**
- Main bakeshop use: **thinning melted couverture** to the right consistency.

White chocolate

- Cocoa butter + sugar + milk solids. Mostly confectionery.
- Cheap versions with **another fat in place of cocoa butter** don't deserve the name chocolate.

6. Substituting cocoa and chocolate

Cocoa is the same as bitter chocolate, **only with less cocoa butter**, so it's often possible to substitute one for the other. *(Your page ends here. The usual trick is to add extra fat when replacing chocolate with cocoa. Check your instructor's ratio.)*

Self-quiz: Chocolate and Cocoa

1. What does *Theobroma* mean?
2. What did Van Houten's press and Dutching each do?
3. Who invented the first chocolate bar? Milk chocolate?
4. List the 8 steps from pod to chocolate.
5. Why does natural cocoa work with baking soda but dutched cocoa doesn't?
6. How much baking powder replaces 15 g of baking soda when switching to dutched cocoa?
7. Dark vs. milk vs. white: what's the cocoa content of each?
8. Couverture vs. compound chocolate: which needs tempering and why?
9. What is the **only** thing that is solid cocoa liquor with no sugar?

QUICK REVIEW: NUMBERS TO MEMORIZE

Topic	Number
Butter	80% fat, 15% water, 5% milk solids
Salted butter	up to 2.5% salt
European butter	82 to 86% fat
Butter storage	32 to 35°F; frozen 0°F for up to 9 months
Margarine	~80% fat, 16% water
Melting points	Butter 90°F, Emulsified 100°F, Lard 110°F, Shortening 115°F
Whole milk	3.5% fat, 8.5% solids, 88% water
Pasteurization	161°F (72°C), 15 sec
Ultra-pasteurization	275°F (135°C), 2 to 4 sec
UHT	280 to 300°F (138 to 149°C), 2 to 6 sec
Cream minimum	18%
Heavy cream	36% or more
Clotted cream	55%
Mascarpone / Ricotta / Cream cheese	70 to 75% / 4 to 10% / 35%
Cultured product shelf life	Sour cream 4 wks, yogurt 3 wks, buttermilk 2 wks
Fresh cheese	7 to 10 days
Dark chocolate	More than 50% liquor
Milk chocolate	Minimum 10% cocoa mass
White chocolate	32% cocoa butter
Couverture	32 to 39% cocoa butter
Dutched swap	+30 g baking powder per 15 g soda omitted

THE 5 BIG TAKEAWAYS

1. **Fat choice is about melting point, texture, and flavor.** Butter wins on flavor, shortening on handling, and a 50/50 blend gives both.
2. **Heat treatments differ by temperature and time**, and the hotter the process, the longer the shelf life.
3. **Cream names are just fat percentages**: 10, 18, 30, 36.
4. **Cultured dairy = bacteria turn lactose into lactic acid**, which thickens, adds tang, and preserves.
5. **Cocoa chemistry**: natural is acidic (use soda), dutched is neutral (use powder). Cocoa butter content separates real chocolate from compound.

PART 4: SUGAR AND SUGAR COOKERY

The big idea

Sugar is **more than a sweetener**. It adds **flavor, color, texture, preservation, and structure.** Controlling sugar's **temperature and concentration** lets chefs make syrups, caramel, candies, and decorations.

1. What is sugar?

- **Sweet, soluble carbohydrates** found naturally in plants and animal products.
- Among the simplest digestible carbohydrates, and they give **energy**.
- Many sugars can form **crystals**.
- **Natural sources:** sugar cane, sugar beet, fruits, honey, maple sap, and milk.

2. Why sugar matters in culinary arts

Sweetness, flavor enhancement, **browning and color**, texture, **moisture retention**, **preservation**, and structure in desserts and candies.

3. History timeline

Date	Event
8000 BC	Sugar cane domesticated in **New Guinea**
500 BC	Crystallized sugar produced in **India**
700 AD	**Arabs** spread sugar cultivation
1493	**Columbus** brings sugar cane to the Caribbean
1747	**Sugar beet** identified as an alternative source

In ancient times sugar was **rare and costly**: a luxury spice, a medicine, and a symbol of wealth for royalty and nobility.

