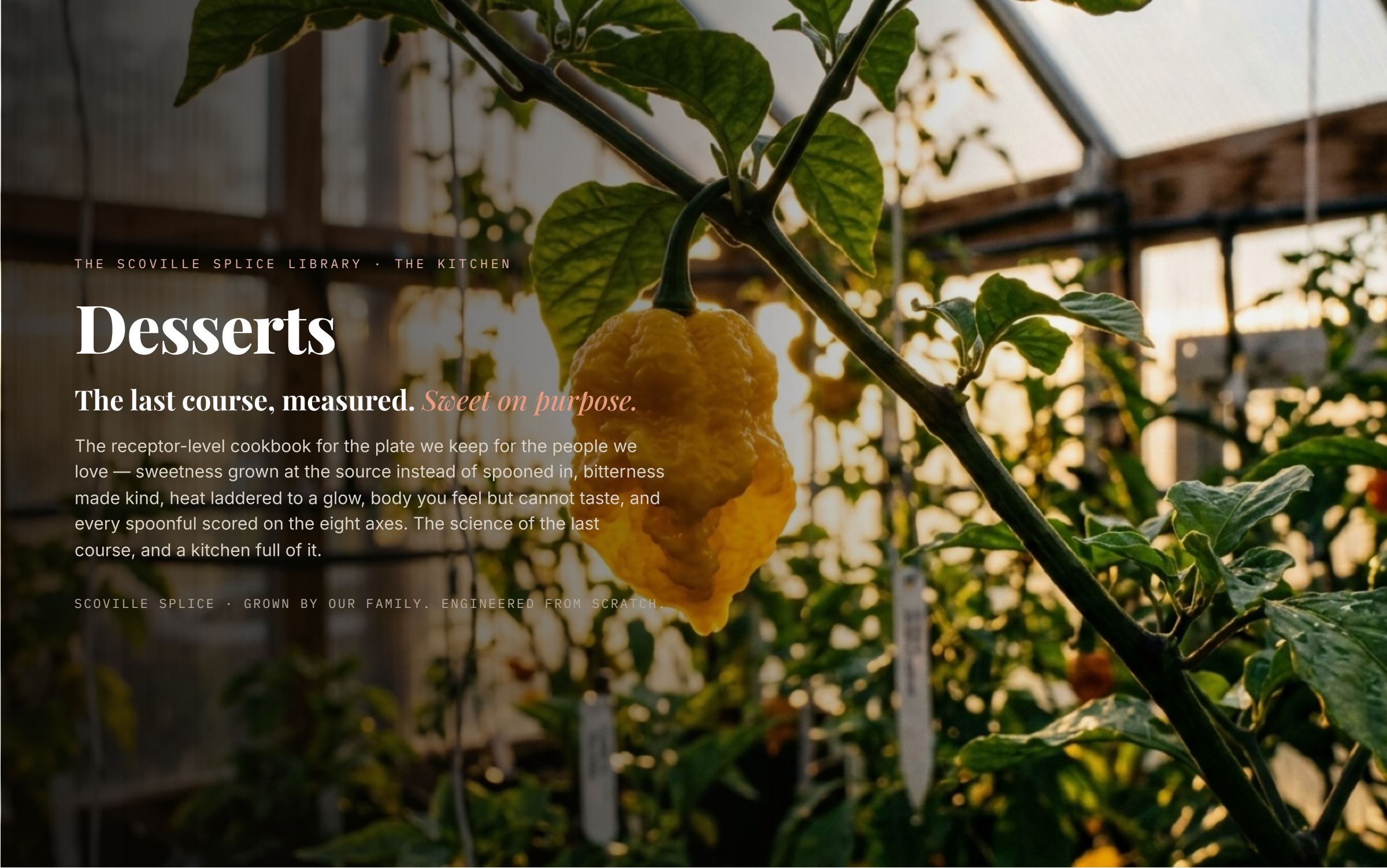

THE SCOVILLE SPLICE LIBRARY · THE KITCHEN

Desserts

The last course, measured. *Sweet on purpose.*

The receptor-level cookbook for the plate we keep for the people we love — sweetness grown at the source instead of spooned in, bitterness made kind, heat laddered to a glow, body you feel but cannot taste, and every spoonful scored on the eight axes. The science of the last course, and a kitchen full of it.

SCOVILLE SPLICE · GROWN BY OUR FAMILY. ENGINEERED FROM SCRATCH.

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Opening essay · The case for a designed dessert

Dessert is the course we keep for the people we love. The savory plates do the day's work — they feed, they fuel, they settle an argument about what to cook. The last plate does none of that. It exists for no reason but pleasure, set down in front of someone for the single purpose of giving them something good, and that uselessness is exactly its dignity. It is the one course that is purely a gift. Which is precisely why, in our family, it is the course most worth designing with care — because the things we make for love are the things we should make most deliberately, not least.

For most of its history, dessert had a single lever. If you wanted it sweeter you added sugar; if you wanted it richer you added cream; if it fell flat you added more of both. The whole vocabulary of the last course came down to a sack and a churn, and it worked — it still works, and some of the recipes in this book lean on butter and cream without apology, because sometimes richness is the honest answer. But a single lever is a poverty disguised as a tradition. It asked one axis of taste to carry an entire plate, and it asked the body to pay, in load, for every increment of joy. We think the last course deserves more range than that, and more kindness.



The greenhouse at first light, where most of our best obsessions arrive before breakfast — including the one that became this book.

We are a family of scientists, and we grew up at a table where *why does this taste like this* was never rhetorical — someone would get up and go look. One pair of hands in this family does the computing; the whole family does the growing, the cooking, the arguing over whether a custard is set. This is the thirty-sixth book in a library built on one idea: that a flavor can be *measured* — not merely described, measured — against the half-activation of the receptor it speaks to. The Iyengar Flavor Index assigns every taste a single number anchored to EC_{50}, the concentration at which a stimulus drives its receptor to half of its full response. Invert that against a fixed reference, scale by a thousand, and loudness becomes a score. Eight axes. We have tuned forty-two plants to speak one or more of them on command, written roughly nineteen thousand constructs,

and shipped a thousand of them live and purchasable today. We can read a strawberry, a coffee bean, and a square of dark chocolate on the same page now — and, more to the point of this book, we can design what each of them does at the end of a meal.

Here is the discovery that turns dessert from a one-lever craft into the most completely addressable course there is: almost every axis the Index measures has a home on the dessert table. Sweetness, obviously — but sweetness is only the lead. **Bitterness** (TAS2R38) is the thing that makes coffee and dark chocolate beautiful and difficult, and it can be turned down twenty to sixty-five percent, to the exact place where the roast is all flavor and none of the wince. **Kokumi** (CaSR) is the body of a custard, the roundness a taster calls *weight* and cannot name, and it can be grown into a cream so that less fat carries more mouthfeel. **Heat** (TRPV1) can be laddered so far down that it stops reading as heat at all and reads instead as *more fruit*. **Cool-burn** (TRPM8) can set ice against that fire on the same spoon. **Pungency** (TRPA1) is the bright ginger-and-cinnamon sharpness of a spiced bake. **Astringency** (the salivary proteins) is the dry tannic finish that keeps a sweet from cloying and gives it a spine. Even **umami** (mGluR1) has a quiet floor in a good matcha. Eight pathways, eight numbers, and dessert — the plate we thought was only sugar — turns out to answer to nearly all of them.

And sweetness itself, the lead, is not even the hardest axis to move. It is a duet: the **TAS1R2** and **TAS1R3** receptors clasp together, and only when both halves are moved does the brain hear *sweet*. Grow a plant's own signal — the steviol glycosides of stevia, the mogrosides of monk fruit, a brazzein-class sweet protein, the native sugars of sugarcane amplified at the source — and a dessert tastes fully, roundly sweet while the body registers almost nothing of the load that sweetness used to cost. The tongue is told the truth. The blood is told very little. For a family that believes in feeding people gently, that is where every dessert in this book begins and what it quietly keeps faith with throughout.

A promise about that word *gently*, made once here and then left to hum under the rest of the book rather than preached: we did not write this to make dessert *healthy*. Healthy is not a word we use at the table, and there are no cures in these pages, no detox, no health halo. We wrote this to make dessert *deliberate* — grown with intention, scored with honesty, and given to the people we love the way the last course was always meant to be given, which is with care. Every recipe here rests on a plant tuned toward what it was meant to be, and every one carries its IFI readout, so you can taste the intention and read it in the same breath. The number is never the point. The giving is the point. The number is only how we keep the giving honest.

Let us begin where every dessert begins, whether the cook knows it or not: with two proteins on the tongue that must agree before a single thing can taste sweet.

Chapter 1 · The sweet clasp — *two proteins that must agree.*

AXIS 01 · IFI-S · TAS1R2·TAS1R3

Taste the first spoonful of anything in this book and you set off a handshake. Not a single lock turning — a handshake, which is to say an event that requires two parties and fails if either is missing. There is no solitary "sweet receptor" waiting on the tongue for sugar. There is **TAS1R2**, and there is **TAS1R3**, two large proteins that sit side by side in the membrane of a specific set of taste-receptor cells, and only when they come together into one clasped unit — a **heterodimer** — can the tongue report *sweet*. One protein alone hears almost nothing. The pair, joined, is the most generous and most promiscuous detector in the mouth, and understanding it is the foundation of every dessert that follows, because everything we do to sweetness we do to this clasp.

Both halves belong to the **class C G-protein-coupled receptors**, a family whose architectural signature is a huge extracellular structure called the **Venus flytrap domain** — two lobes hinged like a clam, named for the plant because they close around what they catch. TAS1R2 carries the flytrap that most sugars fall into. Glucose, fructose, sucrose, and the small synthetic sweeteners such as sucralose and aspartame settle into the cleft between its two lobes; the flytrap closes around them; and the motion of that closing is relayed down through a cysteine-rich linker to the seven-helix transmembrane bundle buried in the membrane. There, on the inner face of the cell, a G-protein named **gustducin** has been waiting.

What happens next is worth naming in full, because it is the machinery every sweet, bitter, and umami taste on the tongue shares in its final steps, and because knowing it tells you why sweetness can be delivered by so many different molecules. The closing flytrap activates gustducin; gustducin releases and fires an enzyme called **phospholipase C-β2 (PLCβ2)**; PLCβ2 cleaves a membrane lipid to release **inositol trisphosphate (IP_3)**; IP_3 opens calcium stores inside the cell and the internal calcium rises; the rising calcium opens a channel called **TRPM5**; the cell depolarizes; and the nerve fires. The receptor that *catches* the sweetness is specific — it is the flytrap of TAS1R2. But the wire that *carries* the signal is generic, shared with the bitter and umami cells, which transmit over the identical cascade. This is the single most important fact about sweetness, so we will state it plainly: the *quality* "sweet" lives entirely in the receptor and not in the nerve behind it. The brain does not taste the molecule. It tastes which receptor fired. And that means if you can move the receptor, you can deliver the full, honest experience of sweetness by *any* molecule that fits it, with no sugar required at all.



Sugarcane — sweetness as the plant itself makes it. The design question is never whether the clasp can be moved, but by what, and at what cost to the body that eats it.

That the clasp can be moved without a grain of sugar is the sentence the whole sweet half of this book hangs from, so let us make it concrete, because the receptor turns out to have not one door but several. Sugars key the flytrap of TAS1R2 directly, settling into the cleft between the lobes. The intensely sweet *proteins* — brazzein, monellin, thaumatin — do not fit any sugar's pocket; they are hundreds of times too large. Instead they appear to engage the receptor the way a wedge engages a closing clam, binding across the outer surface of the flytrap and the cysteine-rich domain and stabilizing the whole clasp in its closed, firing conformation. The sweet-tasting *diterpene glycosides* of stevia and the *triterpene glycosides* of monk fruit find their own distinct footholds on the receptor's surface. And the transmembrane bundle itself carries yet another site — where the sweetener cyclamate binds, and where, remarkably, the sweetness *blocker* lactisole binds to shut the entire receptor off. One receptor, several keyholes, and a brain downstream that cannot tell which door was opened: it hears *sweet* and asks no further questions. On the Index, IFI-S climbs from the quiet sweetness of a ripe pea near **120** to engineered stevia above **3,000** — a bright, coreless sweetness carried by a molecule the body barely metabolizes.

This is the gift the sweet clasp gives dessert, and it is a specific, mechanical gift: **you can raise IFI-S without raising the sugar.** For most of culinary history the sweetness of a dessert and its sugar load were the same quantity, because the only way to move the clasp was to pour sucrose at it. Sweetness and calories were a single dial, welded together, and every increase in one was an increase in the other. Design the sweetness at the source — a steviol glycoside tuned in stevia, a mogroside amplified in monk fruit, a brazzein-class protein, the native sugar of sugarcane pushed higher, the sweetness bred back into a tomato or a melon that modern agriculture bred out — and the receptor hears sweetness in full while the body reads almost nothing of what that sweetness used to cost. The dial comes loose from the sugar. Hold that image, because every chapter that touches sweetness depends on it: a sweetness you can turn up freely, to meet a heat or balance a bitterness or carry a whole cake, without the plate growing heavier as it grows sweeter.

We are careful with this half of the Index, and we will say why plainly, because it is the quiet center of why we build the way we do. A sweetness read from the *shape* of a signal rather than from a load of sugar is the gentlest way we know to keep a dessert joyful and still kind to the body that receives it. We make no claim of it — not here, not anywhere. We simply build it that way, because it is how we would want to be fed, and because the last course, the one made purely of love, is exactly the plate on which that care should be most visible and least spoken. The fire and the spice will get the attention in later chapters. The sweetness, built with intention, is the part that quietly takes care of you while you enjoy the rest.

Chapter 2 · The number for a dessert — *EC50, the Hill curve, a profile to read.*

the mathematics of the last course

We have used the word *measured* a dozen times already, and a family of scientists does not get to use that word for free. Let us earn it — and then do the thing that makes this a book and not a wish, which is to turn a dessert from a matter of opinion into a matter of coordinates. Everything in this library hangs from one formula, and it is worth writing out slowly, because once you have it, "is this sweet enough?" stops being an argument and becomes a reading.

> **IFI(candidate) = 1,000 × EC_{50}(reference) ÷ EC_{50}(candidate).**

EC_{50} is the half-maximal effective concentration — the amount of a stimulus required to drive its receptor to half of its full response. It is the honest measure of *potency*, because it asks not "how much of this compound is present" but "how little of it does the receptor need in order to hear it." A molecule with a low EC_{50} is loud: the receptor answers a whisper of it. A molecule with a high EC_{50} is quiet: it takes a shout. The Index inverts the candidate's EC_{50} against a fixed reference's, so that potency — loudness — becomes the quantity scored, and multiplies by a thousand to land ordinary flavors in a human range. A score of 1,000 means the candidate is exactly as loud as the reference. A score of 2,000 means it is twice as potent — the receptor reaches half-response at half the concentration. Per axis, we normalize to a ceiling of **5,000**, so every number in every readout in this book sits on the same bounded scale.



Every readout in this book begins at a bench like this one — where a receptor's half-response is a number on an instrument before it is ever a sensation on a tongue.

The reason we anchor to EC_{50} and not to "how much sugar is in it" is the quiet rigor beneath the whole Index, and it matters enormously for dessert, where the molecules span an almost absurd range of

potency. Receptors do not respond to a stimulus in a straight line; they respond along an S-shaped curve the pharmacologists write as the **Hill equation**:

```
response = R_max × [c]ⁿ ÷ (EC₅₀ⁿ + [c]ⁿ)
```

where [c] is the stimulus concentration, *n* is the **Hill coefficient** that sets how steeply the response climbs, and EC_{50} is exactly the concentration at which the response reaches half of its maximum, R_max. EC_{50} is the one point on that curve that does *not* depend on how much stimulus a given spoonful happens to carry; it is a property of the molecule-meets-receptor pairing itself. Anchoring to it means a score reports how *loudly a flavor speaks*, independent of the serving — which is the only reason a pinch of a sweet protein and a spoon of sugar can be placed on one comparable scale at all.

Let us run the arithmetic on sweetness, because the span is the whole lesson. Take **sucrose** as a soft agonist of the TAS1R2 flytrap: pleasant, familiar, but requiring a great deal of itself to half-saturate the clasp — an EC_{50} up in the tens of millimolar. Now take **thaumatin**, a sweet protein that half-saturates the same receptor at *nanomolar* concentrations — roughly a millionfold lower, a millionfold louder by mole. Put a designed sweetener at an EC_{50} a hundredth of sucrose's into the formula and the result is a number you can taste against the reference:

```
IFI-S = 1,000 × (EC₅₀ sucrose ÷ EC₅₀ candidate) = 1,000 × 100 =
well past the 5,000 ceiling — which is why we report engineered
stevia at a normalized IFI-S above 3,000, loud and clean,
rather than at the raw ratio.
```

This is why "sweetness" and "sugar" are not the same quantity at all, and why a teaspoon of a designed sweetener can do the work of a quarter-cup of sugar. The Index reads the loudness, not the mass — which is exactly what lets us lift the sweetness on a nutrition panel while the grams of sugar fall.

The Hill coefficient is not a footnote for the dessert cook, either; it is why some sweets *arrive* and some *linger*. A steep *n* means a sensation that comes on suddenly and saturates fast; a shallow *n* means one that eases in across a wide range of concentration and resolves slowly. Sugars climb gently. The sweet proteins, whose binding is slow to clear, linger — their sweetness stays on after the bite, which is a gift in a cushioning dessert and a flaw in a bright one. Heat (TRPV1), as we will see, is steep — it blooms and commits. "The sweetness eases in and the heat comes on fast" is not a metaphor about a chili-chocolate; it is two Hill slopes crossing in the mouth, and a cook who knows that can *place* the crossing on purpose.

Here is the move that makes this a book about dessert and not a book about one axis. Once every axis — sweet, bitter, heat, cool, kokumi, pungency, astringency, umami — is scored on the same EC_{50}-anchored scale, they share a currency, and a shared currency

lets you read a *profile*: not sweetness alone, but sweetness *in relation to* the bitterness it sits against, the kokumi holding it up, the astringency keeping it honest. A dessert's IFI readout is a small radar of the whole mouth, eight numbers describing one spoonful, and the recipes in this book each carry theirs so you can taste the dish and read its coordinates in the same breath. The old recipe could tell you *sweet*. It had no units for anything else on the plate, and no way to say how the sweet and the bitter and the body were balanced against one another. The Index does for the last course what a thermometer did for the word *hot*: it ends the guessing, not by denying the pleasure but by anchoring it. Every number in every readout that follows is that anchor. Learn to read the small radar and you will never again be at the mercy of a dessert that worked once and never again — you will know *why* it worked, which is the only thing that lets you make it work twice.

