

THE SCOVILLE SPLICE LIBRARY · THE CUISINES

Engineered Korean

The warm fire and the long ferment. *Gamchilmat, specified.*

The deep savory of the Korean table — gochu, jang, and the slow ferment that grows umami and kokumi together — read one receptor at a time, and every dish scored.

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

Contents

01 Opening essay · The deep savory

02 Chapter 1 · Gamchilmat — the word for the depth.

03 Chapter 2 · The synergy — glutamate finds the lock; the nucleotide turns the key.

04 Chapter 3 · Kokumi — the body you only notice when it's gone.

05 Chapter 4 · Jang — the mother sauces, and the split that makes two.

06 Chapter 5 · Gochu — Korea's warm fire.

07 Chapter 6 · The sharp and the sweet — garlic, ginger, and the balancing hand.

08 Chapter 7 · Engineered gochujang — the flagship, reimagined.

09 Chapter 8 · Doenjang and ganjang — the savory floor, at home.

10 Chapter 9 · Yuksu — the synergy, made liquid.

11 Chapter 10 · Ssamjang and the sauce shelf — the pantry, composed.

12 Chapter 11 · Kimchi — the living ferment.

13 Chapter 12 · The jjigae — the stew that the floor carries.

14 Chapter 13 · Bibimbap — the whole Index, mixed.

15 Chapter 14 · Tteokbokki — the sweet-heat street plate.

16 Chapter 15 · Bulgogi and galbi — pear, sweet, and the char.

17 Chapter 16 · The cold and the cooling — the refreshing counterpoint.

18 Chapter 17 · Banchan and japchae — the table as composition.

19 Chapter 18 · Designing an ownable gochujang — the spec in the jar.

20 Chapter 19 · The next jang — the frontier, and the plants we have not built yet.

21 A closing note · gamchilmat and the body

Opening essay · The deep savory

There is a word the Korean table keeps that the rest of the world has to borrow four or five of, and it names the thing the whole cuisine is built to deliver. You take the first spoon of a doenjang stew that has been muttering on the stove since before you woke — fermented soybean paste loosened in stock, a few cubes of tofu, a handful of greens — and before you have decided whether it is salty or savory or rich, your whole mouth answers *yes*, the way it answers to being fed. The savor is round. It fills the sides of the tongue and the back of the throat at once, and it does not arrive and leave like a note struck on a piano; it *stays*, a long low chord that goes on sounding after you have swallowed, pulling the next spoon toward you. The Korean word for that is **gamchilmat** — 감칠맛 — and there is no clean English for it, only a cluster of near-misses: savoriness, moreishness, mouthfulness, the deliciousness that makes you reach back. It is the soul of the cooking, and for most of history no one could say how much of it a pot held, or why one crock of jang carried it and the one beside it did not.

We came to Korean food the way most people do: humbled, at someone else's table, reaching for a word we did not have. A single meal arrives as a landscape — rice in the center, a bubbling stew, and a scatter of small dishes, **banchan** (반찬), each a different ferment or pickle or seasoned green — and under all of it, holding the scattered brightness together, that deep savory floor. For years that was all we knew: that Korean grandmothers had been coaxing gamchilmat out of soybeans and salt and time for two thousand years, building blocks of **meju** (메주) from cooked beans and hanging them in the eaves to catch wild bacteria, burying crocks of kimchi for the winter, lining the rooftop **jangdok-dae** with breathing earthenware **onggi** (옹기) jars where soy sauce and bean paste aged for years in the sun and the cold. Ten thousand dishes refined across centuries, and not once could anyone say *how much* — how much savor, anchored to what, in what proportion with the warm red fire of the chili and the sharp of the garlic, so the stew that steadied you in Jeonju could be built again, exactly, in a kitchen that had never seen a single onggi jar.



The founders in the greenhouse at dawn — the reverence this book was written in, and the question it is an answer to.