Memory trick: *New Guinea -> India -> Arabs -> Columbus -> Beet* is the journey of sugar from the Pacific to the Americas, then a new plant source.

4. Sources and manufacture

- **Plant sources:** sugar cane, sugar beet, maple sap, fruits, corn.
- **Dairy source:** milk (lactose).

How refined sugar is made (6 steps)

1. **Extract** juice from cane or beets
2. **Clarify** the juice using **lime and heat**
3. **Evaporate** water to concentrate the syrup
4. **Crystallize** the sugar
5. **Separate** crystals from molasses by **centrifugation**
6. **Refine** to make white sugar, then package

Memory trick: E-C-E-C-S-R: *Extract, Clarify, Evaporate, Crystallize, Separate, Refine.*

5. Chemical classification

- **Monosaccharides** = **one** sugar unit.
- **Disaccharides** = **two** monosaccharide units joined.

Group	Sugar	Where / what
Mono	**Glucose**	Fruits and plant sap
Mono	**Fructose**	Fruit sugar, found in fruits and honey
Mono	**Galactose**	Part of milk sugar (lactose)
Di	**Sucrose**	Common table sugar
Di	**Lactose**	Milk sugar
Di	**Maltose**	Malt sugar, associated with grains

Extra (standard chemistry, not on your page): sucrose = glucose + fructose, lactose = glucose + galactose, maltose = glucose + glucose.

Relative sweetness (sucrose = 100)

Sugar	Sweetness
Fructose	**173** (sweetest)
Sucrose	100
Glucose	74
Maltose	33
Lactose	**16** (least sweet)

Memory trick: Fructose is sweetest, lactose is the weakest. Everything is measured against table sugar at 100.

6. Market forms of sugar

Granulated, superfine (caster), powdered (confectioners'), brown, muscovado, turbinado, rock sugar.

- **Granulated:** larger crystals, dissolves more **slowly**.
- **Caster (superfine):** finer crystals, dissolves **faster**. Good for **meringues, sponge cakes, whipped mixtures**.

- **Brown sugar:** contains **molasses**, so it's moist, richly flavored, and dark. Varieties: light brown, dark brown, muscovado.

7. Syrups used in cooking and baking

- **Common:** cane syrup, maple syrup, corn syrup, honey, molasses, sorghum syrup.
- **Professional kitchens also use: invert sugar, glucose syrup, corn syrup, honey, isomalt** to control sweetness, **crystallization**, and texture.

8. Functional properties of sugar

Four to know: **sweetness, solubility, crystallization, hygroscopicity.**

Solubility

Sugar dissolves in water. It dissolves faster with:

- **Smaller particles**
- **Stirring (agitation)**
- **Warmer water**

Factors: temperature, particle size, agitation, concentration.

Crystallization

Solid sugar crystals forming from a **concentrated solution**. Very important in candy making. Affected by **temperature, agitation, and interfering substances.**

- An **interferent** is an ingredient that **prevents or slows crystal formation**, giving **smooth-textured candies**.
- **Example from your handwritten note: adding acid.**

Hygroscopicity

The **ability to absorb moisture from the air** (your handwritten note).

- Good: baked goods **stay moist** and resist dryness.
- Bad: it can make **candy sticky**.

9. Caramelization

- Sugar heated to high temperature, around **160 to 180°C (320 to 356°F) for sucrose.**
- Produces **brown color, rich flavor, aromatic compounds.**
- Flavor: **sweet, nutty, caramel-like.**
- Examples: caramel sauce, flan topping, **creme brulee**, caramel candies, sugar decorations.