Chapter 3 · The seven the last course borrows — *a table set with eight receptors.*

IFI-B · IFI-K · IFI-H · IFI-C · IFI-P · IFI-A · IFI-U

Sweetness leads the last course, but it has never done the work alone — not in any dessert worth remembering. The great sweets are great because of what stands *behind* the sugar: the bitter depth of coffee, the tannic grip of dark chocolate, the roundness of a proper custard, the warmth of a spiced bake, the cool shock of mint against something warm. A dessert made of sweetness and nothing else cloys by the second bite, because the tongue, told the same thing over and over, stops listening. What keeps a sweet alive is the other axes, present and measured, holding the sweetness up. This chapter is a tour of the seven the last course borrows — the receptors beyond the sweet clasp — so that the parts ahead have a shared map. Each is a whole volume elsewhere in this library; here we name what each one does when it arrives at dessert.



Phoenix, the one cultivar we ever designed to register on all eight axes at once — the clearest proof that a flavor is most complete when no single axis stands alone. A dessert borrows the same principle.

Bitterness — IFI-B — the TAS2R receptors. Bitterness is the tongue's alarm system: a family of roughly twenty-five **TAS2R** receptors, the best known of them **TAS2R38**, evolved to warn us off alkaloids and other potential poisons before we swallow. Coffee and dark chocolate are loved *despite* this alarm — their beauty and their difficulty are the same signal. The platform does not remove bitterness; it *attenuates* it, twenty to sixty-five percent, down to the exact place where the roast is all aroma and none of the wince. In

dessert this is a quiet revolution, because a coffee or chocolate sweet made with attenuated bitterness needs far less sugar to be loved — the sugar is no longer paying to hide anything. Part III is built on it.

Kokumi — IFI-K — the calcium-sensing receptor (CaSR). Kokumi is the strangest axis and the dessert cook's secret, because it has no flavor of its own. It is mouthfeel made molecular: γ-glutamyl peptides reaching the **CaSR**, giving a custard continuity, roundness, the sense that it fills the whole mouth and stays a moment after it is gone. A taster calls it *body* and cannot name it. Grown into vanilla and cream, kokumi lets a dessert carry the weight of one made with twice the fat, at half the heaviness in the eating. Part IV is its home.

Heat — IFI-H — TRPV1. Capsaicin does not warm the tissue; it opens the channel that *reports* warmth, dragging TRPV1's thermal threshold down so your own body heat reads as fire. Laddered far down — below the point where the tongue files a sensation under *hot* — that same signal stops being heat and becomes *lift*, the way a pinch of salt lifts, the way warmth makes a ripe thing smell riper. The dessert frontier lives here. Part V opens on it.

Cool-burn — IFI-C — TRPM8. TRPM8 is heat's mirror: the channel that answers to temperatures *below* about 26 °C and, chemically, to menthol — the sensation of cool with no drop in temperature. It is the rare axis that can make a dessert feel like weather. Set against a trace of heat on the same spoon, it produces the fire-and-ice that the mouth cannot resolve and does not want to. Part V again.

Pungency — IFI-P — TRPA1. Pungency is heat's quick cousin on a different channel. Where capsaicin lingers, the cinnamaldehyde of cinnamon and the gingerols of ginger *flash* at **TRPA1** — a bright front-of-mouth warmth, sharp and then gone, the smell of a cold-month kitchen made edible. It is the whole soul of a spiced bake. Part V closes on it.

Astringency — IFI-A — the salivary proteins. Astringency is the one axis that works on the *mouth itself* rather than on a receptor's chemical sense: tannins and polyphenols binding and precipitating the saliva's **proline-rich proteins (PRPs)** into a clean, gripping dryness. Most desserts fear it. We think the best ones need it — a sweet with no astringency has no spine; it goes round and flat and cloys. A measured dryness, from tea or grape or pomegranate, is the thing that keeps you reaching for the spoon. Part VI is built on it.

Umami — IFI-U — mGluR1 and TAS1R1·TAS1R3. Umami rarely leads a dessert, but it has a floor there all the same — the quiet savory depth of a good matcha, the faint roundness glutamate gives. We note it where it belongs and let it stay quiet. It is a reminder that the eight axes do not switch off at the end of a meal; they only change who leads.

Now hold all eight at once, because this is the thesis of the book and the reason the last chapter exists. Once, in this library, we designed a single cultivar to register on every one of these axes simultaneously — **Phoenix**, the first full-spectrum organism in history, its heat towering while seven other pathways kept it company in proportion. We would never put that fruit in a dessert.

But its lesson belongs at the front of this one: **a flavor is most complete when no single axis stands alone.** A dessert, read on the Index, is not a sweetness with decorations. It is a small composition — a lead and its company, eight possible voices of which a few are singing and the rest are holding — and the cook who can read all eight can build a last course with the completeness of a chord instead of the flatness of a single note. The parts that follow take the axes one movement at a time; the final part composes them back into one plate. Sweetness first, though — grown, not spooned — because it is the lead, and because it is where the whole kindness of this kitchen begins.



PART II OF VII

The Sweetness You Grow

IFI-S · TAS1R2·TAS1R3 · sugars · glycosides · sweet proteins · sweetness at the source

Chapter 4 · The sweet repertoire — *sugars, glycosides, proteins.*

IFI-S · the molecules that move the clasp

The fire that later chapters play with has one feedstock and one keystone enzyme. Sweetness has a *repertoire* — a whole cast of molecules, wildly different in size and chemistry, that all fit the same clasp and all read, to the brain, as the one word *sweet*. Knowing the cast is the beginning of grown-up dessert cooking, because each member brings a different accent, a different EC_{50}, a different relationship to the sugar load, and a different cost to build and to eat. The sugar bowl was one note played loudly. The repertoire is a chord you can voice.

Start with the sugars, because they are the standard the rest are measured against. **Sucrose** — glucose and fructose joined — is the reference sweetness of the human table, and in receptor terms it is a *soft* agonist of the TAS1R2 flytrap: clean, familiar, forgiving, but requiring a great deal of itself to half-saturate the clasp (an EC_{50} up in the tens of millimolar). That softness is why sugar is sweetness you can eat by the spoon, and also why sugar is sweetness that arrives with a heavy load — in sucrose, potency and calories are the same quantity. **Fructose** is louder and rounder on the tongue; **glucose** quieter. Every honey and syrup a dessert has ever leaned on is some ratio of these three, carried with the aromatics of whatever plant made them. There is nothing wrong with sugar — it builds structure a sweetener cannot, as the meringue below will show — but there is everything limiting about sugar as the *only* source of sweet.



Monk fruit, halved — mogroside V, a cucurbitane triterpene glycoside, delivers a sweetness hundreds of times louder than sucrose from a molecule the body barely takes up.

Now the loud ones, where potency and calories finally come apart. The **steviol glycosides** of *Stevia rebaudiana* — stevioside, rebaudioside A, and the prize, rebaudioside M — are **ent-kaurene diterpenes** dressed in sugar groups; they key the clasp at a potency on the order of two to three hundred times sucrose by weight, and pass through the body largely unmetabolized. The **mogrosides** of monk fruit — mogroside V chief among them — are **cucurbitane**

triterpene glycosides that do the same from a different molecular scaffold, with a rounder, fruitier character. And then the extraordinary ones, the **sweet proteins**: **brazzein** (just 54 amino acids, from a West African fruit, and remarkably heat-stable — it survives a bake), **monellin** (from the serendipity berry), and **thaumatin** (207 amino acids, the sweetest known substance by weight, thousands of times sucrose). These do not fit any sugar pocket — they are far too large — but engage the clasp as a wedge across its outer surface, holding the flytrap in its firing conformation. A few milligrams read as a spoonful.

Here is the repertoire as a scale of loudness and as the real engineering targets we have built against, with construct counts drawn straight from the platform:

SWEET SOURCE	KEY MOLECULE(S)	ROUGH LOUDNESS VS. SUCROSE	OUR PLATFORM WORK
Sucrose (reference)	glucose–fructose	1×	the anchor
Sugarcane	native sucrose, amplified	~1× (more per stalk)	Sugarcane · **200** constructs
Stevia	rebaudioside M / A	~200–350×	Stevia · **910** constructs
Monk fruit	mogroside V	~150–250×	Monk Fruit · **80** constructs
Brazzein	brazzein protein	~500–2,000×	sweet-protein route
Thaumatin	thaumatin protein	~2,000–3,000×	sweet-protein route

The practical lesson of the table for the dessert cook is that the sweet lead is not one knob but a *palette*, and choosing the molecule is choosing the character of the whole plate. **Stevia** reaches highest and cleanest — engineered to an IFI-S above **3,000** — a bright, coreless sweetness with almost no body; it is the sweetness that carries a sorbet without weighing it down. **Monk fruit** rounds that, warmer and fruitier, flattering a chocolate. **Sugarcane**, amplified at the source, carries the familiar soft sweetness of the thing itself with its own character intact, which a caramel wants. And the **sweet proteins** bring a sweetness that *lingers* — their binding is slow to clear — which is a cushion in a brooding dessert and a distraction in a crisp one. The repertoire lets you match the sweet molecule's timing to the dish: a sweetness that arrives and resolves for a fruit plate, a sweetness that stays and holds for a dark custard.

One honest complication, because the voice of this library requires it and because it leads straight into the next chapter. Some of the loud sweeteners carry a *tail*. Crude stevioside in particular is famous for a bitter, licorice-like aftertaste — a real off-target, caused when the molecule also keys a couple of the bitter **TAS2R** receptors (notably TAS2R4 and TAS2R14) a beat after the sweetness. That tail is not sweetness; it is a second axis arriving uninvited, and in a dessert — where the sweetness is supposed to be the kind, clean thing — it is exactly the flaw you cannot allow. It is also exactly the kind of problem the platform exists to solve. Before we cook, two recipes to

prove the repertoire: one that needs the sugar for its structure and borrows a sweetener for its sweetness, and one that leans on the designed sweetness entirely.

Swiss Meringue, Honest About Its Sugar

Makes enough for a pavlova or 24 kisses · 30 minutes plus a slow oven · where sugar does a job a sweetener cannot

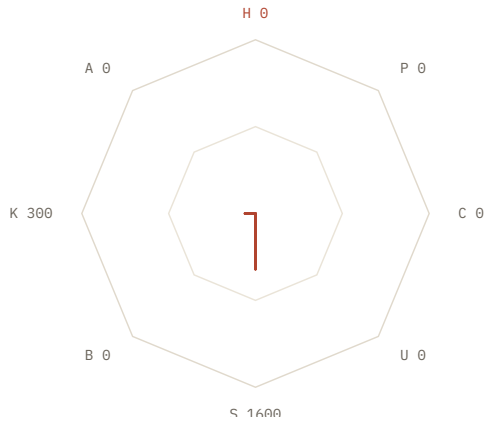
We open the recipes of this book with a confession, because the voice of the library is honesty before cleverness: a meringue *needs* sugar, and not for its sweetness. The sugar is structural — it dissolves into the whipped egg white and holds the foam's water, stabilizing the protein network into something that bakes crisp. A pure high-potency sweetener, present in milligrams, cannot build that scaffold. So we do the grown-up thing: keep enough sugar to do the structural work, and let a designed sweetener carry the rest of the sweetness, so the meringue is lighter on load than the all-sugar original without collapsing.

```
4          egg whites, room temperature
120  g     caster sugar (the structural minimum)
2    tbsp  engineered stevia or monk-fruit sweetener (to IFI-S ~1,600)
1    pinch cream of tartar · 1 pinch fine salt
1    tsp   vanilla, kokumi-rich if you have it
```

1. Set a bowl over barely simmering water. Whisk the whites, caster sugar, cream of tartar, and salt together constantly until the sugar has fully dissolved and the mix is hot to a fingertip — about four minutes. Rubbed between two fingers it should feel smooth, not grainy.
2. Lift off the heat and whip on high to a stiff, glossy meringue that holds a firm peak. Whip in the sweetener and the vanilla at the very end.
3. Pipe or spoon onto lined trays. Bake low and slow at 100 °C for 60–90 minutes, until they lift cleanly and sound hollow, then cool in the turned-off oven.

Why it works — The 120 g of sucrose is doing physics, not flavor: dissolving into the albumen, raising its viscosity, and locking the foam so it dries crisp instead of weeping. The high-potency sweetener does the *sweetness*, carrying IFI-S to a bright 1,600 on milligrams rather than grams. The result is a meringue that reads fully sweet on far less total load than the classic — honest about where sugar is irreplaceable and where it is not.

IFI PROFILE



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IFI-P		0
IFI-C		0
IFI-U		0
IFI-S		1,600
IFI-B		0
IFI-K		300
IFI-A		0

The kokumi is a whisper from the vanilla; everything else is the clean, high sweetness. Crush over the berries of Chapter 15, or sandwich with the vanilla custard of Chapter 10.

The Three-Minute Sorbet Base

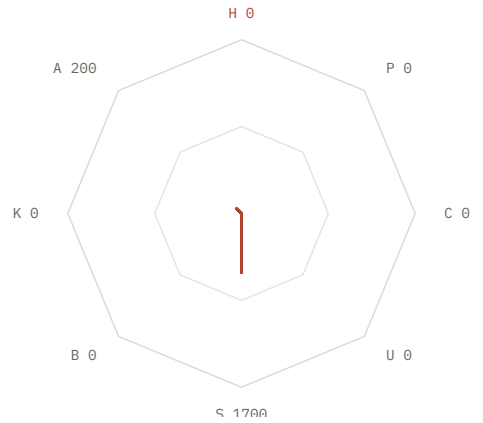
Makes ~700 ml · 10 minutes plus churning · the designed sweetness, almost alone

```
500  g     ripe fruit purée (strawberry, mango, or whatever is best),
sieved
3    tbsp  engineered monk-fruit or stevia sweetener, to taste
1          lemon, juiced
1    pinch flaky salt · 1 tbsp glucose or light honey (for scoopability)
```

1. Whisk everything together until the sweetener has dissolved; taste and adjust — it should taste a touch too sweet cold, because freezing mutes sweetness.
2. Churn until it holds, or still-freeze and fork it smooth every twenty minutes.
3. Serve the moment it is scoopable; it keeps a few days but is best the first day.

Why it works — This is the sweet repertoire at its simplest: the fruit brings its own soft sugars and aroma, and a few grams of designed sweetener lift the whole thing to a loud IFI-S without a sugar syrup's weight. The single tablespoon of glucose is the one place sugar still earns its keep — it lowers the freezing point just enough to keep the sorbet scoopable rather than icy. Potency from the designed molecule; texture from a trace of the real one. That division of labor is the whole craft.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,700
IFI-B	0
IFI-K	0
IFI-A	200

The faint astringency is the lemon, left on purpose to keep the sweetness honest. A pinch of mild chili here turns it into the measured burn of Chapter 11.

Chapter 5 · Sweetness at the source — *restoring, amplifying, cleaning the tail.*

IFI-S · the design of the sweet lead

The deepest move in the sweet lead of a dessert is not to add sweetness but to *build it into the plant* — to raise IFI-S at the source, where it comes loose from the sugar load and from the off-flavors that dog the added sweeteners. Three design problems live here, and the platform has worked all three: cleaning the bitter tail off a glycoside, amplifying a plant's native sweetness, and restoring a sweetness that modern agriculture bred out. Each is the same method, which the next chapter details, aimed at a different enzyme. Together they are the reason the sweetness in this book can be at once loud, clean, and light.

Take the **tail** first, because it is the sweet lead's version of the "attenuation, not amputation" that governs bitterness. Crude stevioside's bitter-licorice aftertaste, met at the end of the last chapter, is a *glycosylation* problem. The steviol backbone is decorated with sugar groups by a series of **UGT glycosyltransferases** — UGT85C2, UGT74G1, UGT76G1, and UGT91D2 — and *which* steviol glycoside the plant ends up with depends on which of these UGTs act, and in what order. Stevioside, the tailed one, carries fewer glucose units; **rebaudioside M**, the clean one, is more fully glycosylated, and that extra decoration is exactly what stops it keying the bitter TAS2R receptors. So the design is not to remove sweetness but to *route the glycosylation* toward Reb M — to push flux through the UGTs that build the clean molecule and away from the ones that leave the tail. We score the result on two axes at once: IFI-S up, and the bitter tail, read on the TAS2R-anchored scale, down toward silence. A sweetness with no second axis sneaking in behind it is the only sweetness fit for the last course, because dessert has no room for an uninvited bitterness muddying the gift.



Tomato, restored — the sweetness and aroma bred out for shelf life and shipping, grown back in through the plant's own sugar machinery. The same restoration logic that fixes a fruit can clean a sweetener.

Now **amplification** and **restoration**, which are two faces of one idea: move the plant's own sugar economy. A fruit's sweetness is set by its **Brix** — its dissolved-sugar fraction — and by the balance of enzymes that make, store, and break down those sugars as it ripens: **sucrose synthase** and the **invertases** that interconvert sucrose and its hexoses, the transporters that load sugar into the fruit, and the acids that frame how sweet the sugar reads. Modern tomato is the cautionary tale and the proof at once. Decades of breeding for yield, uniform ripening, and shelf life quietly selected against the alleles that made a tomato *sweet and aromatic* — the bargain that gives you a fruit that ships beautifully and tastes of almost nothing. The platform's tomato work, **2,040** constructs deep, is in large part a restoration: reading the sugar and acid and volatile machinery, finding where the sweetness was lost, and routing flux back toward it. The same logic restores sweetness to a melon or a strawberry grown for the road rather than the tongue. **Sugarcane**, by contrast, is the amplification case — a plant that is already a sucrose factory, pushed (across **200** constructs) to carry more of its own native sweetness per stalk rather than handed a foreign molecule. Restoration gives a fruit back what it lost. Amplification gives a sweet plant more of what it already is.

Why does a dessert cook care where the sweetness comes from? Because of the single mechanical fact at the center of the whole sweet lead: **a sweetness designed at the source is a dial that is loose from the sugar.** When the sweetness of a dessert is a pour of syrup, lifting it means adding load — and the plate grows heavier exactly as it grows sweeter, so the sweetness you want becomes a sweetness you cannot afford, on the body or on the label. Design the sweetness into a clean Reb M, a sweet protein, an amplified cane, a restored fruit, and the dial turns freely: you can raise the sweetness to carry a whole cake, hold it high against a bitterness or a heat, and shed most of the load in doing so. Every composed dessert in Part VII depends on this, because composition means turning several dials at once, and a dial welded to the sugar is a dial you cannot turn without consequences you did not choose.