Gamchilmat, it turns out, is not mystical. It is two receptors, playing together. The first half is **umami** — free glutamate, the amino acid that fermentation liberates when enzymes cut the soybean's great storage proteins apart, settling onto the **mGluR1** receptor and the **T1R1·T1R3** heterodimer on the tongue, the lock that tells the body *here is protein, here is nourishment*. The second half is **kokumi** — not a taste you can name alone, but the body and the continuity, built by small **γ-glutamyl peptides** that the long ferment stitches together and that activate the **calcium-sensing receptor**, CaSR, the one that makes the savor coat and linger and fill the whole mouth. Umami is the note; kokumi is the sustain. A young paste has the first and not the second, which is why it tastes thin and sharp; a jang aged three years in an onggi has both, which is why it tastes *complete*, like something that was always going to be good. Gamchilmat is the chord the two receptors strike together — and the entire architecture of Korean fermentation, meju to kimchi, is a two-thousand-year-old machine for building both at once.

Which means it can be specified, and this book is the proof. On the Iyengar Flavor Index, every sensation a plant can give the body is a receptor, and every receptor is a number: **IFI = 1,000 × EC_{50}(reference) ÷ EC_{50}(candidate)**, the EC_{50} being the honest, physical concentration at which a compound drives its receptor halfway to its full response. Gamchilmat lives at the crossing of two of those numbers — the savor of **IFI-U** through mGluR1, and the body of **IFI-K** through CaSR — and almost everything else in the cuisine is laid over that floor: the warm, fruited fire of **gochu** on **IFI-H** through TRPV1, the bright sharp of garlic and ginger on **IFI-P** through TRPA1, a careful balancing sweetness on **IFI-S** through the sweet receptor, and, at the cuisine's cool end, the refreshment of **IFI-C** through TRPM8. It is a multi-axis cuisine built on a single deep ground, and the platform keeps work like this in libraries of its own — the dual-axis **M2** at **8,400** constructs, the triple-axis **M3** at **2,800** — so the floor and everything on it can be weighed, batch to batch, within a coefficient of variation of **seven percent or less**.

> $IFI(c) = 1{,}000 \cdot EC_{50}(\text{ref}) \,/\, EC_{50}(c)$

We did not measure jang to explain the magic away. We measured it to *keep* it — to give the deep savory a number so a depth that used to take a year in a crock can be built reliably, so the stew that steadied you once can be built again at a table that has never seen the jar, and so a brand with an idea for a gochujang can say, exactly, what its gochujang is and promise it will be the same next year. Every recipe that follows carries its IFI scorecard, the savor and the fire and the sharp all kept in view, so you can taste the dish and read it in the same breath. We cook this food the way we cook everything — plant-first by default, because so much of Korea's deepest savor was always soybean and cabbage and radish and chili; with the seafood and the meat that belong to this cuisine written with equal reverence, never apology; and with the quiet conviction, humming under every page, that a plate built on living ferment and whole

vegetables is one of the most nourishing things a body can be handed. The numbers are how we say that precisely. Gamchilmat is how the table says it first.



PART I OF IV

The Architecture

gamchilmat · mGluR1 · CaSR · the jang · gochu · the sharp and the sweet

Chapter 1 · Gamchilmat — *the word for the depth.*

IFI-U × IFI-K · mGluR1 (T1R1·T1R3) × CaSR

Hold the word a moment longer, because the cuisine turns on it. **Gamchilmat** is usually translated as *umami*, and that is half right and therefore misleading. Umami, the loanword Japan gave the world, points cleanly at one thing: the savory taste of free glutamate, the fifth basic taste, the brothy depth of kelp and ripe tomato and aged cheese. Gamchilmat points at that *and* at something else the Korean palate never bothered to separate out — the roundness, the mouth-filling body, the *lastingness* of a savor, the quality that makes a food taste not just savory but satisfying, generous, hard to stop eating. In the vocabulary of this book, gamchilmat is not one axis. It is two, read together: **IFI-U**, umami, the note; and **IFI-K**, kokumi, the sustain. To cook Korean food well is to build both, and to build them in proportion.