10. Maillard reaction

- **Reducing sugars react with amino compounds** during heating.
- Gives browning and complex **roasted, toasty, savory** flavors.
- Examples: bread crust, toast, roasted coffee, grilled meats, baked cookies.
- Browning is commonly associated with about **120 to 150°C (250 to 300°F)**. Actual rates depend on **time, water content, pH, and ingredients.**

Caramelization vs. Maillard

	Caramelization	Maillard
Reactants	**Sugar only**	**Sugars + amino compounds** (protein)
Typical heat	About 160 to 180°C	Often about 120 to 150°C
Flavor	Sweet, nutty, caramel	Roasted, complex
Examples	Candy, caramel	Crust, roasted foods

Memory trick: *Caramel = sugar alone, hotter. Maillard = sugar + amino (protein), cooler.*

11. Fermentation and creaming

- **Fermentation:** yeast uses fermentable sugars and produces **carbon dioxide and alcohol.** CO_2 makes bread dough **rise**.
- **Creaming:** sugar crystals beaten with butter or solid fat **trap air**, giving lighter cake batter and better volume and texture.

12. Sugar in baking

Sweetens, **retains moisture**, **tenderizes gluten structure**, supports **color and browning.**

13. Sugar as a preservative

- High sugar **reduces available water** and limits microbial growth.
- Water is drawn out of microorganisms by **osmosis.**
- Examples: **jams, jellies, marmalades, fruit preserves, candied fruits, honey.**
- Proper processing and sealing are still essential for safe storage.

14. What is sugar cookery?

Preparing **syrups, caramel, candies, and confections** by heating sugar (usually with water) to **precise temperatures.**

- As the syrup heats, **water evaporates**, sugar concentration rises, and the final texture changes.
- Tiny temperature differences can make **soft fudge, chewy caramel, or hard brittle.**

15. Types of candies

Crystalline	Non-crystalline
Many **small sugar crystals**	Made to **avoid noticeable crystals**
Fudge, fondant, divinity	**Caramel, toffee, peanut brittle, lollipops**

16. Candy temperature stages

Stage	Temperature	Typical use
Thread	215 to 235°F	Syrups
Soft ball	235 to 240°F	Fudge
Firm ball	245 to 250°F	Caramel

Stage	Temperature	Typical use
Hard ball	250 to 265°F	Nougat
Soft crack	270 to 290°F	Taffy
Hard crack	300 to 310°F	Brittles

These are approximate. **Use an accurate thermometer and consider altitude.**

Memory trick: *"Syrups, Fudge, Caramel, Nougat, Taffy, Brittle"* gets hotter and harder as you go down. Think **S-F-C-N-T-B**.

17. Key principle

Temperature controls structure. Heating sugar syrup: (1) water evaporates, (2) sugar concentration rises, (3) texture gets firmer. Higher temperature = firmer, harder candy.

18. Key takeaways

Sugar is a **functional and structural ingredient** affecting flavor, color, texture, and preservation. Mastering **temperature, concentration, and crystallization** lets pastry chefs make a wide variety of confections.

Self-quiz: Sugar

1. List the six steps of making refined sugar.
2. Which sugar is sweetest? Least sweet?
3. Monosaccharide vs. disaccharide: give three examples of each.
4. Why does caster sugar suit meringues better than granulated?
5. What is an interferent, and what's one example?
6. What is hygroscopicity, and when is it good vs. bad?
7. Caramelization vs. Maillard: reactants and temperatures?
8. How does sugar preserve food?
9. Which candy stage makes fudge? Caramel? Brittle?
10. Crystalline vs. non-crystalline candies: give two examples each.

PRACTICE EXAM: TRICKY QUESTIONS (ALL TOPICS)

Covers Fats and Oils, Milk Products, Chocolate and Cocoa, and Sugar. Try it first, then check the answer key at the very end. Watch for tricky wording like "NOT," "EXCEPT," and look-alike numbers.

PART A: MULTIPLE CHOICE (45 items)

Choose the BEST answer.