This is the chapter where the quiet through-line of the library comes nearest the surface, so we will say it once, plainly, and then let it hum under the recipes. A sweetness read from the shape of a signal rather than from a load of sugar lets a dessert stay joyful without asking the body to pay twice for the joy. We make no claim about that — not a word of health, not a whisper of a cure. We build it that way because it is how we would want to be fed, and because the last course was always, underneath the pleasure, the kind plate. The restoration below proves the point the gentlest way we know: a panna cotta that is barely any sugar and tastes like all of one.

Panna Cotta, Barely Any Sugar

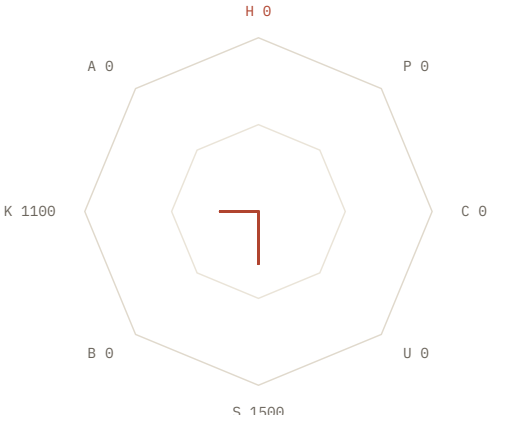
Serves 4 · 15 minutes plus setting · the dessert that proves the point

400	ml	whole milk
200	ml	cream
1	tsp	engineered stevia or monk-fruit sweetener (to IFI-S ~1,500)
1		vanilla pod, split and scraped (kokumi-rich if you have it)
3		sheets gelatin (or 2 g agar)
1		pinch fine salt

1. Bloom the gelatin in cold water until soft. (For agar, whisk it cold into the milk and bring to a gentle boil.)
2. Warm the milk, cream, vanilla seeds, sweetener, and salt together until it steams — do not boil. Taste it: it should be sweet enough to make you pause, and it will be, on a fraction of what sugar would take.
3. Melt the drained gelatin into the warm cream off the heat. Strain through a fine sieve.
4. Pour into four glasses and set in the cold for at least three hours. Serve with nothing, or with the berries of Chapter 15.

Why it works — The sweetness here is grown, not added. Engineered stevia moves both halves of the TAS1R2·TAS1R3 duet at an IFI-S well north of sugar's, so a single teaspoon does what a quarter-cup used to — the clasp hears a full, round *sweet* while the body reads almost nothing behind it. The vanilla is not only for flavor: it is the first whisper of kokumi, the body you will meet properly in Chapter 10, which is why this sets to something that feels richer than its cream alone could explain.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,500
IFI-B	0
IFI-K	1,100
IFI-A	0

Nourishment note, quiet: the sweetness your tongue reads here never reaches the body the way sugar does. We do not call that healthy. We call it gentle, and we mean it as a kind of manners toward the person you are feeding.

Chapter 6 · Designing the sweet — *ESM2, flux balance, CRISPR.*

the method, and why it makes a sweetness clean

Here is the part people find hardest to believe, so we will be concrete about every step: we design a flavor *in silico*, before a single seed exists, and the plant we grow is a readout of a calculation we already trust. This is the method that founded the company — it built the ten-rung heat ladder you will meet in Chapter 11 — and five of its seven modules transfer unchanged to any genome we can sequence, which is why the same pipeline that specifies a superhot pepper can clean the tail off a steviol glycoside or route more sucrose into a cane. The method has four movements, and we will walk them on the enzyme we know best, then say how each applies to sweetness.

First, the structure. An enzyme is a shape, and you cannot reason about an edit without it. We build a high-confidence structural model of the target enzyme with a protein-folding network and score every residue two ways: by local confidence (**pLDDT**), which tells us which parts of the model are rigid scaffold and which are floppy and uncertain, and by the **predicted aligned error (PAE)** between domains, which tells us how sure the model is about the *relative* geometry of one region to another. We design into the high-confidence active-site cleft — where the substrate actually sits — and leave the uncertain termini alone.

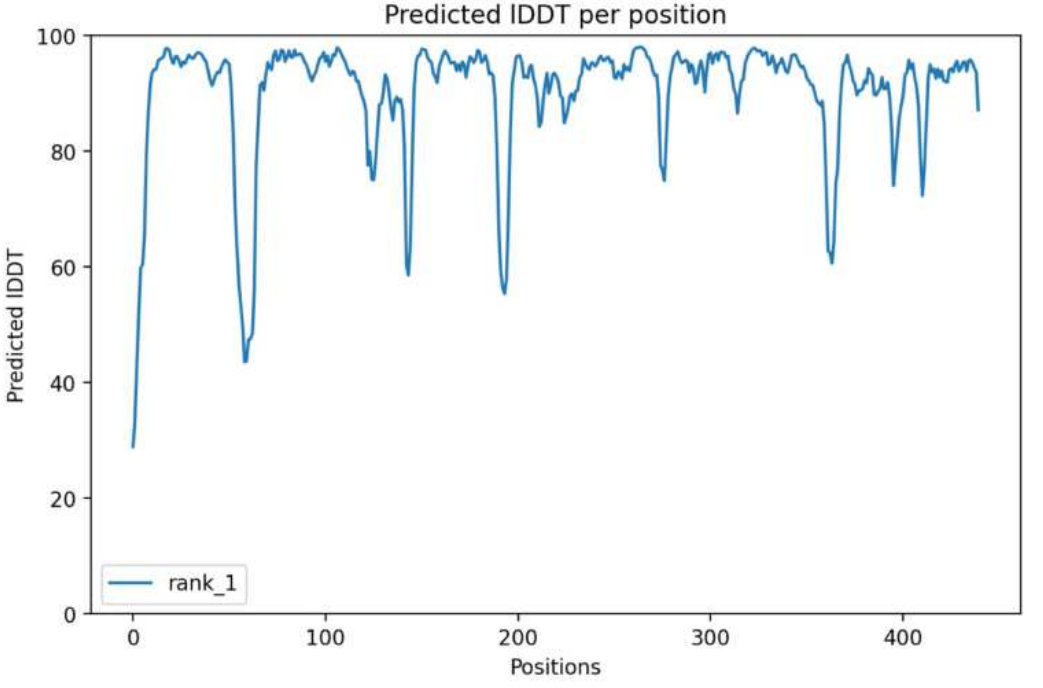


FIG. 6a — a platform acyltransferase model coloured by per-residue confidence (pLDDT): the active-site cleft, where catalysis happens and where we design, resolves at high confidence; the floppy termini, which we leave alone, do not.

Second, the language model. We score every possible single-residue substitution in the enzyme with a protein **language model** — an **ESM2-class** network of **650 million parameters**, trained by masked-language modeling on the grammar of hundreds of millions of natural proteins. The model has never been told what our enzyme *does*; it has only learned what proteins *are*, and from that it estimates, for every position and every possible amino acid, how

surprising — how destabilizing, how unnatural — a given substitution would be. The **log-likelihood ratio** it assigns a variant turns out to be a remarkable zero-shot predictor of that mutation's real effect, with no experimental training data at all. We fold that evolutionary-grammar score together with an explicit **ΔΔG** of fold stability computed from the structure: the grammar catches the mutations that break *function*, the ΔΔG catches the ones that break the *fold*, and their product ranks the whole mutational landscape by the property we actually want. For the heat enzyme, that ranking surfaced candidate substitutions no breeding program had ever found — because breeding selects a phenotype and hopes the genotype followed, while we read the genotype first. For the Pun1 acyltransferase, the analysis identified three candidates; the two retained in the shipped double-variant construct are:

EDIT	EFFECT	ΔΔG (KCAL/MOL)
S39L	binding affinity ↑ (N-terminal)	−2.1
L345G	steric relief, active-site cleft	−1.8
C175S *(structural annotation — not in shipped construct)*	disulfide-misfold prevention	−0.9

Third, the flux check. A better enzyme is useless if it is not the step that controls the outcome — and that is the job of a genome-scale **flux-balance analysis (FBA)**. We write the plant's metabolism as a stoichiometric matrix **S** — a row per metabolite, a column per reaction — and impose the single steady-state constraint **S · v = 0** on the flux vector **v**, bounded by each enzyme's capacity. That leaves a whole convex space of feasible flux distributions, which we search by linear programming, asking: if I push *this* enzyme, how far does the product pool actually move, and what else moves with it? For sweetness this is the module that does the real work of *restoration* and *routing*: it finds whether a fruit's lost sweetness is limited by sugar synthesis, by transport, or by an invertase bleeding sucrose away — and it finds the UGT routing that sends a stevia plant's flux toward clean Reb M instead of tailed stevioside. The founding result of the company came from exactly this model: our flux analysis predicted that the most effective levers for heat design sit upstream in the phenylpropanoid pathway — at 4CL and HCT/CCoAOMT — where flux control coefficients are highest, not at the terminal Pun1 step, which labels the capsaicin product but does not govern the rate. That prediction told us precisely where to push. The same math tells us precisely where to push on sugar.

Fourth, the write, and the measure. The surviving edits are written with **CRISPR**, the plant is grown, and the prediction is *measured* — the sugar and glycoside profile by **LC-MS/MS**, so the molecular makeup of the sweetness is a number before it is a sensation; the perceived sweetness and any bitter tail by a **trained descriptive panel** calibrated to the receptor-anchored scale; and the whole eight-axis profile by the Index. The statistic that is the real product is the **coefficient of variation**. Across the platform, every construct we design is specified to hold its profile to a **CV of seven percent or less**, against the roughly forty-two percent that dogs conventionally

bred material. For a baker, that number is everything the designed ingredient is actually selling: a designed sweetener ordered at IFI-S 1,500 is IFI-S 1,500 in February and in August, in this bag and the next, so a recipe that worked once works every time. A flavor that drifts from batch to batch is not an ingredient; it is a rumor.

This is the whole platform in one page, and the scale behind it is worth stating plainly, because every number in this book pulls from it: roughly **19,000 engineered constructs**, **1,000 live and purchasable today**, across **42 host organisms** and **8 sensory axes**, held to that **≤7% CV**, backed by **3 patents filed** and **21 peer-reviewed papers** released openly on Zenodo under CC BY 4.0. The dessert cook does not need to run a flux model. They need only to trust that the sweetness in the bag was designed, measured, and reproduced — which frees them to do the part no algorithm can, which is to decide what to make for the people they love, and then make it the same way twice.



PART III OF VII

The Bitter Made Kind

IFI-B · the TAS2R receptors · coffee · cacao · attenuation, not amputation

Chapter 7 · Bitterness, attenuated — *the guard receptors, turned down.*

AXIS 04 · IFI-B · TAS2R38

Every other axis in this book *adds*. This one *takes away*, and in dessert that makes it a quiet revolution — because the two most beloved difficult flavors of the last course, coffee and dark chocolate, are loved not for their bitterness but *despite* it, and the sugar that usually makes them drinkable is mostly paying a ransom. Turn the bitterness down to the right place and the ransom is no longer owed. The dessert gets lighter, truer, and more itself.

Begin with the biology, because it explains why bitterness feels like a warning: it *is* one. Bitterness is the tongue's alarm system, and unlike the single sweet clasp it is served by a whole family — roughly **twenty-five TAS2R receptors** in humans, a committee of sentries each tuned to a different class of potentially toxic compound. The most studied is **TAS2R38**, the receptor behind the famous PTC/PROP "taster" gene, which divides people into those who find certain Brassica compounds punishingly bitter and those who barely notice. The reason the family is so large and so eager is evolutionary: bitterness evolved to catch alkaloids, glucosinolates, and other plant defenses before they were swallowed, so the system is deliberately *over*-sensitive — better a false alarm than a missed poison. That over-sensitivity is a gift when you are foraging and a liability when you are trying to enjoy an espresso, because the very compounds that make coffee and cacao *interesting* — their chlorogenic acids, their methylxanthines, their polyphenols — also trip the sentries.



Coffee, in cross-section — the bean whose chlorogenic acids and caffeine make it beautiful and difficult at once. The platform does not remove the difficulty; it turns it down to where it flatters.

The platform's discipline here is one phrase, and it governs the whole axis: **attenuation, not amputation.** We do not strip bitterness out — a coffee with no bitterness at all is a flat, lifeless thing, and a chocolate with none is candy. We *lower* it, by a measured **twenty to sixty-five percent**, to the exact place where the roast or the roast's

cousin is all aroma and structure and none of the wince. Mechanically, this is flux work at the enzymes that build the bitter compounds. In coffee (a host we work across **40** constructs), the dominant bitter load comes from **chlorogenic acids** and their roast-degradation products, and from **caffeine**; the platform reroutes and trims that load at its biosynthetic source rather than masking it in the cup, so that what remains is the whole aromatic architecture of coffee with the harsh edge lifted away. The score runs on the TAS2R-anchored scale, read as an *attenuation*: an IFI-B of 2,400 names a bitterness turned down toward two-thirds of its native loudness, measured, reproducible, and the same in every batch.

This matters more for dessert than for any other course, and the reason is a chain of simple consequences. A bitter coffee or a punishing dark chocolate is usually *sweetened into submission* — the sugar is there to mask the bitterness, not to sweeten the dish, which is why a mediocre chocolate dessert is so often cloying: it has been over-sugared to hide a bitterness that was never addressed. Attenuate the bitterness at the source and the whole equation changes. The dessert needs far less sugar to be loved, because the sugar is no longer doing hidden work; the sweetness you *do* add is free to be about pleasure instead of damage control; and the designed, load-light sweetness of Part II can now carry the plate without a syrup's weight. Low-bitter coffee and low-bitter cacao are, in a real sense, what make a *light* chocolate dessert possible at all. The rest of this part is built on that: a coffee that needs no burying, and a chocolate that can finally be deep without being harsh. We begin with the simplest proof — a dessert that is nothing but cold sweet cream meeting a hot bitter shot, as equals.

Affogato, the Long Way

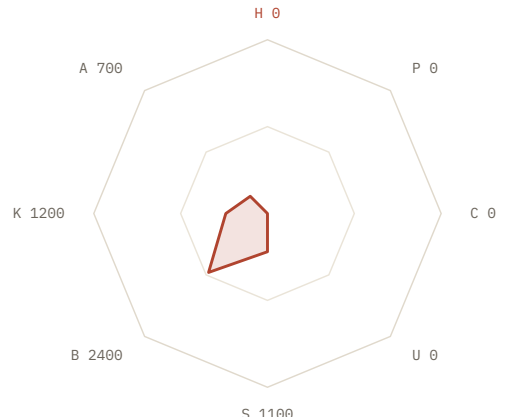
Serves 4 · 15 minutes · the clearest proof of the attenuated bitter

```
4    scoops the Panna Cotta of Chapter 5, frozen, or good vanilla gelato
4    shots  espresso from low-bitter beans (or your best, pulled short)
2    tbsp   dark chocolate, finely grated
            engineered sweetener, only if you want it
```

1. Set a cold scoop of frozen cream in each of four small cups or glasses.
2. Pull the espresso and pour it hot over the cream *at the table*, so everyone watches it cave and melt into a swirl.
3. Shower with grated chocolate. Sweeten only if the coffee asks — which, made this way, it rarely does.

Why it works — The beans here sit near IFI-B **2,400** on the attenuation scale, their bitterness turned down toward two-thirds of native loudness. What remains is the whole aromatic architecture of coffee with the harshness lifted out — so the cold sweet cream and the hot bitter shot meet as *equals* instead of one masking the other. In a classic affogato the sugar in the gelato is partly there to fight the coffee's bite; here there is no fight, so the cream's own gentle sweetness is plenty. Two temperatures, two axes, no ransom paid.

IFI PROFILE



IFI-H		0
IFI-P		0
IFI-C		0
IFI-U		0
IFI-S		1,100
IFI-B		2,400
IFI-K		1,200
IFI-A		700

The astringency is coffee's own dry finish, left in to flatter the sweet; the kokumi is the melting scoop. Bitterness present and beautiful, not punishing — the whole point of the axis in one glass.

Chapter 8 · Chocolate — *warmth folded into the dark.*

IFI-B × IFI-H · TAS2R38 × TRPV1 · and three more besides

Chili and chocolate is the oldest sweet-heat idea there is, and the one most often done badly — a good chocolate dosed with a heat it cannot carry, so that you taste the burn and then the apology. Done with design, it becomes what it always wanted to be: a dark that is deep without being harsh, and a heat so precisely placed it arrives only at the finish, like a coal found at the bottom of the cup. But to cook chocolate well on the Index you have to see it honestly, which means seeing that a square of dark chocolate is not one flavor but a small crowd of axes, and that adding heat to it is not a two-axis problem but a five-axis composition wearing a two-axis name.

Read a good 70% dark bar on the Index before the chili ever arrives, and here is who is already in the room. There is **sweetness**, of course, though less than people think. There is **bitterness** — the cacao's methylxanthines (**theobromine** chiefly, caffeine in support) and its **polyphenols**, firing the TAS2R sentries. There is **astringency** — cacao is rich in **flavanols and procyanidins**, tannins that bind the saliva's proteins into that characteristic dry grip. And there is **kokumi** — the deep, mouth-filling roundness that makes good chocolate feel like it coats the whole mouth and stays. Four axes, composed, before you have added a thing. This is why chocolate is the most complete single ingredient most dessert cooks ever handle, and why it rewards being read rather than guessed.



Cacao, in cross-section — a dark bar is four axes before anything is added to it: sweetness, the bitterness of its methylxanthines, the astringency of its procyanidins, and a deep kokumi body.

Now drop heat into that, and the trap becomes clear. **Heat and bitterness reinforce each other's sharp edges** — add a chili to a punishing dark chocolate and you do not get a composition, you get two assaults arriving together, each making the other feel harsher. This is why bad chili-chocolate is *bad*: not because the idea is wrong but because the bitterness was never addressed, so the heat lands on an existing sharpness and doubles it. The designed fix is subtraction, and it is the work of this library's *Zero-Bitter* volume: cacao's bitterness answers to the TAS2R receptors, and the platform's attenuation approach — the same twenty-to-sixty-five-

percent turndown applied across our coffee and Brassica work — pulls it down without touching what makes cacao taste like cacao. (Cacao is a design target carried in depth in Book 16 of this library; here we simply use its attenuated bitterness as an ingredient.) Pull the bitterness down, and suddenly there is room — room for the heat to be a *pleasure* rather than a second sting, and room for the sweetness to be heard. The **astringency** we mostly leave: a little tannic grip is the backbone the whole thing hangs on, the spine of Chapter 14 arriving early. The **kokumi** we treasure: it is what gives the heat somewhere long and slow to unfold.