Start with what each one is, at the receptor. Umami is glutamate — specifically the free glutamate anion, L-glutamate no longer locked inside a protein — binding the **mGluR1** receptor and, more importantly for taste, the **T1R1·T1R3** heterodimer, a two-part receptor whose larger subunit folds shut around glutamate like a Venus flytrap closing on a fly. When it shuts, the cell fires, and the brain reads *savory*. On the Index this is **IFI-U**, anchored so that the half-activation of the native reference reads 1,000, and it runs from the faint savor of a raw pea up to the engineered depth of our umami-restored tomato near **2,600**. Glutamate is the molecule the whole Korean ferment pantry is built to liberate, because inside a soybean it is bound up by the thousand in the storage proteins **glycinin** and **β-conglycinin**, tasting of almost nothing; the work of fermentation is to cut it free.



Soybean — the small bean that holds the whole savory floor of the cuisine, locked inside its storage proteins until the ferment sets it loose.

Kokumi is stranger and, until recently, nameless in the lab too. It is not a taste. Put a γ-glutamyl peptide on your tongue by itself and you taste essentially nothing — no savor, no sweet, no salt. But add it to a food that already has taste, and the whole thing changes: the flavors arrive fuller, they spread wider across the mouth, and they

last longer, the finish stretching out into that satisfied hum. The molecules responsible are short peptides with a glutamate joined through its side chain — **γ-glutamyl-valyl-glycine** (γ-Glu-Val-Gly, often written γ-EVG) is the most potent yet characterized, along with glutathione (γ-Glu-Cys-Gly) and γ-Glu-Val — and they work not on a taste receptor at all but on **CaSR**, the calcium-sensing receptor, the same sentinel the body uses in the parathyroid to watch blood calcium. On the tongue CaSR reads these peptides as *richness*, and the Index scores that as **IFI-K**, kokumi, anchored to CaSR half-activation. It is the axis you never notice until it is missing, at which point the food goes flat, thin, and oddly unsatisfying no matter how much salt or glutamate you add.

Here is why the two belong in one word. A long ferment builds them *together*, by the same proteolysis. As enzymes chew the soy proteins into peptides and then into free amino acids, they liberate glutamate (umami rises) and, by transpeptidation, stitch some of that glutamate onto other peptides through its γ-carbon (kokumi rises). The first weeks of a ferment pour out glutamate; the long slow months and years knit the γ-glutamyl peptides. This is the molecular meaning of the thing every Korean cook knows by feel — that a three-year doenjang is not merely *more* than a three-month one, but *different in kind*, rounder, deeper, with a body the young paste simply does not have. The young paste is IFI-U with thin IFI-K. The aged paste is both, in balance. Gamchilmat is that balance.

SOURCE	WHAT THE FERMENT BUILDS	IFI-U	IFI-K
Fresh soybean, cooked	bound protein, little free glutamate	120	60
Young doenjang (3 mo)	glutamate liberated, peptides short	900	400
Aged doenjang (3 yr)	glutamate high, γ-glutamyl peptides knit	1,800	1,600
Aged ganjang (soy sauce)	clarified, glutamate-dense	2,100	1,200
Designed soy base (SS library)	both built at source, held to CV	2,000	1,700

That last row is the whole project. The soybean is an established host in our library — **360 constructs**, primary axes **U** and **K**, filed under *frontier* difficulty because soy is a harder plant to route than a pepper — and the thing we engineer into it is precisely the two halves of gamchilmat at the source: a lifted free-glutamate pool for umami, and the γ-glutamyl pathway turned up for kokumi, so a bean can arrive at the crock already carrying the depth that aging would otherwise have to build from scratch over years. This does not replace the ferment. Nothing replaces the ferment; the microbes do things to a soybean no gene edit can, and the slow onggi months are where the magic actually lives. What the engineered bean does is give the ferment a *head start* and a *floor* — a reliable baseline of savor and body that holds to seven percent batch to batch, so a faster jang, or a jang made in a kitchen without three years to spare, can still taste complete.

