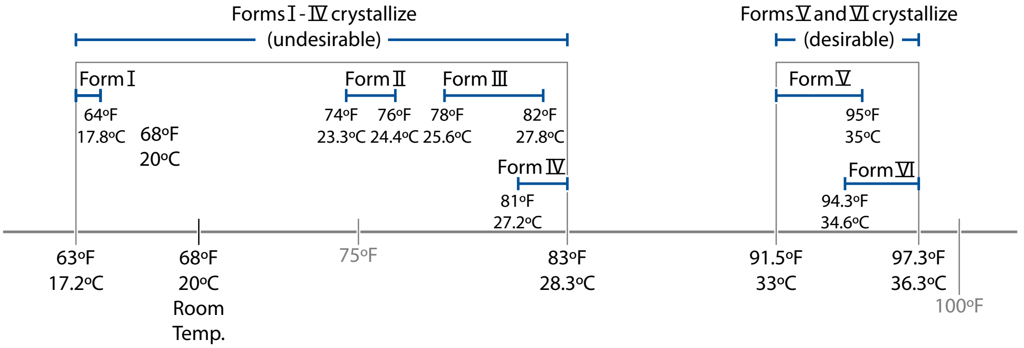
When chocolate is melted and tempered, it's the cocoa fats that actually melt. Cocoa solids don't melt, so it's not technically accurate to say "melting chocolate." You temper chocolate by melting and then selectively solidifying the fats in cocoa fat. It can be an intimidating and finicky process. The traditional method is to heat the chocolate above 110°F / 43°C, then cool it to around 82°F / 28°C, and then reheat it to between 89°F / 31.5°C and 91°F / 32.5°C. Once it's at this temperature, you must perform a thermal balancing act: too warm, you lose the temper; too cold, it hardens. Making great chocolate requires a great understanding of temperature, whether you use a good thermometer or careful observation (~90°F / 32°C happens to be just about the temperature of your lips).

But where do these temperatures come from? Cocoa fat can solidify into a crystalline structure in six possible different forms, based on how the fatty acids in the triglycerides are arranged, and each one of those forms melts at a slightly different temperature. The key to tempering is in changing how the fats crystallize; once melted, they can recrystallize into any of the six forms. It's for this reason that tempering works at all. Tempering coerces the fats to solidify into the desired structure; in a properly tempered chocolate 3–8% of its mass consists of "good" cocoa fat crystals.



Melting points of the six polymorphs of cocoa fat.

Good cocoa fat crystals come in two forms, called Form V and Form VI. (The standard classification comes from a 1966 research paper; other researchers call these two forms $beta_2$ and $beta_1$ crystals.) These two versions can crystallize into a tighter grid, creating a firmer structure that gives chocolate a pleasing smoothness and firm snap when broken. (This has to do with the shape of the triglycerides of Forms V and VI, which can pack together more tightly than the other forms.) The other four crystalline structures, Forms I–IV, lead to a softer, chewier texture.

Chocolate can go bad (the horrors!) if exposed to extreme temperature swings, which will slowly convert the good cocoa fat crystals to Forms I–IV. Such chocolate is described as having *bloomed*, having a splotchy appearance and a gritty texture. Blooming happens because about a quarter of the cocoa fat is still liquid at room temperature, and with subtle changes in temperature over time those liquid fats can migrate to the surface, recrystallizing the good fats in the process. (If the entire bar just crumbles up like chalk, then the sugar has bloomed from moisture. Melt the whole bar and retemper it, and store it in a drier place next time.)

Like most natural fats, the fats in cocoa butters are a mix of different types of triglycerides (mostly made up of stearic, oleic, and palmitic acids). Plus, the *T. cacao* plants don't all grow exactly the same. Chocolate from beans grown at lower elevations, for example, will have a mixture of fats with a slightly higher melting point than chocolate from beans grown at higher, cooler elevations. Still, the temperature variances are relatively narrow, so the ranges used here will generally work for dark chocolates. Milk chocolates require temperatures about 2°F / 1°C cooler; the additional ingredients affect the melting points of the different crystalline forms. When looking at chocolate for tempering, make sure it does not have other fats or lecithin added because these ingredients will also affect the melting point—more than about 0.5% lecithin will greatly slow down the tempering rate.

Luckily for chocolate lovers worldwide, chocolate has two quirks that make it so enjoyable. For one, the undesirable forms of fat all melt below 90°F / 32°C, while the desirable forms noticeably melt around 94°F / 34.4°C. If you heat the chocolate to a temperature between these two points, the undesirable forms melt and then solidify into the desirable form. The second happy quirk is a matter of simple biology: the temperature of the inside of your mouth is in the range of 95–98.6°F / 35–37°C, just above the melting point of tempered chocolate, while the surface temperature of your hand is below this point.

Traditional tempering works by melting all forms of fat in the chocolate, cooling it to a low enough temperature to trigger nucleation formation (i.e., causing some of the fat to crystallize into seed crystals, including some of the undesirable forms), and then raising it to a temperature high enough to melt Form I–IV crystals but cool enough for Forms V–VI to crystallize. This three-temperature process requires a watchful eye and, during the second and third steps, stirring to encourage the crystals to form while keeping them small.

What causes seized chocolate?

Assume you haven't been caught smuggling chocolate between countries, *seized chocolate* is what happens when a small amount of moisture gets mixed into the cocoa solids and fats. Think of what happens when a few drops of water are mixed into dry sand: it clumps up. It's exactly the same with chocolate. The cocoa solids are like the sand, but instead of being surrounded by air, they're surrounded by fat. Try pinching some cocoa powder between two dry fingers and rubbing; it'll be smooth. Add a tiny amount of water and it seizes up; add a bit more water, and it's back to being smooth. If you get water in your chocolate, you'll have to mix in more liquid—about 20–40% by weight depending upon the amount of cocoa solids present—for the mixture to be able to flow again. You'll be stuck with chocolate that won't solidify, but it's great for making ganache (see page 281)!

Some tempering methods call for adding chopped-up chocolate at the second temperature point to rapidly seed the chocolate; this also accelerates cooling, which can be useful. It's also possible to temper small amounts of already-tempered chocolate (bars, not chocolate chips, which won't be tempered—that's why they're cheaper!) by bringing it directly up to ~90°F / 32°C, either with careful control in a microwave (nuke for 10-second intervals, stirring each time, and make sure that temperature doesn't exceed 92°F / 33.3°C) or in a water bath (see page 339).

To make tempering easier, use *couverture* chocolate (couverture is French for "cover"); this is chocolate used for covering other foods like fruits or cakes that is easier to temper due to a higher percentage of cocoa fats. In the EU, couverture chocolate must be at least 31% cocoa fat (not cocoa solids!); the US has no legal definition. With more cocoa fats in the mix, it's easier to get a sufficient quantity to correctly crystallize and give the right metastructure. If you can't find it, or you enjoy the experimentation process, buy cocoa fat and add 10% by weight to your chocolate as it melts. Make sure you buy cocoa fat and not white chocolate, which is only ~20–25% cocoa fat!