And the heat itself is dosed to the *dish*, not to the fruit — which is the move that lets a dessert borrow a superhot's precision without its violence. A flagship pepper like **Ember** (SS-0087) carries IFI-H **1,570** in the pod, which sounds like the opposite of dessert; but heat, like sweetness, obeys concentration, and a measured trace of a clean, high cultivar divides down to a dessert's whisper far more reliably than a heavy hand of a muddy pepper ever could. We ladder *down* from precision, as Chapter 11 explains in full. The point in a chocolate is a warmth that blooms only at the swallow, the coal at the bottom of the cup — present, intentional, and gone clean.

Chili-Chocolate Pots de Crème

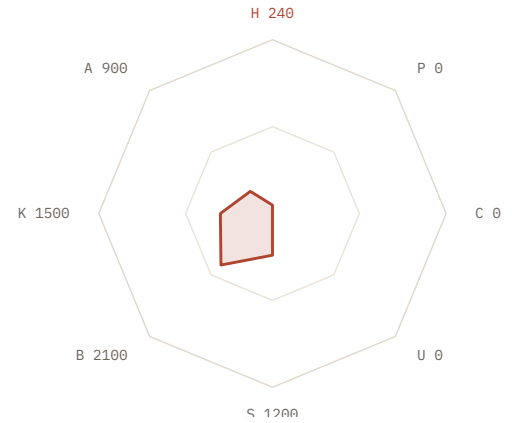
Serves 6 · 30 minutes plus chilling · the brooding archetype, made tender

```
200  g      dark chocolate (70%, low-bitter if you have it), chopped
300  ml     cream
150  ml     whole milk
3           egg yolks
2    tbsp   engineered sweetener
              a measured trace of designed chili, dosed to IFI-H ~240
              (a shaving of Ember · SS-0087, or a pinch of mild chili)
1    pinch  flaky salt
```

1. Warm the cream, milk, and salt until steaming. Pour over the chopped chocolate and let it sit a minute, then stir smooth and glossy.
2. Whisk the yolks with the sweetener, then temper in the warm chocolate cream a ladle at a time, stirring constantly so the yolks thicken rather than scramble.
3. Cook gently back on low heat, stirring, until it coats the back of a spoon. Off the heat, stir in the measured chili. Taste for the finish — the heat should surface *last* and leave clean.
4. Pour into small cups and chill at least four hours, until set to a trembling firmness.

Why it works — Custard is a kindness to a brooding chocolate: the fat and the cold stretch the heat out long and slow, so a trace that would read as a sting on the tongue reads instead as a deep, late warmth. The bitterness is held near IFI-B 2,100 — attenuated just enough that the dark reads as *deep* rather than sharp — which is what makes room for the heat to be a pleasure. The kokumi of the set cream gives the whole thing length; the astringency, left in, gives it a spine.

IFI PROFILE



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IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,200
IFI-B	2,100
IFI-K	1,500
IFI-A	900

Read how many axes are singing: this is nearly the whole Index folded into a cup. A scrape of orange zest is welcome.

Dark Chocolate, Chili, Flaky Salt

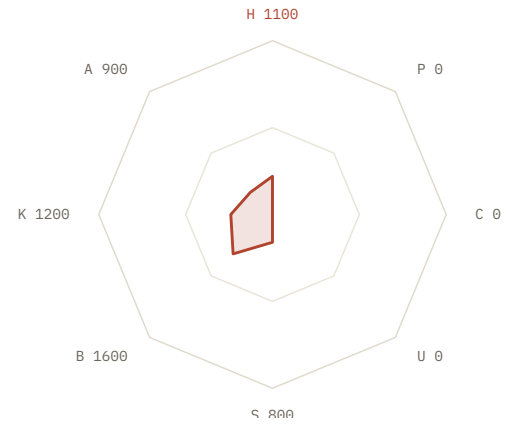
Makes a small slab · 30 minutes plus setting · the one we break off in the evening

200	g	dark chocolate, 70% (a low-bitter one if you have it)
0.5	tsp	mild designed chili flake (IFI-H ~300)
1	pinch	smoked flaky salt
1	tbsp	cacao nibs, for grip and sound

1. Melt two-thirds of the chocolate slowly over a bare whisper of heat. Off the heat, stir in the remaining third until smooth and slightly cooled — a rough temper, enough for a clean snap.
2. Stir in half the chili. Pour the chocolate thin onto parchment.
3. Scatter the nibs, the rest of the chili, and the salt across the surface while it is still wet.
4. Let it set at cool room temperature — not the fridge, which dulls both the snap and the aromatics. Break into shards.

Why it works — With the cacao's bitterness turned down at the source, the heat lands on sweetness and body instead of on an existing sharpness, so it reads as warmth blooming through the dark rather than a second sting. The astringency, left in, gives structure; the kokumi gives length; the salt is the pin that holds it all together. Almost the whole Index, in a square you break with your thumb.

IFI PROFILE



IFI-H	1,100
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	800
IFI-B	1,600
IFI-K	1,200
IFI-A	900

This runs hotter than the pot de crème on purpose — a slab is for grown-ups at the end of the night. Drop the chili to IFI-H ~300 for a gentler version.

Flourless Chocolate Cake, Less Sugar Than You Fear

Serves 10 · 45 minutes plus cooling · deep, dark, and honest

```
250  g     dark chocolate (70%, low-bitter), chopped
180  g     butter
4          eggs, separated
80   g     caster sugar (structural) + 3 tbsp engineered sweetener
30   g     cocoa powder (low-bitter), sifted
1    pinch salt · 1 tsp vanilla
```

1. Heat the oven to 170 °C; line a 23 cm springform. Melt the chocolate and butter together gently; cool slightly. Stir in the yolks, sweetener, cocoa, salt, and vanilla.
2. Whip the whites to soft peaks, add the caster sugar, and whip to a firm glossy meringue. Fold a third into the chocolate to loosen it, then fold in the rest in two goes, keeping the air.
3. Bake 30–35 minutes, until set at the edge and barely trembling at the centre. Cool fully in the tin — it will sink into a dense, fudgy crumb.

Why it works — The same division of labor as the meringue: a structural minimum of caster sugar stabilizes the whipped whites that lift the cake, while a designed sweetener carries most of the sweetness at a fraction of the load. The low-bitter chocolate and cocoa mean the cake does not need the usual wall of sugar to be palatable, so it tastes of *chocolate* — deep, a little bitter in the good way, round with kokumi — rather than of sweetness pretending to be chocolate.

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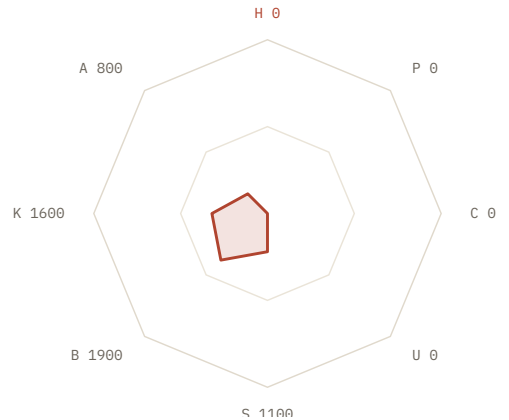

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IFI-C		0
IFI-U		0
IFI-S		1,100
IFI-B		1,900
IFI-K		1,600
IFI-A		800

A serious, grown-up cake. Serve with the crème anglaise of Chapter 10, or a spoon of barely-sweet cream, and a few of the astringent berries of Chapter 15 to cut it.

Chapter 9 · Coffee at the end of the meal — *tiramisu, granita, the cold and the hot.*

IFI-B · the dessert built on a bean

Coffee is the one bitter the world willingly ends a meal on, and the desserts built around it are among the oldest proofs that bitterness, placed right, is a pleasure. But the classics — tiramisu, granita al caffè, the affogato of Chapter 7 — were all engineered by generations of cooks to *manage* coffee's bite with sugar and dairy and time. Give those same cooks a coffee whose bitterness is already attenuated to where it flatters, and the sugar comes down, the coffee flavor comes *up* (no longer buried under its own defense), and the dessert becomes what it was always reaching for: a thing that tastes of coffee rather than of sweetened coffee. This short chapter is two of those classics, rebuilt on a designed bean, with the science of *why they get lighter* sitting between them.



Coffee cherries on the branch — the whole aromatic architecture of the cup is already here; the platform's work is only to lift the wince out of it and leave the rest.

A note on the mechanism, because it is the quiet engine of this whole part and worth saying once more in the context of a recipe. When you attenuate coffee's bitterness at the source — trimming the chlorogenic-acid and methylxanthine load at the enzymes rather than masking it in the cup — you are not making the coffee *weaker*. Aroma and bitterness are separate things: most of what you love about coffee is volatile aromatics read by the nose, while the bitterness is a taste read by the TAS2R sentries on the tongue. Lower the second without touching the first and you get *more*

perceived coffee character, not less, because the aromatics are no longer competing with an alarm. A low-bitter espresso smells and tastes more intensely of coffee while asking for less sugar — which is exactly the combination a coffee dessert wants.

Tiramisu, Rebuilt

Serves 8 · 40 minutes plus overnight · the classic, lightened at the source

```
4          egg yolks
3    tbsp  engineered sweetener + 2 tbsp caster sugar (for the sabayon's
body)
500  g     mascarpone, room temperature
250  ml    cream, softly whipped
300  ml    strong espresso from low-bitter beans, cooled
2    tbsp  cocoa (low-bitter), plus more to finish
             24–30 savoiardi (ladyfinger) biscuits
1    pinch salt · optional 2 tbsp coffee liqueur
```

1. Whisk the yolks, sweetener, and caster sugar over barely simmering water to a pale, thick sabayon, three to four minutes; cool slightly. Beat in the mascarpone and salt until smooth, then fold in the whipped cream.
2. Stir the cocoa and (if using) the liqueur into the cooled espresso. Dip each biscuit briefly — a second a side, no more, or they collapse — and lay a layer in the dish.
3. Spread half the cream; repeat the biscuits and cream. Dust the top with cocoa, cover, and chill overnight.
4. Dust again with cocoa just before serving, and cut with a hot knife.

Why it works — Tiramisu is a bitterness-management machine: the sugar in the sabayon, the fat in the mascarpone, and the long rest all exist partly to round off the coffee's bite. Start from a low-bitter espresso near IFI-B 2,200 and much of that management is already done at the source, so you can pull the sugar back and let the coffee lead. The mascarpone and cream bring a loud kokumi; the cocoa dust adds a second, gentler bitterness on top. It tastes more of coffee than the original, on less sugar — the whole thesis of the part, in a spoon.

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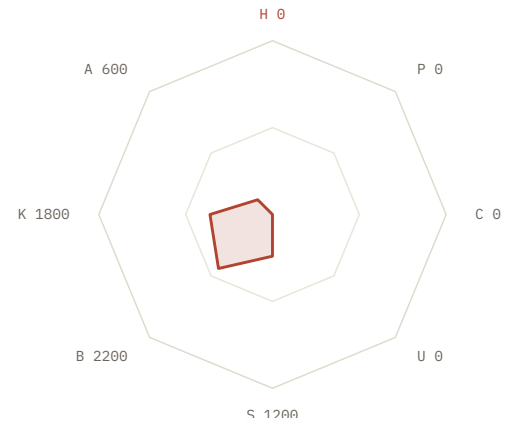

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IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,200
IFI-B	2,200
IFI-K	1,800
IFI-A	600

The kokumi is the headline texture here — the mascarpone doing what twice the cream would. A dessert that eats lighter than it looks.

Coffee Granita, Cream on Top

Serves 6 · 15 minutes plus freezing · the hot country's answer to the bitter bean

```
500  ml    strong coffee from low-bitter beans, hot
3    tbsp  engineered sweetener, to taste
1    pinch salt
250  ml    cream, barely sweetened and softly whipped, to serve
```

1. Stir the sweetener and salt into the hot coffee until dissolved; taste — it should be pleasantly sweet, a touch more than you want, because freezing mutes it.
2. Pour into a shallow tray and freeze, dragging a fork through the crystals every thirty minutes, until it is a loose, glittering brown snow.
3. Spoon into cold glasses and crown with the soft cream.

Why it works — Granita is bitterness at its most exposed — there is nowhere for a harsh coffee to hide in a bowl of frozen coffee crystals — which makes it the truest test of an attenuated bean. At IFI-B near 2,300 the coffee reads as deep and aromatic rather than sharp, so a modest sweetener is enough and the cold cream on top is a kokumi-rich foil rather than a rescue. The astringency of the coffee, left in, keeps the whole thing from going flat as it melts.

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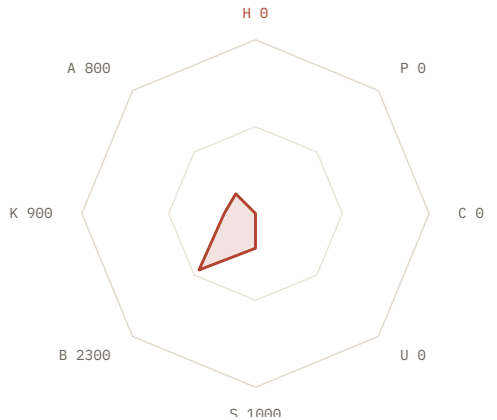

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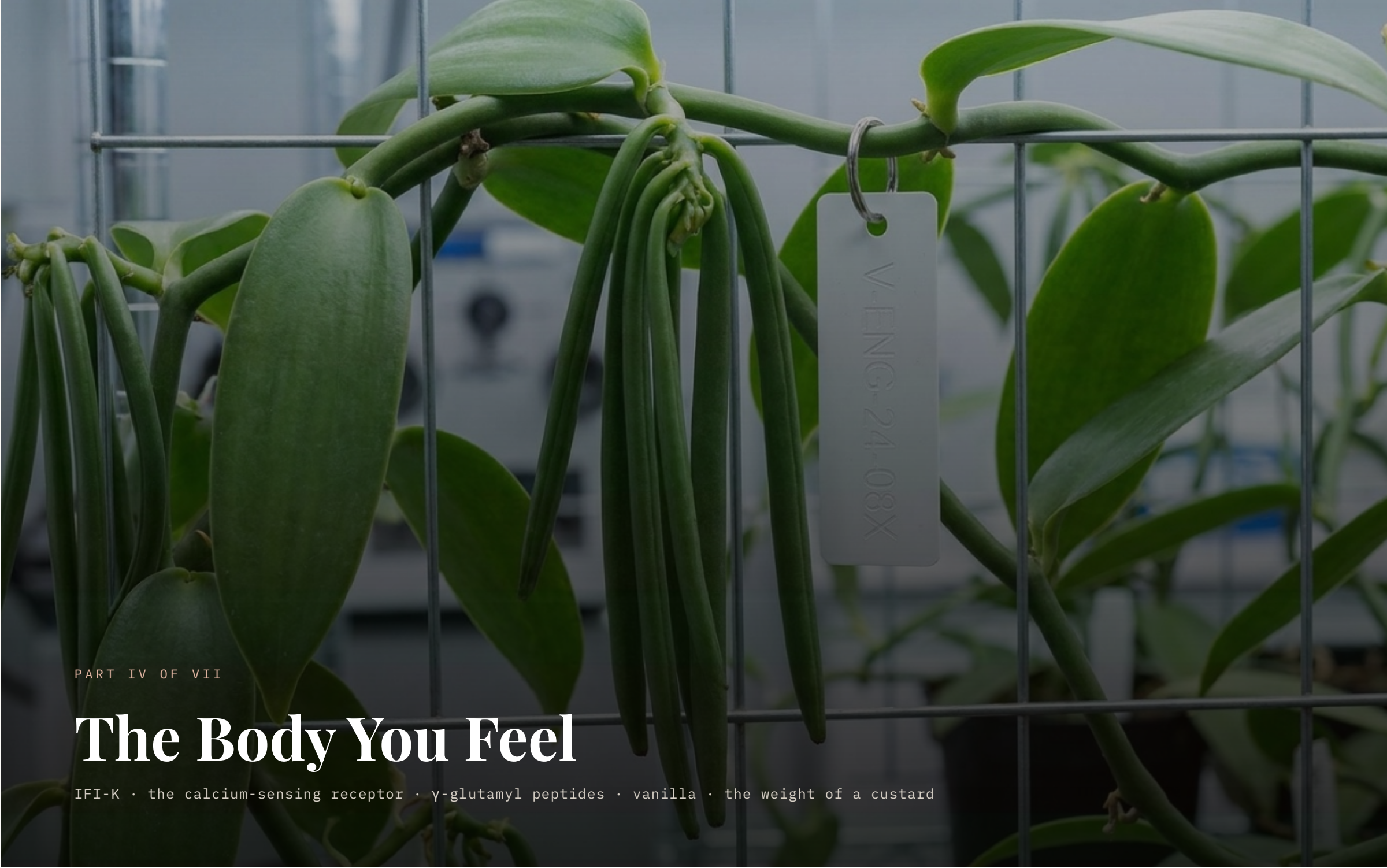
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,000
IFI-B	2,300
IFI-K	900
IFI-A	800

The cream's job is contrast, not correction. If your coffee still bites, that is the bean talking, not the recipe — start from a better one.



PART IV OF VII

The Body You Feel

IFI-K · the calcium-sensing receptor · γ-glutamyl peptides · vanilla · the weight of a custard

Chapter 10 · Kokumi — *richness you feel, not taste.*

AXIS 05 · IFI-K · CaSR

There is a quality in a great custard that every taster recognizes and almost none can name. It is not sweetness, not fat exactly, not flavor — it is *weight*, a continuity and roundness, the sense that the spoonful fills the whole mouth and lingers a beat after you swallow. Cooks call it body, or richness, or sometimes just *more*. The Index calls it **kokumi**, and it is the strangest and most useful axis in the whole dessert kitchen, because — uniquely among the eight — it has no flavor of its own. You cannot taste kokumi. You can only taste what it does to everything else.

The mechanism is as quietly elegant as the sensation. Kokumi is carried by **γ-glutamyl peptides** — small peptides built on an unusual gamma-linkage of glutamate, the most famous being **glutathione** (γ-Glu-Cys-Gly) and the tripeptide **γ-Glu-Val-Gly** — and their receptor is not a taste receptor in the ordinary sense at all. It is the **calcium-sensing receptor, CaSR**, a class C GPCR (a cousin, structurally, of the sweet and umami receptors) that the body uses all over to monitor calcium, and that sits on taste cells as a *modulator*. The γ-glutamyl peptides are **allosteric agonists**: they bind CaSR and, rather than producing a taste of their own, they amplify and prolong the signals of the *other* tastes arriving at the same time. A kokumi peptide makes a sweetness feel rounder, a savory note feel deeper, a mouthful feel more continuous — it is a volume-and-sustain knob for the whole mouth, wired to a receptor that reports not flavor but *fullness*. This is why body is so hard to name: it is not a note, it is the resonance under the notes.



Vanilla, split — not only the vanillin everyone knows, but the kokumi underneath it, which is why real vanilla makes a custard feel richer than its cream alone can explain.