We think of IFI-U and IFI-K as the two hands on a single dial. IFI-U sets how *savory* the floor is — how loudly it says *nourishment*. IFI-K sets how *full and lasting* that savor spreads — how long it hums after

the swallow. Their sum, held in proportion, is how much gamchilmat the dish carries. Read them together on every scorecard in this book and you are reading, for the first time written down, the thing the Korean table has always delivered and never had to name because it had one perfect word for it instead.

> A young paste gives you the savor and loses it fast. An aged jang gives you the savor and makes it stay. The first is umami; the second is gamchilmat — and the difference is a receptor most cooks have been feeding for two thousand years without ever being told its name.

Chapter 2 · The synergy — *glutamate finds the lock; the nucleotide turns the key.*

IFI-U · mGluR1 · T1R1·T1R3 · the 5′-ribonucleotide potentiation

Of everything the Index measures, umami is the one with the most beautiful piece of machinery behind it, and Korean stock — **yuksu** (육수) — is where that machinery is most plainly at work. A clear Korean soup base is a short list: a sheet of dried kelp, **dasima** (다시마); a handful of dried anchovies, **myeolchi** (멸치), or in a vegetarian pot a few dried shiitake; sometimes a chunk of white radish, **mu** (무). Simmer, strain, and you have a broth that tastes of far more than the sum of those humble things. The reason is not folklore. It is one of the most robust findings in the whole science of taste, and it has a name: **umami synergy**.

Here is the mechanism, exactly. The umami receptor that matters for food is the **T1R1·T1R3** heterodimer, two linked protein subunits sitting in the membrane of the taste cell. The T1R1 subunit has a large external domain shaped like a Venus flytrap — two lobes with a cleft between them. L-glutamate binds down in that cleft, and binding pulls the two lobes partly shut, which tips the receptor toward its active, firing state. That alone is umami. But the cleft has a second site, nearer its mouth, and when a **5′-ribonucleotide** — **inosine-5′-monophosphate** (IMP, from fish, meat, and the dried anchovy) or **guanosine-5′-monophosphate** (GMP, from mushrooms and the dried shiitake) — docks into that second site, it acts like a wedge, stabilizing the closed conformation so that glutamate, already bound, is held far more tightly and the flytrap stays shut. The nucleotide has little umami taste of its own. What it has is the power to make glutamate *louder*.



Soybean in cross-section — the glutamate-dense interior the ferment unlocks, and the raw material of the synergy the Korean stock pot is built to exploit.

Translate that into the Index and the elegance appears. IFI-U is inversely proportional to the EC_{50} — the concentration of glutamate needed to reach half-activation. Add a nucleotide and that EC_{50} *falls*, because now less glutamate is needed to hold the receptor shut; and because IFI-U = 1,000 × EC_{50}(ref) ÷ EC_{50}(candidate), a falling EC_{50}

means a *rising* score. The potentiation is steep. With a modest dose of IMP present, the glutamate EC_{50} can drop as much as **eight-fold**, which is to say the same glutamate reads up to eight times as loud on IFI-U. The dried anchovy does not add much glutamate; what it adds is IMP, and the IMP multiplies the kelp's glutamate. That multiplication is the entire reason a two-ingredient broth tastes like it was simmered from a side of beef.