Fats and Oils

1. Which fat has the HIGHEST melting point? A) Butter B) Lard C) Emulsified shortening D) Regular shortening

2. A recipe says "cream the shortening and sugar." Which fat should you use? A) Emulsified shortening B) Oil C) Regular shortening D) Clarified butter

3. Fresh butter is made up of about: A) 80% fat, 15% water, 5% milk solids B) 80% fat, 5% water, 15% milk solids C) 85% fat, 10% water, 5% milk solids D) 70% fat, 20% water, 10% milk solids

4. You use salted butter in a formula written for unsalted butter. What should you do? A) Increase the sugar B) Reduce the salt in the formula C) Add more liquid D) Nothing, they are identical

5. Which statement about margarine is correct? A) It melts at a lower temperature than butter B) It is about 80% fat and 16% water C) It is never hydrogenated D) It contains no water

6. Why does oil give fine-textured muffins and chiffon cakes? A) It creams air into the batter B) It coats more proteins, so gluten strands are shorter C) It is solid at room temperature D) It makes gluten strands longer

7. Which is NOT a function of fats? A) Tenderizing B) Increasing keeping quality C) Developing gluten D) Creating flakiness

8. Which butter has 82 to 86% milkfat and little or no salt? A) Whipped butter B) European-style (cultured) butter C) Clarified butter D) Salted butter

9. What is the main drawback of whipped butter? A) It loses all flavor B) It turns rancid faster C) It has a higher melting point D) It cannot be spread

10. Which pair correctly describes lard? A) Rendered beef fat, very stable B) Rendered pork fat, prone to rancidity C) Rendered pork fat, very long shelf life D) Hydrogenated vegetable oil, flavorless

Milk and Milk Products

11. Whole milk contains: A) 3.5% fat, 8.5% nonfat solids, 88% water B) 8.5% fat, 3.5% solids, 88% water C) 3.5% fat, 88% solids, 8.5% water D) 2% fat, 10% solids, 88% water

12. Which process holds milk at 280 to 300°F (138 to 149°C) for 2 to 6 seconds? A) Pasteurization B) Ultra-pasteurization C) UHT processing D) Homogenization

13. Which product does NOT have enough fat to whip into a foam? A) Heavy cream B) Light whipping cream C) Half-and-half D) Clotted cream

14. Evaporated milk vs. sweetened condensed milk: A) Both have about 60% of the water removed, but only sweetened condensed has 40 to 45% sugar B) Evaporated milk has more sugar C) Sweetened condensed has only 40% of the water removed D) They can be substituted for each other

15. Skyr, marketed as Icelandic yogurt, is actually: A) A cultured cream B) A fresh, fat-free cheese C) A kind of sour cream D) Sheep's-milk yogurt

16. Which cheese is made from the whey left over from other cheeses? A) Mascarpone B) Cream cheese C) Ricotta D) Quark

17. What is the correct way to prepare cream cheese for a filling? A) Add the sugar first to break it up B) Soften it on low speed with a paddle before adding sugar, eggs, or liquids C) Whip it on high speed D) Freeze it first

18. Which cultured product has the SHORTEST storage life under proper conditions? A) Sour cream B) Yogurt C) Buttermilk D) All are equal

19. Compared with regular pasteurized heavy cream, ultra-pasteurized heavy cream: A) Has a shorter shelf life and whips more easily B) Has a longer shelf life but does not whip as easily C) Is identical D) Can be frozen without damage

20. Which has the HIGHEST fat content? A) Cream cheese B) Ricotta C) Mascarpone D) Clotted cream

21. Despite its "diet food" image, yogurt: A) Has the same milkfat as the milk it was made from B) Is always fat-free C) Has double the milkfat D) Has less fat because of the cultures

Chocolate and Cocoa

22. Natural cocoa works with baking soda because it is: A) Alkaline B) Acidic C) High in fat D) Treated with alkali

23. When you substitute dutched cocoa for natural cocoa, you: A) Add 30 g baking soda B) Increase baking powder by 30 g for each 15 g of soda omitted C) Add 15 g baking powder D) Change nothing

24. In 1828, Van Houten patented: A) Milk chocolate B) A hydraulic cocoa press C) The first chocolate bar D) Conching

25. Who made the first modern chocolate bar (1847)? A) Daniel Peter B) Henri Nestle C) Casparus van Houten D) Joseph Fry

26. Couverture contains how much cocoa butter? A) 10 to 15% B) 32 to 39% C) Exactly 50% D) 70 to 75%

27. Which product must be tempered? A) Compound chocolate B) Cookie coating C) Couverture D) Chocolaty coating

28. Which product is straight chocolate liquor with no sugar, also called block cocoa? A) Semisweet chocolate B) Unsweetened chocolate C) Cocoa powder D) Couverture