For the dessert cook, this is close to a secret weapon, because richness has always come at a cost. The traditional way to make a custard feel full is to add fat — more cream, more yolks — and fat is heavy in the eating as well as on the body. Kokumi offers a second, independent route to the same *felt* richness: grow the γ-glutamyl peptides into the ingredients and the CaSR does the work the extra cream used to do, so a custard made with three parts milk to one

part cream can carry the body of one made with pure cream, at half the heaviness. **Vanilla** is where we grow it on purpose. Everyone knows vanilla for its **vanillin**, the aromatic molecule; fewer know that real vanilla also carries a kokumi load, and that the platform's vanilla work (**40** constructs — a small, patient program, vanilla being one of the slowest and most complex flavors there is) tunes *both*: the vanillin for aroma and the kokumi peptides for body. A kokumi-rich vanilla is why the panna cotta of Chapter 5 set to something richer than its cream could explain, and why every custard in this book asks for the best vanilla you can find.

A word on the honesty of this, because it is the clearest place in the dessert kitchen where the library's quiet ethos becomes a technique. When kokumi does the work of richness, a dessert can carry less fat and lose nothing in the mouth. We do not frame that as a diet, and we never will — there is no claim here, no "lighter" on a label, no number promised to a body. We frame it as *getting the same pleasure for a little less heaviness*, which is only good sense and good manners at a table. The point was never to take something away. The point was to find where the richness actually comes from — a receptor, it turns out, not only a fat globule — and to feed it directly. Three custards follow, each leaning on kokumi to feel like more than it is.

Crème Anglaise, Less Cream Than You Think

Serves 6 · 25 minutes · the pouring custard, built on body not fat

300	ml	whole milk
100	ml	cream
1		vanilla pod, kokumi-rich if you have it, split and scraped
4		egg yolks
2	tbsp	engineered sweetener
1	pinch	salt

1. Warm the milk, cream, salt, and vanilla seeds together until steaming. Pull off the heat and let it steep ten minutes — this is where the kokumi and aroma move into the dairy.
2. Whisk the yolks and sweetener pale. Temper in the warm milk slowly, then return everything to low heat.
3. Stir steadily with a spatula until it thickens to a pourable custard — it is ready when it coats the back of the spoon and a finger drawn through leaves a clean line (about 82 °C; do not let it boil).
4. Strain and cool. Pour over anything in this book — or eat it warm from the pan, which is what we actually do.

Why it works — Three parts milk to one part cream, where the classic is all cream, and you will not miss the difference — because the body is coming from kokumi, not fat. The vanilla carries its γ-glutamyl peptides to the CaSR and the mouthfeel arrives anyway, round and complete at IFI-K 1,800, while the custard eats lighter than its richness suggests. The yolks still thicken and enrich; they are simply no longer asked to do the whole job alone.

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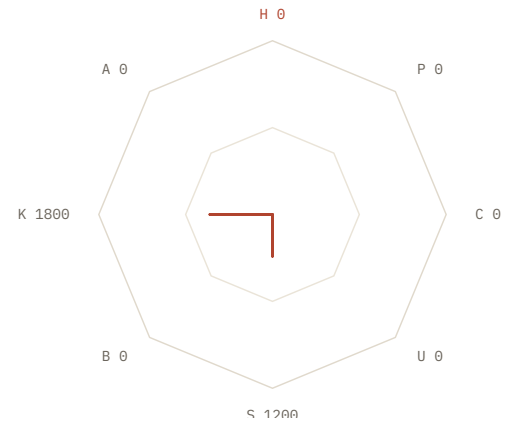

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IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,200
IFI-B	0
IFI-K	1,800
IFI-A	0

The calm center of the book. This is the custard the gingerbread of Chapter 13 wants poured over it while still warm.

Baked Cheesecake, the Body Grown In

Serves 12 · 1 hour plus chilling · dense, tall, and lighter than it looks

```
600  g     cream cheese, room temperature
200  g     fromage blanc or quark (lighter than all cream cheese)
120  g     caster sugar (structural) + 3 tbsp engineered sweetener
3          eggs + 1 yolk
200  ml    cream
2    tbsp  cornstarch · 1 tsp vanilla, kokumi-rich · zest of 1 lemon ·
pinch salt
             a thin digestive-biscuit base, pressed and pre-baked
```

1. Heat the oven to 160 °C. Beat the cheeses smooth with the sugar, sweetener, and cornstarch. Beat in the eggs and yolk one at a time, then the cream, vanilla, zest, and salt — do not overbeat, or it cracks.
2. Pour onto the pre-baked base in a lined springform. Bake in a water bath 50–60 minutes, until set at the edge and still wobbling at the centre.
3. Turn the oven off and leave the cheesecake inside, door ajar, an hour; then chill overnight. It firms as it cools.

Why it works — Cutting part of the cream cheese with lighter quark would normally cost you body — the dense, mouth-filling weight that makes cheesecake *cheesecake*. The kokumi-rich vanilla gives it back: the CaSR reads fullness the fat is no longer entirely providing, so the cake eats dense and round on less saturated richness. The structural sugar stabilizes the custard set; the sweetener carries the rest.

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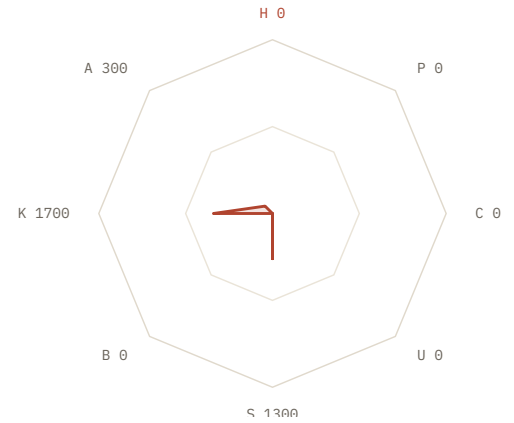

IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,300
IFI-B	0
IFI-K	1,700
IFI-A	300

The faint astringency is the lemon zest, cutting the richness so it never cloys. Top with the astringent berries of Chapter 15.

Vanilla Ice Cream, a Custard Base

Makes ~1 litre · 30 minutes plus churning · the one to build everything on

```
400  ml    whole milk
300  ml    cream
5          egg yolks
3    tbsp  engineered sweetener + 2 tbsp sugar (for texture and scoop)
2          vanilla pods, kokumi-rich, split and scraped · pinch salt
```

1. Make a crème anglaise as above with these quantities, steeping the vanilla well.
2. Chill the base thoroughly — overnight is best; a cold base churns smaller crystals.
3. Churn until thick, then freeze to firm. Let it soften five minutes before scooping.

Why it works — Ice cream lives or dies on body, because freezing flattens everything — cold mutes sweetness and dulls aroma, so a frozen custard needs more richness than a warm one to read as full. Kokumi is the lever: a kokumi-rich vanilla base eats creamy and complete even as you pull some of the fat and sugar back, because the CaSR keeps reporting fullness the cold would otherwise rob. The small amount of real sugar is kept for *texture* — it lowers the freezing point and keeps the scoop soft — a job the high-potency sweetener cannot do.

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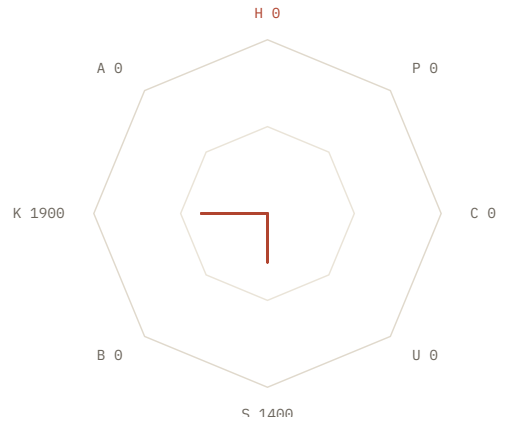

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IFI-C		0
IFI-U		0
IFI-S		1,400
IFI-B		0
IFI-K		1,900
IFI-A		0

The base for the affogato, the fire-and-ice of Chapter 12, and the whole-table cake at the end. Fold in anything; the body is already there.



PART V OF VII

Heat, Cool, and the Spice

IFI-H · IFI-C · IFI-P · TRPV1 · TRPM8 · TRPA1 · fire laddered to a glow, and its opposites

Chapter 11 · Sweet heat — *the dessert frontier.*

IFI-S × IFI-H · TAS1R2·TAS1R3 × TRPV1

Of all the places two axes meet, this is the one we love most at the end of a meal. Heat, laddered far down below the threshold of *hot*, does not fight sweetness — it lifts it, the way a pinch of salt lifts, the way warmth makes a ripe thing smell riper. A strawberry with a whisper of warmth behind it does not taste *spicy*; it tastes *more like a strawberry*, brighter and more present, as though someone turned up its contrast. This is the dessert frontier, and it is a real place on our roadmap, not a metaphor — but to cook it well you have to understand both how heat is made and how it is made *gentle*, because the whole trick is precision.

Heat is capsaicin finding **TRPV1**, the channel that also answers to temperatures above 43 °C and to acid. Capsaicin does not warm the tissue; it lowers the channel's thermal threshold, so your own body heat is suddenly read as a burn — the fire is real to the nerve and imaginary to the thermometer. Crucially for dessert, this means heat is *tunable at the molecule and at the dose*, and the strength of it is an EC_{50} against TRPV1 like any other axis. Where capsaicin is made, and how its *shape* is set, is a pathway we can read end to end. The aromatic head of the molecule comes from the **phenylpropanoid branch** — PAL → C4H → 4CL → HCT → COMT — the trunk road of plant chemistry that runs in *every* vascular plant, strawberries included; the oily tail comes from branched-chain fatty-acid synthesis; and the two are joined by a keystone acyltransferase at the **Pun1** locus, in the pale placental tissue of the pod. Four terminal enzymes — **pAMT, Pun1/CS, KAS, BCAT** — are all that a pepper adds to the universal branch to make fire. That fact is the thesis of this whole company, and it is why the dessert frontier is possible at all: heat is not a pepper's private property; it is a short spur a sweet fruit is only a handful of genes away from.



A strawberry in cross-section — sweet, aromatic flesh that could carry a grown-in warmth from within, rather than a dusted-on heat from without. The cleanest sweet-heat there is.

The platform developed a ladder of ten superhot cultivars in *Capsicum chinense*, each a computationally specified rung above the last — and the dessert cook's relationship to that ladder is to

ladder down from it. You will never pour the top of this ladder into a dessert; you will borrow a few clean drops of its precision. Here is the ladder, because the right-hand column tells a story that matters for sweet-heat:

CULTIVAR	SKU	SHU (PREDICTED)	IFI-H	AXES
Ember	SS-0087	866K	1,570	2/8
Cinder	SS-0088	1.05M	2,290	3/8
Kindle	SS-0089	1.25M	2,000	3/8
Flare	SS-0090	1.48M	—	4/8
Blaze	SS-0091	1.72M	2,630	4/8
Wildfire	SS-0092	1.96M	2,930	5/8
Scorch	SS-0093	2.21M	3,220	5/8
Firestorm	SS-0094	2.47M	3,490	6/8
Solara	SS-0095	2.72M	3,980	6/8
Phoenix	SS-0096	2.95M	4,200	**8/8**

Notice the axes climbing with the heat: the same careful flux routing that specifies extreme heat lets us grow *company* for it on the other pathways, which is why the summit cultivar carries all eight axes. A dessert never needs that altitude — but it benefits enormously from the *precision* that built it, because a trace of a high, clean cultivar carries well-shaped warmth into a sorbet far more reliably than a heavy hand of a muddy pepper. The heat is dosed to the **dish**: a shaving of Ember's 1,570 divides down to a dessert's IFI-H of 180 or 240, a warmth that reads as lift, not fire.

The frontier proper is to put the heat *inside the fruit* — to grow a strawberry that carries its own warmth, rather than a sweet fruit dusted with a hot one. We call the line **Sweet Heat**, and it belongs to the Cross-Family tier of the Beyond-Peppers roadmap (seven to ten genes, a horizon of a few years, the tier where the heat-making spur leaves the nightshades for good). It is a ladder of nerve:

RUNG	NAME	WHAT IT TASTES LIKE	READS AS
1	**Warm Kiss**	barely more than a flush; sweetness with a warm edge	IFI-H ~120
2	**Sugar Burn**	a real, happy sting *inside* the sweetness	IFI-H ~180
3	**Candied Fang**	sharp enough to make you laugh; heat clearly present	IFI-H ~260
4	**Devil's Dessert**	the dare at the top; heat leading, fruit cushioning	IFI-H ~400

We are honest about where this stands: Sweet Heat is frontier, not shelf. A fruiting plant keeps its own calendar, cross-family flux balance is genuinely hard, and we hold the single-fruit sweet-heat to the same CV ≤ 7% and the same eight-axis honesty as everything else before it ships. But the design is written, the method is in place, and in the meantime the kitchen composes sweet-heat the way cooks always have — a sweet thing and a trace of a hot thing, held in ratio — only now with both numbers in view and a clean, free sweet dial to turn. These recipes name the roadmap cultivars where they belong, and tell you the everyday substitute where you need one.

Strawberry Sorbet, a Measured Burn

Serves 4 · 20 minutes plus churning · heat you read as more fruit

```
600  g     ripe Sugar Burn strawberries (or the best strawberries you
have, plus a tiny pinch of mild chili)
2    tbsp  engineered monk-fruit or stevia sweetener, to taste
1          lemon, juiced
1    pinch flaky salt · 1 tbsp glucose (for scoop)
```

1. Hull and blend the strawberries to a smooth purée; sieve for a glassy sorbet, or leave it rustic.
2. Whisk in the sweetener, lemon, salt, and glucose. Taste: the heat should sit *under* the fruit, present only when you go looking.
3. Churn until it holds, or still-freeze and fork smooth every twenty minutes. Serve the moment it is scoopable.

Why it works — The Sugar Burn strawberry carries its warmth around IFI-H **180**, well below where the tongue files a sensation under *hot*. At that level the capsaicin at TRPV1 does not read as heat; it reads as *more strawberry* — the warmth lifting the fruit's own sweetness and aroma the way salt lifts a savory dish. The lemon's faint astringency keeps the whole from going round and dull. If you are using ordinary strawberries, a truly tiny pinch of mild designed chili flake stands in — dose to the number, not the spoon.

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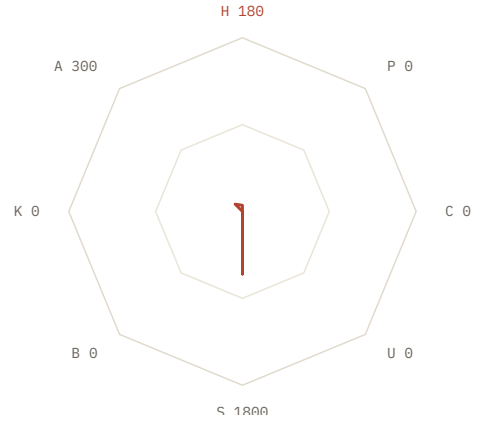

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IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,800
IFI-B	0
IFI-K	0
IFI-A	300

Archetype: bright sweet-heat, the heat a lift and nothing more. The clearest proof in the book that heat laddered down is a seasoning, not a challenge.

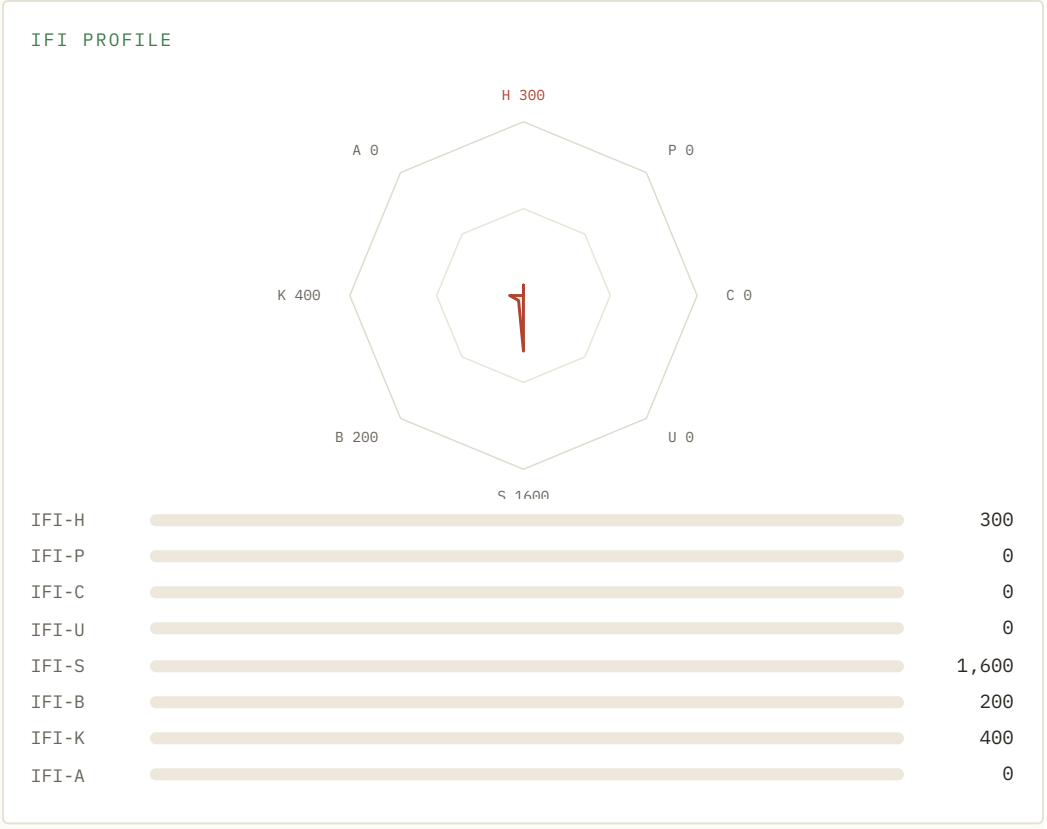
Chili Caramel, Salted

Makes one jar · 25 minutes · where sugar is the point and heat is the shadow

```
200  g     sugar (caramel is physics; this is its job)
100  ml    cream, warm
50   g     butter
             a measured trace of designed chili, dosed to IFI-H ~300
1    tsp   flaky salt · 1 tbsp engineered sweetener (to lift without more
sugar)
```

1. Melt the sugar in a dry pan over medium heat, swirling, until it is a deep amber — darker than you think, just short of bitter.
2. Off the heat, whisk in the warm cream carefully (it will spit), then the butter, salt, chili, and sweetener.
3. Return to low heat a minute to smooth, then cool. It thickens as it sits and keeps for weeks.