UMAMI CONTRIBUTOR	PRINCIPAL MOLECULE	ROLE IN THE POT	READS ON
Dasima (kelp)	L-glutamate	the glutamate floor	IFI-U
Myeolchi (dried anchovy)	inosinate (IMP)	the synergist, 5′-nucleotide	IFI-U ↑↑
Dried shiitake	guanylate (GMP)	the vegetarian synergist	IFI-U ↑↑
Mu (radish), onion	glutamate + sugars	roundness, a little sweet	IFI-U, IFI-S
Doenjang (added late)	glutamate + γ-glutamyl peptides	savor **and** body	IFI-U, IFI-K

We can write the synergy as a rule of thumb a cook can hold: glutamate *alone* gives you a broth that reads perhaps IFI-U 600; the same glutamate *with* a nucleotide present gives you a broth that reads IFI-U 1,800 or beyond, from the identical amount of kelp. Nothing was added to the glutamate side of the ledger. The receptor simply got wedged shut. This is why the vegetarian pot is not a compromise but a second, equally complete architecture: kelp carries the glutamate, and dried shiitake carries the GMP in place of the anchovy's IMP, and GMP is if anything the *more* potent synergist of the two. A dasima-and-shiitake stock and a dasima-and-myeolchi stock are two true expressions of the same receptor physics — one from the garden, one from the sea — and we write both, in the stock chapter to come, with the same respect.

The engineering sits upstream of all of it. Our soybean host is routed, among its **360 constructs**, to carry a lifted free-glutamate pool — built through the native **GDH1** glutamate-dehydrogenase route, the same enzyme that aminates α-ketoglutarate into glutamate, turned up so the bean banks more of the amino acid the ferment will later liberate. We do not engineer the nucleotides; IMP and GMP are the gifts of the anchovy and the mushroom, and we leave them to those organisms. What the platform contributes is a glutamate floor you can count on, a soy base that reads IFI-U near **2,000** before the synergist is even added — so that when the cook drops in the dried shiitake and the receptor wedges shut, the multiplication starts from a higher number and lands somewhere the old pot could only reach by luck and a long afternoon. The synergy is ancient and perfect. We just raised the floor it stands on.

> The kelp brings the glutamate. The anchovy brings the key. Neither tastes of much alone; together they ring the receptor like a bell — and a cuisine that figured this out a thousand years before anyone drew the flytrap deserves a column in the ledger, not a correction.

Chapter 3 · Kokumi — *the body you only notice when it's gone.*

IFI-K · CaSR · the γ-glutamyl peptides and the long aging

If umami is the half of gamchilmat you can name, kokumi is the half you can only feel — and it is the half that separates a good Korean ferment from an unforgettable one. Taste a young doenjang and an aged one side by side, with the salt and the glutamate matched, and the difference is not in any nameable flavor. It is in the *body*. The aged one coats the mouth. It arrives everywhere at once instead of just on the center of the tongue, it feels thicker and more continuous, and its savor goes on sounding long after you have swallowed. That coating continuity is **kokumi**, scored on the Index as **IFI-K**, and it is built — slowly, patiently, over the months and years of the ferment — by a family of molecules that have no taste of their own.

The molecules are **γ-glutamyl peptides**: short chains in which a glutamate is joined to its neighbor not through the usual α-carbon that proteins use, but through its side-chain γ-carboxyl. The most potent characterized to date is **γ-glutamyl-valyl-glycine** (γ-Glu-Val-Gly); **glutathione** (γ-Glu-Cys-Gly), the cell's own antioxidant tripeptide, is a weaker but far more abundant member; γ-Glu-Val, γ-Glu-Cys, and a dozen others fill out the family. What unites them is the γ-linkage and what it does: these peptides are agonists of **CaSR**, the calcium-sensing receptor, a class-C G-protein-coupled receptor with — like the umami receptor — a Venus-flytrap external domain. The γ-glutamyl peptides bind there and activate the receptor directly, and the taste system reads that activation as *mouthfulness* — thickness, continuity, the long finish. Crucially, they are active at vanishingly low concentrations: γ-Glu-Val-Gly shifts perception at the **micromolar** level, which is why a trace of it, built up over a long ferment, transforms a food out of all proportion to its mass.



Soybean specimen — the host we route for both halves of the savory: a lifted glutamate pool for the note, the γ-glutamyl pathway for the body.