29. A product labeled "sweet chocolate" may contain as little as ___ chocolate liquor. A) 5% B) 15% C) 35% D) 50%

30. Which step comes IMMEDIATELY BEFORE pressing? A) Roasting B) Grinding C) Conching D) Cracking and winnowing

31. Which statement about white chocolate is correct? A) It contains cocoa solids B) It has 32% cocoa butter and is not considered real chocolate C) It must have 50% liquor D) It is the same as compound chocolate

32. If too much soda is used in a chocolate product, the color will be: A) Light brown B) Reddish brown C) Pale tan D) Black

Sugar and Sugar Cookery

33. Which sugar is the SWEETEST (sucrose = 100)? A) Sucrose B) Glucose C) Fructose D) Maltose

34. Caramelization of sucrose occurs at about: A) 120 to 150°C B) 160 to 180°C C) 215 to 235°C D) 300 to 310°C

35. The Maillard reaction requires: A) Sugar only B) Reducing sugars plus amino compounds C) Fat plus sugar D) Acid plus sugar

36. An example of an interferent that slows sugar crystallization: A) Adding acid B) Stirring vigorously C) Cooling very fast D) Adding more sugar crystals

37. Hygroscopicity is the ability of sugar to: A) Absorb moisture from the air, which can keep cakes moist but make candy sticky B) Dissolve in water C) Form crystals D) Brown at high heat

38. Caster sugar is preferred for meringues because it: A) Has larger crystals B) Has finer crystals and dissolves faster C) Contains molasses D) Is coarser

39. Which candy stage is used for FUDGE? A) Thread B) Soft ball C) Firm ball D) Hard ball

40. Which is a NON-crystalline candy? A) Fudge B) Fondant C) Divinity D) Toffee

41. In refining, the extracted cane or beet juice is clarified using: A) Lime and heat B) Acid and cold C) Centrifugation D) Molasses

42. Galactose is a component of: A) Sucrose B) Maltose C) Lactose D) Fructose

43. High sugar concentrations preserve food mainly through: A) Osmosis, drawing water from microorganisms B) Added acidity C) Fermentation D) Carbon dioxide production

44. Brittles are made at which stage? A) Soft crack B) Hard ball C) Hard crack (300 to 310°F) D) Firm ball

45. Sugar beet was identified as an alternative source of sugar in: A) 1493 B) 1747 C) 700 AD D) 500 BC

PART B: IDENTIFICATION (30 items)

Write the exact term. No choices given.

Fats and Oils

1. The process that turns liquid oils into solid fats.
2. A uniform mixture of two substances that do not normally mix, such as oil and vinegar.
3. Butter that has had its water and milk solids removed.
4. The type of margarine that is tough, waxy, and used for Danish dough and puff pastry.

5. The fat that is nearly 100% fat, is rendered from pork, and is prone to rancidity.
6. The term for any fat's ability to shorten gluten strands.

Milk and Milk Products

7. The process of holding milk at 161°F (72°C) for 15 seconds.
8. The process that breaks fat globules into tiny particles so cream does not rise.
9. The acid produced when bacteria convert lactose in cultured dairy products.
10. The enzyme, usually from calves' stomachs, used to coagulate milk proteins.
11. The German word for "curd," also the name of a fresh soft cheese.
12. The milk proteins that coagulate during cheesemaking.
13. The Italian region that mascarpone comes from.
14. The canned milk product with 60% of the water removed and NO added sugar.
15. The substance made by cutting, kneading, and cooking curds, then packing them into molds.
16. The cheese made from whey, used in cannoli and Italian cheesecake.

Chocolate and Cocoa

17. Cocoa that has been processed with an alkali.
18. The final step that smooths chocolate and drives off harsh acidic notes.
19. The process of carefully melting chocolate and then cooling it to a set temperature.
20. The fat pressed out of chocolate liquor, used to thin melted couverture.
21. The meaning of *Theobroma*.
22. What the Aztecs used cacao beans as.
23. The cocoa product made by grinding nibs, containing both cocoa solids and cocoa butter.