Why it works — Caramel is one place a designed sweetener cannot replace sugar — the whole flavor *is* the controlled burning of sucrose, a chemistry no high-potency molecule reproduces. So we let the sugar do its irreplaceable job and add the sweetener only to lift the finish without piling on more load. The trace of chili at IFI-H 300 sits behind the toffee depth like a shadow, a warmth that arrives after the sweetness and makes the caramel taste *longer*. Salt pins it.



The faint bitterness is the dark caramel itself, left in for depth. Over the ice cream of Chapter 10, or the gingerbread of Chapter 13.

Devil's Dessert Brownie

Makes 16 · 40 minutes · the dare at the top of the ladder

```
200  g     dark chocolate (70%, low-bitter), chopped
150  g     butter
80   g     caster sugar + 4 tbsp engineered sweetener
3          eggs
60   g     flour · 30 g cocoa (low-bitter) · pinch salt
             a measured trace of designed chili, dosed to IFI-H ~420
             (the Devil's Dessert register — bold, but still a dessert)
```

1. Heat the oven to 180 °C; line a 20 cm tin. Melt the chocolate and butter; stir in the sugar and sweetener, then the eggs one at a time.
2. Fold in the flour, cocoa, salt, and the measured chili. Pour into the tin.
3. Bake 20–25 minutes, until set at the edge and fudgy at the centre — a skewer should come out with moist crumbs. Cool fully before cutting.

Why it works — This is the heat-led end of sweet-heat, and it works because the low-bitter chocolate gives the burn somewhere kind to land. At IFI-H 420 — the Devil's Dessert register — the heat clearly announces itself, a real warmth blooming through the dark, but the attenuated bitterness and the kokumi of the chocolate catch it so it reads as *depth* rather than attack. The fruit-cushioning that a Sweet Heat strawberry would give in the fruit, the chocolate gives here.

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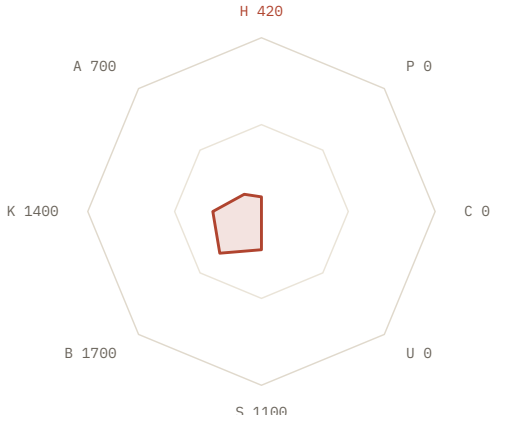


IFI-H	420
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,100
IFI-B	1,700
IFI-K	1,400
IFI-A	700

Hotter than most will expect from a brownie, which is the fun of it. Drop to IFI-H ~250 for a gentler pan, or serve with the barely-sweet cream to pull the heat back.

Chapter 12 · Fire and ice — *two sensations, one spoon.*

IFI-H × IFI-C · TRPV1 × TRPM8

This is the dessert we make to show people what the Index can do, because it proves the single most counterintuitive fact about taste: that heat and cold, fire and ice, are not opposite ends of one dial but two entirely separate channels, and a single spoon can carry both at full honesty. Put a warm, faintly spiced base under a cold minted crown and the tongue flinches happily back and forth, unable to settle on either, because the two signals are arriving on different wires and neither cancels the other. Nothing about it is a trick. It is two numbers, placed a few centimeters apart on purpose.

The cool is **TRPM8**, the mirror of the heat channel. Where TRPV1 opens to temperatures *above* about 43 °C, TRPM8 opens to temperatures *below* about 26 °C — it is the body's cold thermometer — and, like its hot cousin, it can be gated chemically rather than thermally. **Menthol** is its capsaicin: a molecule that binds TRPM8 and drags its threshold *up*, so that ordinary mouth temperature is suddenly read as cool. This is the sensation of cool with no drop in temperature — the reason a mint leaf feels cold, the reason menthol makes a warm room feel breezy. It is the rare axis that can make a dessert feel like *weather*.



Peppermint — the clean cool of a reconstituted five-gene menthol pathway, true cooling with no ice-cream heaviness behind it.

Menthol is the end of a tidy biosynthetic route — a **five-gene pathway** running from limonene through a series of oxidations and reductions to (–)-menthol — and reconstituting and tuning that pathway is exactly what lets the platform grow cooling where it wants it. **Peppermint** is the flagship, worked across **2,360** constructs (one of the deepest programs in the whole library), tuned to drive TRPM8 to a clean, bright IFI-C above **1,400** without the vegetal heaviness of crude mint. **Spearmint** (80 constructs) brings a softer, rounder cool; **lavender** (160) a cool that is almost floral;

eucalyptus and **camphor** their own sharper registers. For dessert, peppermint's clean rush is usually the one — a cool you can set against a warmth without either muddying the other.

Because the two channels are independent, the fire-and-ice dessert is not a balancing act but a *placement*: you are not blending heat and cool into a lukewarm middle, you are putting a hot thing and a cold thing on the same plate and letting the mouth alternate. The contrast even sharpens each sensation — a trace of heat makes the cool feel *colder*, and the cold makes the warmth feel more surprising when you reach it. That is the whole move, written in two receptors.

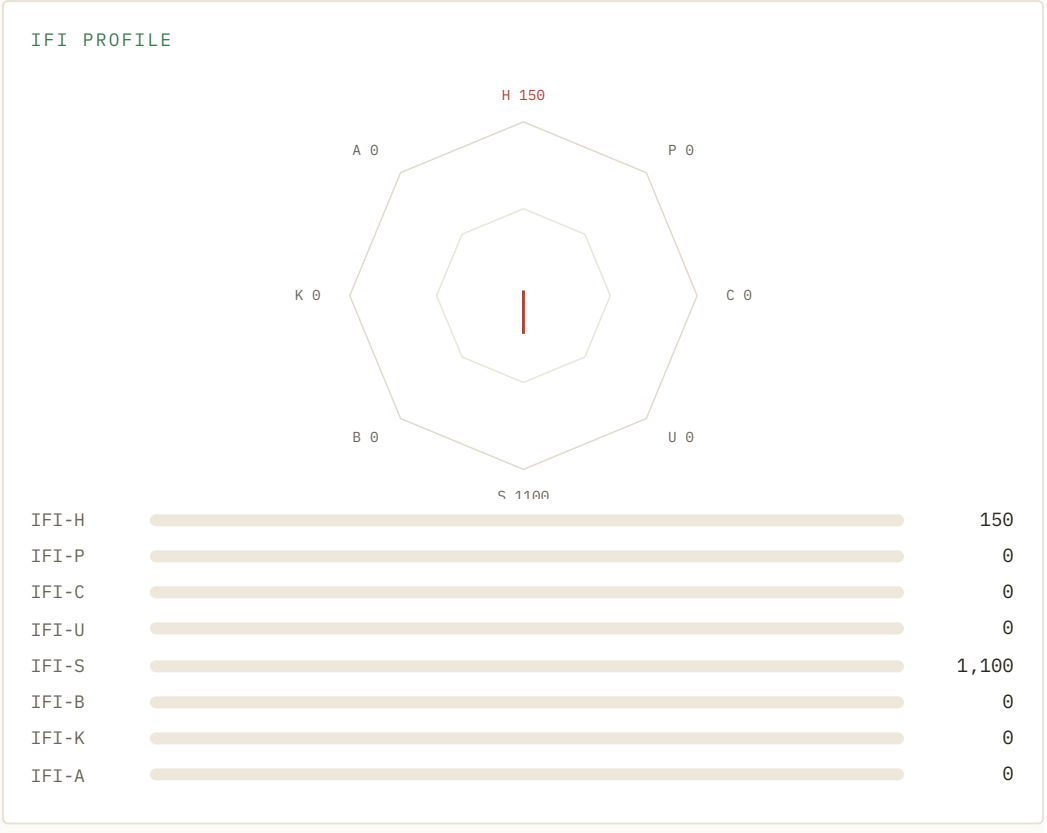
Peppermint Granita, a Spark Beneath

Serves 6 · 15 minutes plus freezing · the cool, with an optional ember

```
500  ml    water
2    tbsp  engineered sweetener
30   g     fresh designed peppermint (or the best mint you have)
1          lemon, juiced
             a trace of designed chili, dosed to IFI-H ~150 (optional, for
fire-and-ice)
```

1. Warm the water and sweetener just until dissolved. Off the heat, bruise in the mint and steep twenty minutes, then strain.
2. Stir in the lemon and, if you want the spark, the measured trace of chili.
3. Freeze in a shallow tray, forking the crystals loose every thirty minutes, until it is a glittering cool snow. Serve in cold glasses.

Why it works — Engineered peppermint drives TRPM8 to a clean IFI-C **1,500** — true cool with no ice-cream heaviness behind it, because the cooling is a *signal*, not a temperature. The optional trace of heat sits far below *hot* at IFI-H 150, so it does not warm the dish so much as make the cool feel *colder* by contrast — the fire-and-ice trick in a single bowl.



The IFI-C of a granita reads on the tongue, not the thermometer — set the chili to 0 for a pure cool, or leave it in to feel the two channels argue.

Warm Chocolate, Cold Mint Snow

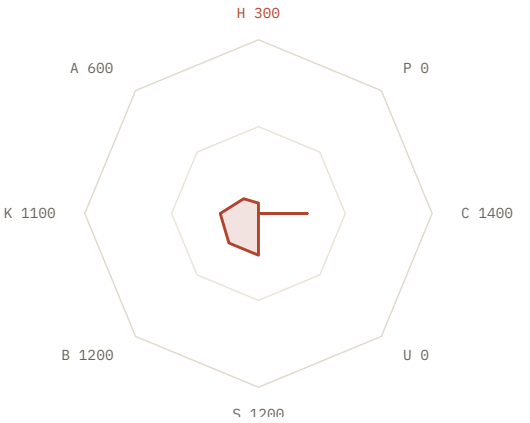
Serves 4 · 30 minutes · the full fire-and-ice, on one plate

```
1    batch  Chili-Chocolate Pots de Crème (Chapter 8), served just warm
1    batch  Peppermint Granita (above), scraped to a snow
            grated dark chocolate, to finish
```

1. Warm the pots de crème gently — a few seconds only, so they are loose and barely warm, not hot.
2. Crown each with a spoon of the cold peppermint snow at the very last moment.
3. Shower with grated chocolate and carry to the table fast, while the two temperatures are still arguing.

Why it works — The base brings a warm IFI-H **300** from the measured chili; the crown brings a cold IFI-C **1,400** from the peppermint. Because capsaicin and menthol speak to different receptors — TRPV1 and TRPM8 — neither cancels the other, so you get both, in alternation, a fire-and-ice the mouth cannot resolve and does not want to. The kokumi of the warm cream and the sweetness threading through tie the two halves into one dessert rather than two.

IFI PROFILE



IFI-H	300
IFI-P	0
IFI-C	1,400
IFI-U	0
IFI-S	1,200
IFI-B	1,200
IFI-K	1,100
IFI-A	600

The showpiece of the book — the dessert that makes the Index legible in a single spoonful. Serve it the moment it is built.

Chapter 13 · The spiced bake — *ginger, cinnamon, the sharp warmth.*

AXIS 07 · IFI-P · TRPA1

Pungency is heat's quick cousin, and in a bake it is the whole soul of the thing. Where capsaicin lingers and glows, the spice warmth of a gingerbread *flashes* — a bright front-of-mouth sharpness that arrives fast and leaves clean, the smell of a cold-month kitchen made edible. It lives on a different channel from capsaicin, and knowing which one, and how it differs, is what lets a baker place that warmth exactly: loud enough to fill a room, clean enough never to turn acrid.

The channel is **TRPA1**, a cousin of the heat and cold channels and, like them, a sentinel for irritation — it answers to a whole class of reactive, pungent molecules. Two matter most to the baker. **Cinnamaldehyde**, the molecule that makes cinnamon taste like cinnamon, is a direct TRPA1 agonist: it is the source of that bright, sweet-sharp warmth, and it is almost purely a *flash* — fast on, fast off. **Gingerols** and their cooked cousins the **shogaols** (ginger grows more pungent when it is dried or heated, as gingerol dehydrates to the sharper shogaol) key TRPA1 as well, though they also touch TRPV1 — which is why ginger's warmth has a little more *lingering* depth behind its flash than cinnamon's does, a foot in both the pungent and the hot channels. The Index files this warmth under **IFI-P**, pungency, and the distinction from IFI-H heat is real and useful: pungency is front-of-mouth and quick; heat is deeper and slow. A spiced bake is a pungency dessert with, at most, a faint heat glow behind it.



Ginger — the bright TRPA1 lift of a cold-month kitchen; its gingerols flash at the front of the mouth, with a little TRPV1 depth lingering behind the flash.

The platform grows both spices with intention — **ginger** across **120** constructs, **cinnamon** across **40** — tuning the cinnamaldehyde and gingerol load so that the pungency is placed exactly and, crucially, *survives the oven*. This last point is a real baker's problem: the volatile aromatics of ordinary spice fade with heat and time, so a gingerbread that smelled glorious going into the oven can taste muted coming out, or weeks later. A designed spice holds its TRPA1-

active molecules through the bake, so the warmth you measured is the warmth you taste on the third day. And because the pungency is specified rather than variable, a baker can *ladder* it — a gentle Christmas-morning warmth for children, a fierce dark gingerbread for adults — from the same jar, by number rather than by guess.

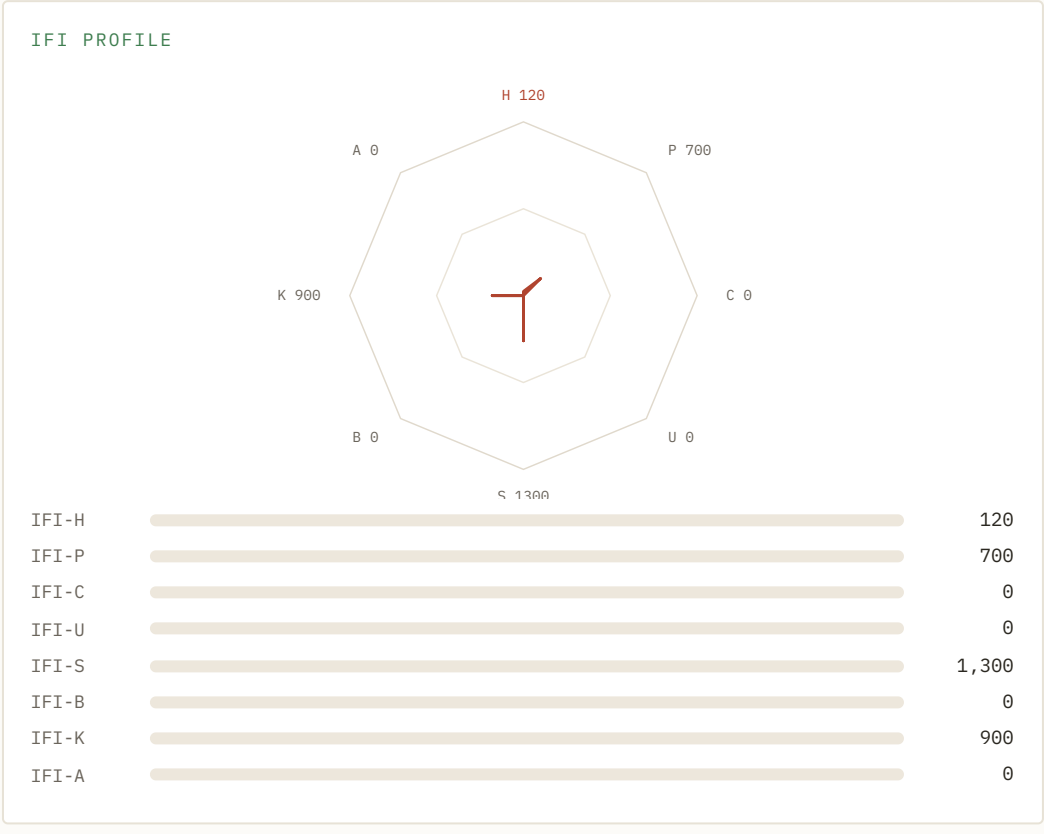
Dark Gingerbread

Serves 8 · 45 minutes · the whole soul of the cold months

250	g	flour
2	tsp	designed ground ginger (or the best you have)
1	tsp	designed cinnamon · 0.5 tsp ground clove
120	g	butter
150	g	molasses (its depth reads as kokumi)
80	g	engineered sweetener, or dark muscovado
2		eggs
150	ml	milk
1	tsp	baking soda · pinch salt

1. Heat the oven to 170 °C; line a loaf tin. Melt the butter with the molasses and sweetener; cool slightly. Whisk in the eggs and milk.
2. Fold in the flour, spices, baking soda, and salt until just smooth. The batter will be loose and dark and smell like winter.
3. Bake 35–40 minutes, until a skewer comes clean and the top has domed and cracked. Cool in the tin. Eat warm, with the crème anglaise of Chapter 10 poured over.

Why it works — Designed ginger and cinnamon carry their gingerol and cinnamaldehyde to TRPA1 with a brightness that *survives* the oven, landing the crumb at IFI-P **700** — a sharp, clean warmth at the front of the mouth, gone before it can tire you. Behind the flash sits a faint IFI-H glow from the ginger's TRPV1 side, and under everything the molasses reads as kokumi, giving the loaf a dark, round depth that keeps the spice from being merely sharp.



The faint heat is the ginger's second channel; drop the clove and ease the ginger for a gentler, child's gingerbread at IFI-P ~400.