Sugar and Sugar Cookery

24. The malt sugar associated with grains.
25. An ingredient that prevents or slows sugar-crystal formation.
26. The process by which water is drawn out of microorganisms in high-sugar foods.
27. The candy stage at 215 to 235°F, used for syrups.
28. The type of candy with many small sugar crystals (fudge, fondant, divinity).
29. The two products yeast makes from fermentable sugars.

30. The method used to separate sugar crystals from molasses.

ANSWER KEY

Part A: Multiple Choice

#	Ans	Why (tricky bits)
1	D	Shortening 115°F beats lard 110°F, emulsified 100°F, butter 90°F
2	C	Emulsified shortening does NOT cream well
3	A	Watch the water and milk solids order
4	B	Salted butter has up to 2.5% salt
5	B	Margarine melts at a slightly HIGHER temperature than butter
6	B	Oil blends throughout, so gluten strands are shorter
7	C	Fats shorten gluten, they don't develop it
8	B	European or cultured butter
9	B	More air means faster rancidity
10	B	Lard is pork fat and goes rancid easily
11	A	Don't swap the 3.5 and 8.5
12	C	UHT is 280 to 300°F; ultra-pasteurization is 275°F for 2 to 4 sec
13	C	Half-and-half is 10 to 18% fat
14	A	Both are 60% water removed; sugar is the difference
15	B	Skyr is a fat-free cheese, not true yogurt
16	C	Ricotta, "re-cooked whey"
17	B	Soften first, then add sugar, eggs, or liquids

#	Ans	Why (tricky bits)
18	C	Buttermilk 2 wks, yogurt 3, sour cream 4
19	B	Ultra-pasteurized lasts longer but whips less easily
20	C	Mascarpone 70 to 75%, clotted cream 55%, cream cheese 35%, ricotta 4 to 10%
21	A	Yogurt has the same milkfat as its source milk
22	B	Acid plus soda gives leavening
23	B	30 g baking powder for every 15 g soda omitted
24	B	The press; Dutching came with it
25	D	Fry 1847; Peter and Nestle made milk chocolate in 1875
26	B	Couverture is 32 to 39% cocoa butter
27	C	Compound and coating chocolates do NOT need tempering
28	B	Unsweetened chocolate = straight liquor
29	B	Semisweet and bittersweet need at least 35%
30	B	Grinding makes the liquor, which is then pressed
31	B	White chocolate has no cocoa solids
32	B	Too much = reddish brown
33	C	Fructose 173
34	B	160 to 180°C. Maillard is 120 to 150°C
35	B	Maillard needs amino compounds; caramelization is sugar alone
36	A	Acid is the interferent example from your handwritten note
37	A	Good in baked goods, bad in candy
38	B	Finer crystals dissolve faster
39	B	Soft ball 235 to 240°F; firm ball is caramel

#	Ans	Why (tricky bits)
40	D	Toffee is non-crystalline; the others are crystalline
41	A	Lime and heat
42	C	Lactose is glucose plus galactose
43	A	Osmosis
44	C	Hard crack makes brittles; soft crack makes taffy
45	B	1747. 1493 was Columbus

Part B: Identification

1. Hydrogenation
2. Emulsion
3. Clarified butter
4. Pastry margarine
5. Lard
6. Shortening (any fat acts as a shortening because it shortens gluten strands)
7. Pasteurization
8. Homogenization
9. Lactic acid
10. Rennet
11. Quark
12. Casein
13. Lombardy (Lombard region)
14. Evaporated milk
15. Green cheese
16. Ricotta
17. Dutch-process (dutched) cocoa
18. Conching
19. Tempering
20. Cocoa butter
21. "Food of the gods"

22. Currency
23. Chocolate liquor
24. Maltose
25. Interferent (example: acid)
26. Osmosis
27. Thread stage
28. Crystalline candies
29. Carbon dioxide and alcohol
30. Centrifugation

How to score yourself

- **Part A:** 1 point each (45 points)
- **Part B:** 1 point each (30 points)
- **Below 80%?** Reread the Quick Review table and redo only the items you missed.