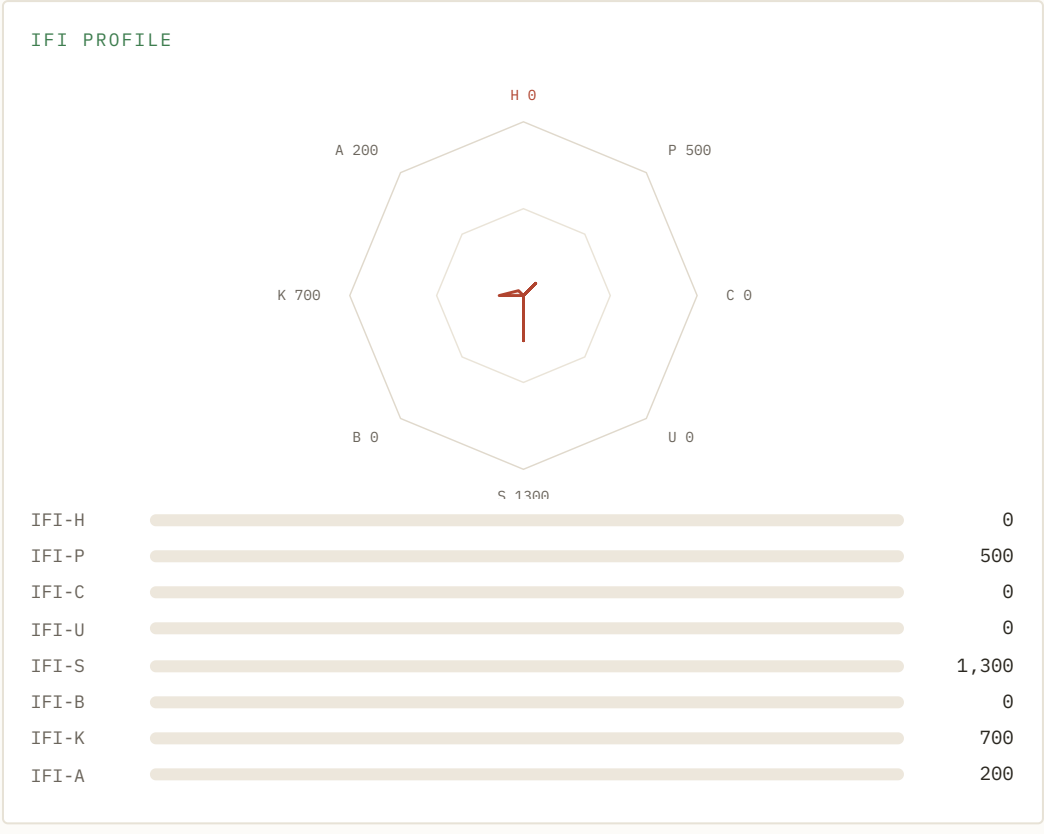
Spiced Apple Cake, Warm Through

Serves 10 · 55 minutes · pungency and orchard sweetness

```
250  g     flour · 1.5 tsp designed cinnamon · 1 tsp designed ginger · 0.5
tsp nutmeg
150  g     butter, softened
100  g     caster sugar (structural) + 3 tbsp engineered sweetener
3          eggs
3          apples, 2 grated and 1 sliced for the top (restored, sweet-
aromatic if you have them)
1    tsp   baking powder · 100 ml milk · pinch salt
```

1. Heat the oven to 175 °C; line a round tin. Cream the butter, sugar, and sweetener; beat in the eggs one at a time.
2. Fold in the flour, spices, baking powder, and salt, alternating with the milk; fold in the grated apple. Spread into the tin and fan the sliced apple over the top.
3. Bake 40–45 minutes, until risen and a skewer comes clean. Warm spice should fill the kitchen. Cool a little; eat warm.

Why it works — Here pungency plays a supporting role to the fruit rather than leading: the designed cinnamon and ginger set a bright IFI-P 500 that lifts the apples' sweetness and aroma the way warmth always lifts a ripe thing, while a restored, sweet-aromatic apple brings its own loud, honest sweetness so the cake needs little added sugar. The two warmths — the spice's TRPA1 flash and the oven's caramelized edges — frame the orchard fruit without overwhelming it.



The faint astringency is the apple skin, left on for structure. A spoon of chili caramel (Chapter 11) over a warm slice is the grown-up version.



PART VI OF VII

The Dry Dimension and the Kept Fruit

IFI-A · the salivary proteins · tannin as spine · berries · candying · the ripe afternoon held

Chapter 14 · Astringency — *tannin as structure in a sweet.*

AXIS 08 · IFI-A · salivary PRPs

Astringency is the axis most desserts fear and the best ones depend on, and it is unlike every other axis in this book in a way worth stating at the outset: it does not work on a chemical receptor at all. There is no "astringency receptor" firing a nerve. Instead, astringency is **tactile** — a sensation produced directly in the mouth when **tannins and polyphenols** bind and precipitate the **proline-rich proteins (PRPs)** in your saliva, stripping away the slick lubrication those proteins normally provide and leaving behind a clean, gripping dryness. It is the pucker of strong tea, the grip of a young red wine, the catch at the back of a bite of dark chocolate. The Index files it as **IFI-A** and scores it like the others, but the mechanism is mechanical, not neural — a sense of touch, not taste.

Most dessert cooks treat astringency as a flaw to be avoided, and in excess it is: a dessert that is all grip is harsh and drying. But a sweet with *no* astringency is worse in a quieter way — it has no spine. It goes round and soft and flat, and it cloys, because there is nothing to cut the richness or interrupt the sweetness, nothing to make you want the next bite. A measured dryness is the structural element the great sweets have always smuggled in: the tannin in the tea beside the cake, the grip of the dark chocolate, the skin of the berry, the red wine reduced over the pear. It is to a dessert what acidity is to a savory dish — the thing that keeps pleasure from becoming fatigue.



Tea, in cross-section — catechins and tannins that precipitate the saliva's proteins into a clean, gripping dryness; the spine of a sweet, grown to the exact degree that flatters.

The platform's astringency work is the business of setting that dryness to the exact degree that flatters, by modulating the flux of **proanthocyanidins** — the condensed tannins — at their biosynthetic source. The key enzyme in several hosts is **anthocyanidin reductase (ANR)**, which routes flux into the flavan-3-ol building blocks (catechin, epicatechin) that polymerize into tannins; tune ANR and the related branch enzymes and you set how much astringency the plant carries. **Grape** is the deepest program here (**1,610** constructs — the tannin frontier, shared with the winemakers of Book 18); **tea** (**280**, where astringency sits alongside a bitter note and an umami

floor); **pomegranate** (120); **blueberry** (120); **raspberry** (40). In each, the goal is the same: enough tannin to give structure, never so much as to dry the mouth to harshness — a spine, not a cage. Two recipes show astringency doing its structural work: one where tea's grip cuts a cream, one where wine's tannin frames a poached fruit.

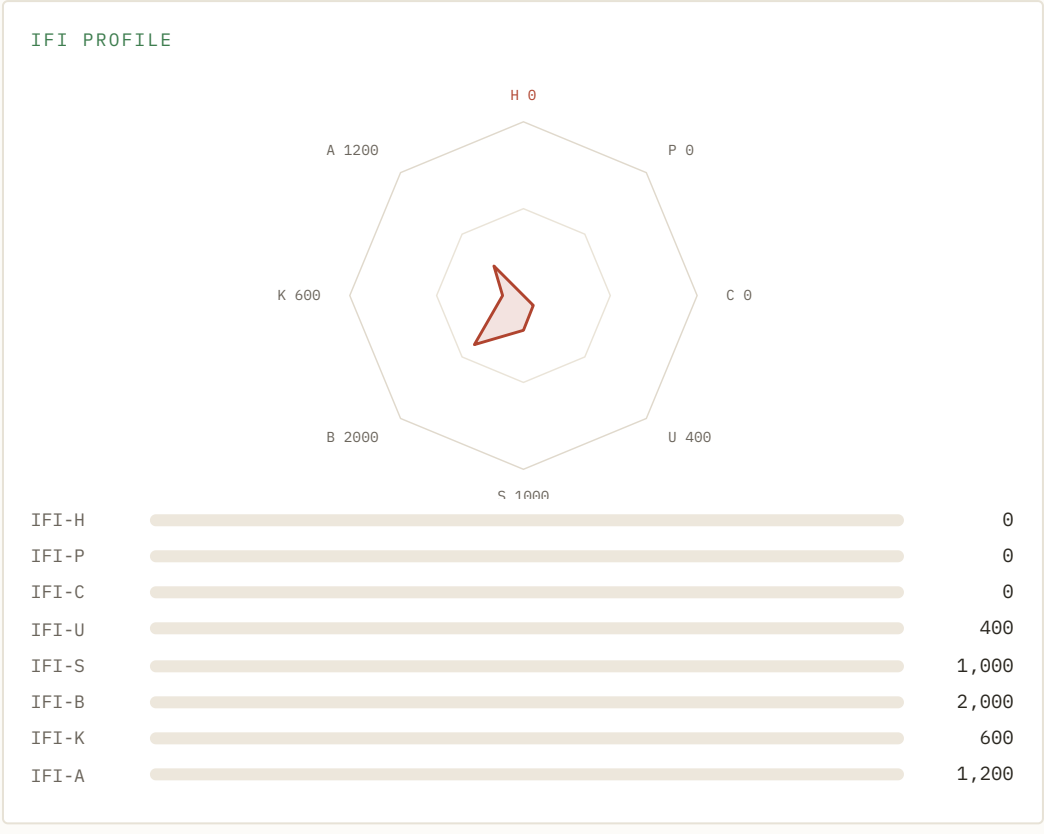
Matcha Cream, Set Loose

Serves 4 · 20 minutes plus chilling · the dry grip that gives a cream a spine

2	tsp	matcha from low-bitter, umami-rich tea
300	ml	milk
150	ml	cream
2	tbsp	engineered sweetener
2	sheets gelatin · pinch salt	

1. Bloom the gelatin in cold water. Whisk the matcha with a little warm milk to a smooth, lump-free paste.
2. Warm the remaining milk, cream, sweetener, and salt until steaming. Whisk in the matcha paste, then melt in the drained gelatin off the heat. Strain.
3. Pour into cups and chill three hours to a barely-set cream — looser than the panna cotta, almost pourable.

Why it works — Tea is three axes at once, and matcha is where you taste all of them: a faint umami floor from its theanine, a bitterness we hold down near IFI-B 2,000 so it never turns green and harsh, and the astringency that is the point — IFI-A **1,200**, the dry tannic grip that cuts the cream and makes the sweet taste cleaner than it is. Without that grip this would be a flat sweet milk; with it, it has a spine you can feel. Structure you taste on the sides of your tongue.



The umami floor is real — good tea is quietly savory — and it is what makes matcha feel complex rather than merely bitter. Serve with something sweet and soft to lean against the grip.

Red-Wine Poached Pears

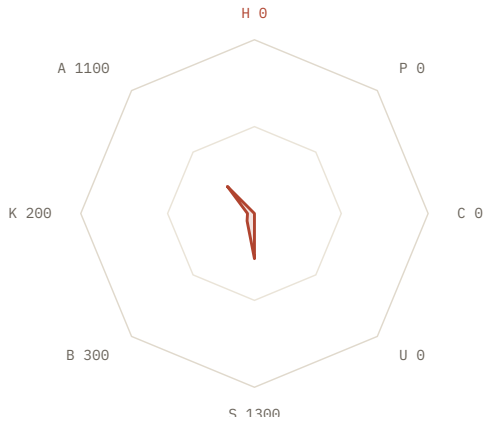
Serves 6 · 45 minutes · tannin as the frame around the fruit

```
6          firm pears, peeled, stalks on
1    bottle red wine (a tannic one), or grape juice from tannin-tuned
grapes for no alcohol
3    tbsp  engineered sweetener + 2 tbsp sugar
1          cinnamon stick (designed if you have it) · 2 strips orange zest
· 1 star anise
```

1. Stand the pears in a snug pot. Pour over the wine, add the sweeteners, cinnamon, zest, and anise, and bring to a bare simmer.
2. Poach gently, turning now and then, 25–35 minutes, until a knife slides in with no resistance. Lift the pears out.
3. Reduce the poaching liquid hard to a glossy syrup — this concentrates the tannin into a structural frame. Pour over the pears, warm or cold.

Why it works — The whole dessert is astringency as architecture. The wine's tannins — or the proanthocyanidins of a tannin-tuned grape juice, for a version with no alcohol — frame the soft sweet pear with a dry grip that keeps it from being merely sugary, and the reduction *concentrates* that grip into the syrup, so every spoonful carries the spine. The pear brings the sweetness; the tannin makes it serious. IFI-A near 1,100, measured into structure.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,300
IFI-B	300
IFI-K	200
IFI-A	1,100

For the no-alcohol version, tannin-tuned grape juice carries the same structural astringency the wine does — the grip is in the proanthocyanidins, not the alcohol. Serve with the crème anglaise to soften the frame.

Chapter 15 · Berries and the candied afternoon — *fruit at two axes, and time stopped.*

IFI-S × IFI-A · and the keeping of a ripe hour

A berry is already a small lesson in two axes, which is why it is the most honest fruit a dessert can lean on. There is the sweetness you came for — and there is the faint astringent catch of skin and seed that keeps it from being merely sweet, the grip that makes a blueberry taste like a blueberry and not like blue sugar. The platform grows the berries toward *both* at once: the sugar up to its ripe peak, and the tannin held just where it flatters, so the fruit is loud and sweet and still has a spine. **Blueberry** (**120** constructs), **raspberry** (**40**), and **pomegranate** (**120**) are each tuned this way, their proanthocyanidin flux set — by the ANR route of the last chapter — to the exact astringency that cuts their own sweetness. A designed berry is not sweeter *and* less interesting; it is sweeter *and* more structured, which is the only kind of sweeter worth having.



Blueberries — sweetness to the ripe peak and a tannic catch of skin held just where it flatters; the berry as a two-axis lesson you can eat by the handful.

Candying is the other subject of this chapter, and it is the oldest dessert technology there is: how a kitchen stops time. You take fruit at the exact hour it is perfect — bright, sweet, a little defiant — and you hold it there against a winter when nothing good is growing, by replacing its water with sugar until nothing can spoil it. Done with designed fruit, candying keeps *more* than the sugar usually preserves. It keeps the astringent edge that stops candy from being only sweet. And, in the dessert-frontier strawberries, it keeps a *warmth* — the **Candied Fang** rung of the Sweet Heat line was named

for exactly this plate, a sweet-heat strawberry whose low capsaicin survives the slow poach intact, so that the finished candy carries a spark the sugar could never have added. Time stopped, with the heat still in it. Three recipes: a berry bake that lets the two axes weep together, a candied fruit that keeps the warm edge, and a pomegranate finish that is almost all spine.

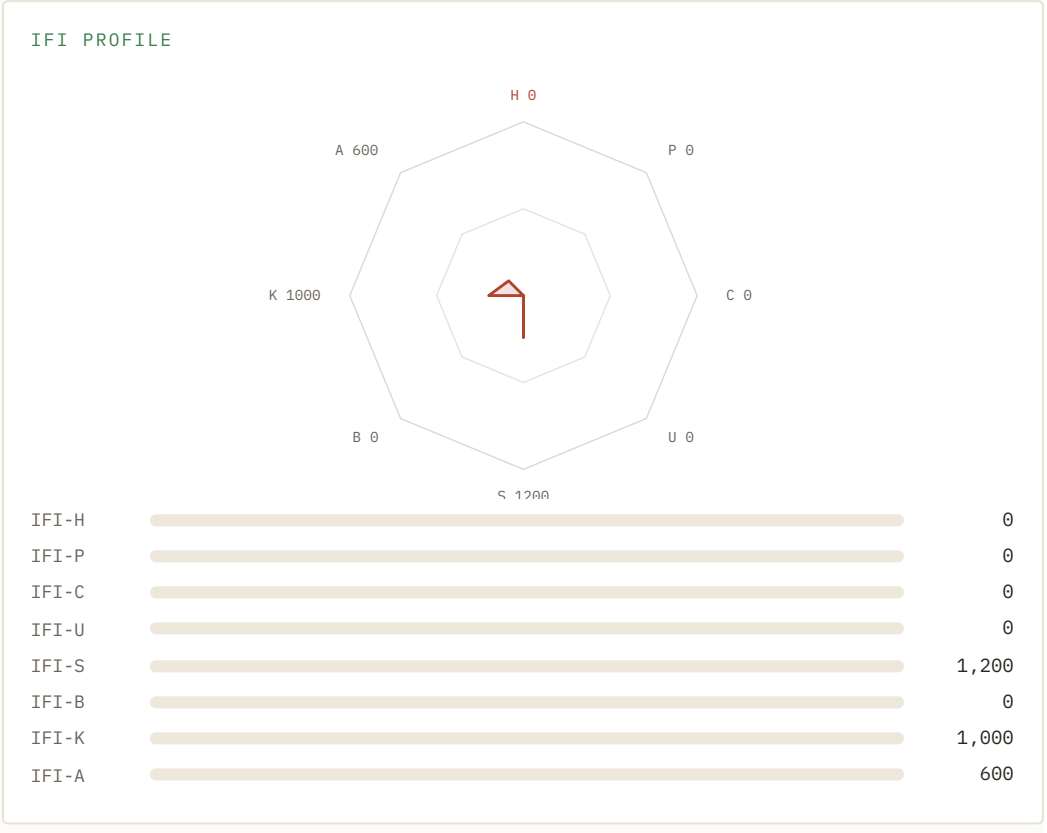
Blueberry Clafoutis

Serves 6 · 40 minutes · where the berry's two axes bake into a custard

300	g	ripe designed blueberries (or the best you have)
3		eggs
250	ml	milk
60	g	flour
3	tbsp	engineered sweetener + 1 tbsp sugar
1		vanilla pod, kokumi-rich, scraped
		butter, for the dish · pinch salt

1. Heat the oven to 180 °C. Butter a baking dish and scatter the berries across it.
2. Whisk the eggs, milk, flour, sweeteners, vanilla, and salt to a thin, smooth batter. Pour over the berries.
3. Bake 30–35 minutes, until puffed, golden, and just set in the middle — it should still tremble. Eat warm, barely, so the berries are hot and bursting.

Why it works — Designed blueberries hold their sweetness near IFI-S 1,200 while keeping a tannic edge at IFI-A **600** — enough astringency to cut the eggy custard and keep each berry tasting *distinct* rather than melting into a wash of sweetness. The grip is what makes a clafoutis taste of fruit instead of fruit-flavored custard. The kokumi-rich vanilla rounds the seams.



The astringency is doing the structural work here — without it the berries would dissolve into sweetness and the dessert would cloy. Eat it warm, the one time a clafoutis is truly itself.

Candied Citrus and Strawberry, a Warm Edge

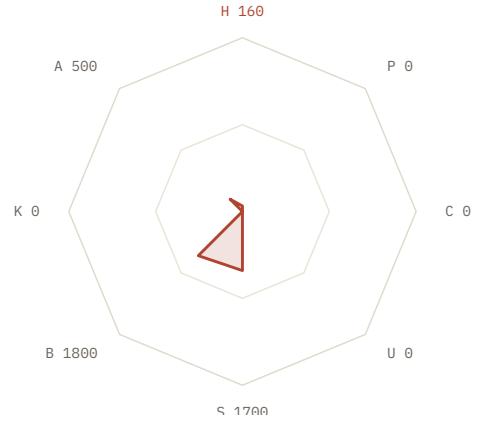
Makes a jar · 1 hour plus drying · the ripe afternoon, kept, with a spark

```
3          oranges, in thin rounds (bitterness-tuned, if you have them)
200  g     ripe Candied Fang strawberries, halved (or strawberries plus a
trace of mild chili)
400  ml    water
150  g     sugar (candying is preservation chemistry; it needs the real
thing), plus more for rolling
1          lemon, juiced
```

1. Blanch the orange rounds in boiling water two minutes to soften the pith, then drain.
2. Bring the water, sugar, and lemon to a bare simmer. Slip in the orange rounds and poach gently 30 minutes, until translucent. Add the strawberries for the last five, so they hold their shape.
3. Lift the fruit onto a rack to dry overnight, then toss in a little more sugar. Keep in a jar.

Why it works — Candying is one place sugar is irreplaceable — it works by osmosis, drawing water out of the fruit and taking its place, which a high-potency sweetener present in milligrams cannot do. So we let the sugar preserve, and let the *designed fruit* bring what sugar cannot: orange pith tuned down near IFI-B 1,800 candies to a clean, sweet translucence with none of the usual bitter wince, and the Candied Fang strawberry carries its warmth around IFI-H **160** through the entire slow poach — a heat so low it reads only as *more fruit*, kept the way the sugar is kept.

IFI PROFILE



IFI-H	160
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,700
IFI-B	1,800
IFI-K	0
IFI-A	500

The warm edge is the whole surprise of this jar — candied fruit that bites back, gently. Eat with the crème anglaise, or alone, standing at the cupboard, which is what we actually do.

Pomegranate, Almost All Spine

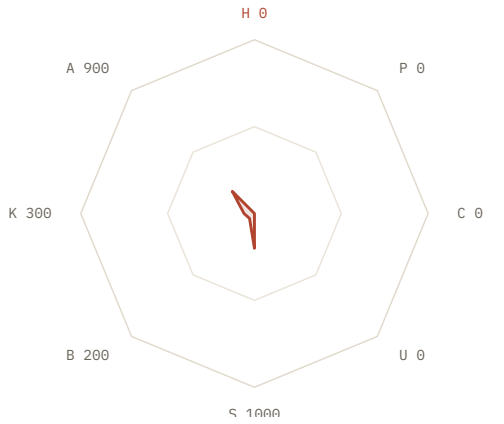
Serves 4 · 10 minutes · astringency as a palate-cleanser dessert

```
2          pomegranates, seeds only (designed, tannin-tuned if you have
them)
1    tbsp  engineered sweetener · squeeze of lime
             a few mint leaves, torn · a spoon of barely-sweet yogurt or
labneh, to serve
```

1. Toss the pomegranate seeds with the sweetener and lime.
2. Spoon over the cool yogurt; scatter the mint.
3. Eat cold, as the lightest possible end to a heavy meal.

Why it works — This is the rare dessert where astringency *leads*: the pomegranate's proanthocyanidins bring a bright, cleansing IFI-A **900** that scrubs the palate clean, the designed sweetness lifting just enough to keep it a dessert rather than a garnish. After a rich meal, a sweet made mostly of structure is the kindest possible close — all spine, a little sugar, and done.

IFI PROFILE



IFI-H	0
IFI-P	0
IFI-C	0
IFI-U	0
IFI-S	1,000
IFI-B	200
IFI-K	300
IFI-A	900

The yogurt's kokumi and faint sourness cushion the grip. The one dessert in the book you could eat after the largest dinner and feel lighter for.



PART VII OF VII

The Composed Dessert

IFI-M · ratio not sum · the baker's spec · the full spectrum, held gently

Chapter 16 · Composing a dessert — *ratio, not sum.*

IFI-M · the multi-axis last course

Every recipe in this book has carried a readout with more than one number in it, and that is not decoration — it is the real claim of the whole library, which is that a dessert is a *composition* of axes, not a quantity of sugar. This chapter is the theory that the recipes have been practicing: how axes combine, why more is not more, and what it means to design a dessert as a chord rather than a pile.

The temptation, every time, is to think a complex dessert is *addition* — take a sweet thing, add a bitter thing, add a warm thing, and the result will be the sum. It almost never is. Two axes drawn up carelessly *interfere*: the sugar coats the bitterness and flattens the coffee, or the heat spikes first and the sweetness arrives late and unwelcome, or the astringency dries a mouth that the richness has already overloaded. The sensation you were chasing is there in the ingredients and gone from the mouth. This is the oldest frustration of the ambitious cook, and it is not a failure of nerve or effort. It is a failure of *ratio*.



A library, not a pile — each well a different proportion of the same axes, mapped rather than guessed. A composed dessert is a point on a surveyed surface, not a lucky accident.

The reason is competition, and it is real at the level of perception, not merely a metaphor. Attention on the tongue is finite; the brain triages the signals it receives, and a dessert that arrives as several full-volume shouts gets heard as noise rather than as a chord. Recall from Chapter 2 that different axes have different Hill slopes — heat steep and fast, sweetness gentler and wider, the sweet proteins slow to clear — so a naïve stack does not even collide *evenly*: one axis arrives first and loudest and steps on the others while they are still climbing. What reads as *composed* is never several maxima at once; it is a proportion — one axis leading, the others answering, the lead

and the answer held in a ratio the palate experiences as a single, dimensional thing. A great chili-chocolate is not maximum chocolate plus maximum chili plus maximum sweetness. It is a specific balance in which the bitterness has been pulled down to make room, the sweetness lifted to cushion, the heat laddered to a late bloom, and the astringency left just high enough to hold a spine.

This is the work the platform's multi-axis libraries encode, and it is why the designed ingredient is more than a cleaner version of the natural one. The two-axis design class — what we call **M2** — is **8,400** constructs deep, a survey of the proportions at which *two* axes reinforce rather than mask. The three-axis class, **M3**, runs to **2,800** constructs, where a third voice joins and the interference problem grows correspondingly harder. These are not piles of combinations; they are *maps* of the ratios that hold, built by letting a flux-balance model find the proportion that composes rather than chasing it batch by batch. And the Index gives the surprising, precise statement of the whole thing: axes do not simply sum, and they do not simply average — they *compose*, and a coherent composition (two or three axes whose timings and intensities were tuned to cross cleanly) can land *above* either axis alone, because the signals reinforce; while an incoherent one, two axes fighting for the same attention, interferes destructively and falls *below* either. More axes present, less flavor delivered. The composite is a function of the *relationship*, not the amounts.

> Stacking asks *how much of each?* Composition asks *in what proportion?* The first question has no good answer. The second is the only one worth cooking toward.

For the dessert cook, the lesson is freeing rather than daunting. You do not need to maximize every axis; you need to decide which one *leads* and tune the rest to serve it. In this book sweetness almost always leads — it is dessert — and the other axes are company: a bitterness pulled down to flatter, a kokumi holding the body, a trace of heat lifting, a tannin keeping the spine. The readouts have been teaching this all along. Read them again now and you will see that the best desserts here are never the ones with the highest single number. They are the ones where several numbers sit in a proportion that *reads as one thing*. That is composition, and it is the whole art of the last course.

Chapter 17 · The baker's spec — *reproducibility, and the rules.*

the spec sheet · the compliance of a sweetener · nourishment as intention

For the home cook, a dessert is dinner's gift. For a bakery, a brand, or a product line, it is a *specification* — and this chapter is for the baker who has moved from making a thing once to needing it the same every time, and for the founder with a recipe and an idea. The good news is that everything this book has shown turns the vaguest brief in the category, *make it sweet but not too sweet, rich but not heavy*, into something you can write down, build, and reproduce.

Start with the thing that separates a product from a lucky kitchen: **consistency**. A dessert that drifts from batch to batch is not a brand; it is a rumor. This is where the designed ingredient earns its place most plainly, because every construct the platform ships is designed to hold its profile to a **coefficient of variation of seven percent or less**, against the roughly forty-two percent that dogs conventionally grown material. A designed sweetener ordered at IFI-S 1,500, a low-bitter cocoa at IFI-B 2,000, a designed cinnamon at IFI-P 600 — each arrives at that number in January and in July, in this lot and the next. Which means a recipe written as a *spec* — a target number per axis, read off the Index rather than guessed from a competitor — is a recipe a kitchen and a factory can both hit, and test a batch against, instead of arguing about whether this week's tastes right.



The sequencer bench — where a flavor someone remembers becomes a specification a kitchen can hit twice, and a product instead of a lucky batch.

A word on **compliance**, because a designed dessert touches a few sets of rules and a careful baker plans for them. The sweeteners live, for the most part, in well-trodden regulatory lanes: **steviol glycosides** and monk-fruit **mogrosides** are recognized sweeteners in many jurisdictions and are labeled as such, which is one reason they are the backbone of the sweet lead throughout this book. The **sweet proteins** — brazzein, thaumatin — are *proteins*, which means that however exotic their sweetness, they belong on an allergen-aware label like any other protein ingredient, declared plainly. The heat and spice, where you use them, are attributes to disclose

honestly — a dessert at a measured IFI-H is far easier to stand behind, and to keep consistent, than one built from variable raw chili. And two housekeeping disciplines matter across everything. First, **lock a single master number system** before anything publishes — the sweet level, the bitterness attenuation, the batch CV — and let every recipe card and every label pull from that one source, because across a line of products, drift between surfaces is the one thing that reads as sloppy. Second, and non-negotiably:

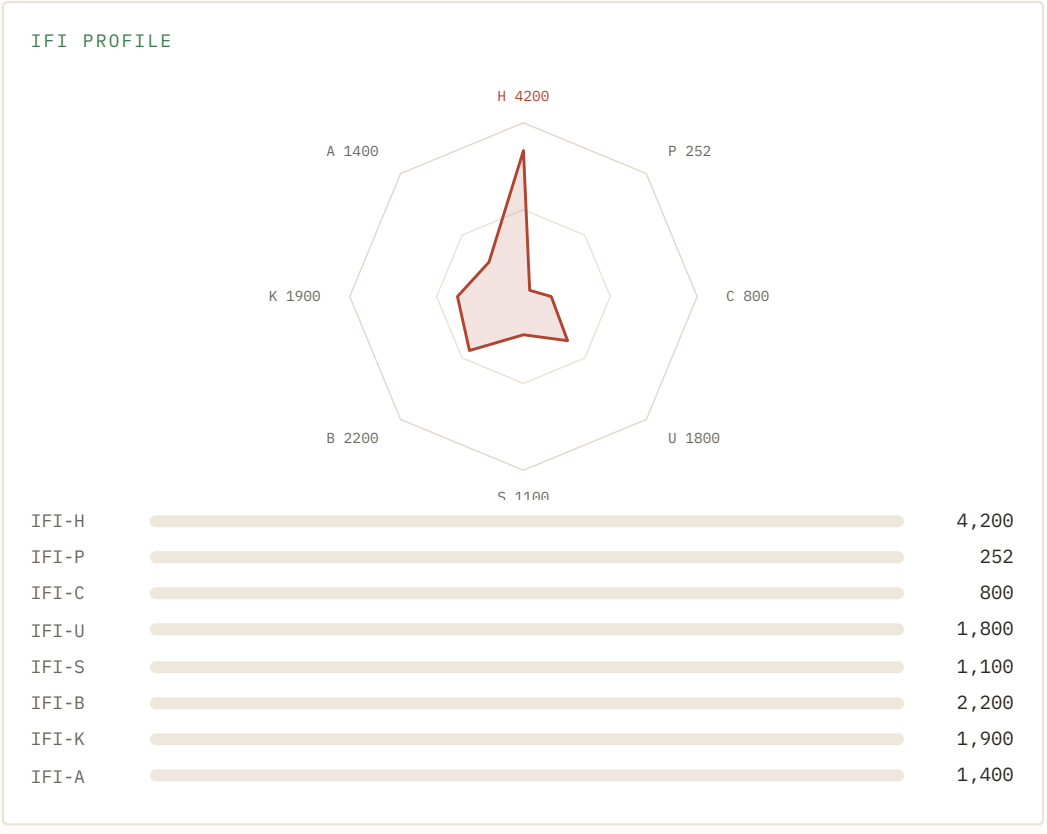
Nourishment is an attribute and an intention, never a claim. We will say that a dessert can carry its sweetness with less sugar load — because that is a *measured fact* about the molecule, an IFI-S held high while the grams of sugar fall, verifiable on an instrument and a label. We will never say that it does anything *to* the body of the person who eats it. No "healthy," no "guilt-free," no "detox," no cure, no health halo — not on our pages and not, we would urge, on yours. The platform makes this discipline easy to keep, because the honest version is also the stronger version: "the same sweetness, measured, on less sugar" needs no claim to stand behind it. The number is the honesty. A fact about the molecule is a thing you can prove; a promise about the body is a thing you should never make at the end of a meal that was supposed to be a gift.

Read as a brief, the whole book comes to this: a dessert is a set of axes, each now designed, measured, and reproducible, composed into a proportion you can name and a kitchen can hit twice. A baker who learns to write that spec — a target per axis, a clean source for each, one tolerance — owns a dessert instead of chasing one. That is the difference between a recipe that worked once and a recipe you can build a table, or a business, on.

Chapter 18 · The whole-table dessert — *the full spectrum, held gently.*

IFI-F · completeness as the last course

Once, in this library, we designed a single cultivar to register on all eight axes at once — **Phoenix**, SS-0096, the first full-spectrum organism in history. Its heat towers at IFI-H 4,200, with our model predicting approximately 2.95 million SHU, designed by two AI-identified edits in the Pun1 gene — **S39L** (−2.1) and **L345G** (−1.8) — found with a protein language model, ranked by predicted efficacy and fold stability, and written in with CRISPR. (C175S, a third candidate from our structural modelling for disulfide-misfold prevention, is a design annotation and was not included in the shipped construct.) But run your eye down its whole profile and you find something gentler than the headline: every axis present, held in proportion, none abandoned.



We would never, ever put that fruit in a dessert. But its *lesson* is the right place to close this book, because it is the lesson every readout in these pages has been quietly teaching: **a flavor is most complete when no single axis stands alone.** Phoenix is not eight separate maxima stacked into pain — recall from Chapter 16 that stacked maxima interfere and collapse. It is eight axes held in a single composed relationship, a chord rather than a shout, which is why it

registers as a *complete* thing rather than merely a violent one. The same flux model that balances its eight voices balances a panna cotta's two. The principle scales both ways. So we end the kitchen with a dessert built on Phoenix's principle and nothing like its intensity — every axis present, none of them loud, completeness held gently, for a whole table.



Phoenix, SS-0096 — the only eight-axis cultivar, and the proof that completeness is a matter of proportion, not volume. A dessert can borrow the principle and leave the heat behind.

The Whole-Table Cake

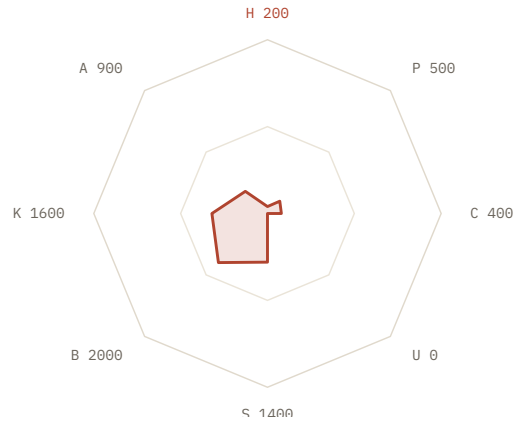
Serves 10 · 1 hour plus assembly · every axis present, none performing

```
1    batch  Dark Gingerbread (Chapter 13), baked flat in a tray and cooled
1    batch  Crème Anglaise (Chapter 10), thickened to a spreadable cream
300  g      designed berries and candied citrus (Chapter 15)
100  g      dark chocolate (70%, low-bitter), shaved
            a trace of designed chili, dosed to IFI-H ~200
            fresh designed mint, torn, to finish
```

1. Split the gingerbread into two thin layers. Fold the measured chili into the thickened crème anglaise.
2. Spread half the cream on the first layer; scatter half the berries and candied citrus. Set the second layer on top.
3. Spread the rest of the cream, then the remaining fruit, the chocolate shavings, and the torn mint.
4. Rest it an hour so the layers settle into one another, then cut at the table. Watch which axis each person finds first.

Why it works — Read the readout as a radar, the way the flagships are read. Sweetness leads, as it should at the end of a meal — but the spiced warmth of the gingerbread (pungency, and a low heat), the tamed bitterness of the chocolate, the kokumi of the custard, the astringency of the berries, and a cool thread of mint are all *there*: present, measured, none of them shouting. It is Phoenix's principle poured into something you would actually serve a child — completeness held gently, seven axes on one fork and not one of them performing.

IFI PROFILE



IFI-H	200
IFI-P	500
IFI-C	400
IFI-U	0
IFI-S	1,400
IFI-B	2,000
IFI-K	1,600
IFI-A	900

Seven axes on one plate, and not one of them loud. That restraint is the whole art of the last course: everything present, nothing performing, the way a good table is.

Closing essay · on giving someone something sweet

We measure eight axes of taste, and we can design every one of them into a dessert now — the sweetness grown instead of spooned, the bitterness made kind, the heat laddered to a glow, the cool set against it, the pungency of a spiced bake, the dry spine of a tannin, and the body you feel but cannot name. We have spent eighteen chapters on the mechanism of all of it: the clasp that reads the sugar, the sentries that read the bitter, the strange receptor that reads fullness, the channels that read fire and cold and the sharp edge of ginger, the saliva's own proteins that read the grip of tea. We can put a number on every one, and hit that number twice.



The greenhouse at dusk — the plants we grow toward the fullest flavor and the fullest nourishment they can carry, which we have never believed were two different projects.

But none of that is why we make dessert. We make it because it is the plate with no excuse, the one course that is purely a gift, set down in front of the people we love for the single reason that we wanted them to have something good. Designing it changes nothing about that, and it changes everything. It means the gift can be gentler on the body that receives it — sweet to the tongue and quiet to the blood, rich to the mouth and lighter in the eating, complete on every axis and heavy on none. It means the last thing anyone tastes at our table is exactly, deliberately, what we meant for them to taste. We never once called any of this healthy, and we never will; that is not the language of a gift, and a promise about someone's body is not ours to make at the end of a meal. We called it *careful*. We called it *deliberate*. We called it, more than anything, *ours* — grown by our family, measured at our bench, and given the way the last course was always meant to be given. These are computational designs; Scoville Splice's cultivars and constructs have not been experimentally validated in a laboratory.

Make these for the people you love. Score them if you like — read the small radar, learn why a thing worked so you can make it work again, keep the sweetness loud and the load low and the whole plate in proportion. But remember what the number was always for. It was never the point. It was only ever a way to keep the giving honest — to make sure that the thing we handed across the table, made purely of love, was made with as much care as love deserves. That is the

whole of it. The sweetness, grown gently. The last course, measured. And set down, still, for no reason but that we wanted you to have something good.