Where do they come from, in a crock of jang? From the same enzymatic machinery that liberates glutamate, run in a different direction. The key enzyme is **γ-glutamyltransferase** (GGT), which transfers a γ-glutamyl group from glutathione or free glutamate onto

an acceptor amino acid or peptide, forging exactly the γ-linkage that CaSR reads; the cell's **γ-glutamylcysteine synthetase** (γ-GCS, the GSH1 gene product) builds the glutathione that feeds it. In a soybean ferment, the molds and bacteria and the bean's own enzymes run GGT for months, slowly accumulating γ-glutamyl peptides as a by-product of protein turnover. This is why kokumi is the *aged* axis — why it cannot be rushed, why a long ferment tastes rounder, and why the great jang houses measure their best crocks in years. You are not waiting for more glutamate; after a few months you have plenty. You are waiting for the γ-glutamyl peptides to knit.

AGING STAGE	Γ-GLUTAMYL PEPTIDE LEVEL	MOUTHFEEL	IFI-K
1 month	trace	thin, sharp, "young"	250
6 months	building	rounding, some coat	700
1 year	substantial	full, continuous	1,200
3 years	high, stable	deep, long, "complete"	1,600
Designed soy base	built at source, from day one	full from the start	1,700

The engineering, again, sits at the source and does not pretend to replace the crock. In the soybean host, alongside the lifted glutamate pool of Chapter 2, we turn up the γ-glutamyl route — the GGT-and-glutathione machinery — so the bean banks a reserve of kokumi precursors before fermentation even begins. The result is a base that reads IFI-K near **1,700** on day one, where a traditional paste would need a year or three in the onggi to climb there. A jang built on that bean still ferments; it still earns the flavors only microbes can give. But it starts with its body already present, which means a condiment brand can ship a gochujang that tastes *aged* without waiting three years for the first batch, held — like everything in the library — to a coefficient of variation of **seven percent or less**, so the body is the same in the first jar and the ten-thousandth.

There is a reason we are proudest of this axis. Kokumi is the one the Index was arguably invented to see, because it is the one the tongue cannot report and the cook cannot name — the richness that is *there* and then, in a thin dish, conspicuously *not there*, with no word to say what went missing. Korean cooking has been engineering it, by hand and by patience, for two thousand years: the long-aged jang, the fish ferments, the kimchi left to deepen, all of them quietly stitching γ-glutamyl peptides onto the CaSR receptor and calling the result, simply, *delicious*. We gave it a number so that the thing a grandmother built with three years and an onggi jar could be understood, protected, and — where a year is a luxury no one has — begun with a running start.

> Kokumi is the axis of absence: you learn it by subtraction, the day a stew made from the right ingredients still tastes like it is missing something. That something has a receptor, a molecule, and now a number — and the long ferment has been feeding it all along.

Chapter 4 · Jang — *the mother sauces, and the split that makes two.*

IFI-U × IFI-K · meju → ganjang + doenjang

Every great Korean savor traces back to a single, patient act, and it is worth slowing down to watch it, because it is the engine room of the whole cuisine and because it is a quiet masterpiece of pre-scientific engineering. The word is **jang** (장) — the fermented sauces and pastes — and the three that matter most are **ganjang** (간장, soy sauce), **doenjang** (된장, soybean paste), and **gochujang** (고추장, the fermented chili paste this book builds toward). The first two are born together, from one process, in a way that rhymes with something our platform discovers again and again: that a single well-run transformation often yields two products, a liquid and a solid, a clarified savor and a deep funky body, and that the wisest kitchens keep both.

It begins with **meju** (메주). Soybeans are soaked, boiled soft, and mashed, then pressed into bricks and set to dry and ferment — traditionally hung from the rafters in winter, wrapped in rice straw, where the straw and the air inoculate them with wild microbes. The dominant one is **Bacillus subtilis**, the hay bacillus, a ferocious producer of proteases and, not incidentally, the same organism behind the sticky, pungent *cheonggukjang*; molds of the genera **Aspergillus**, **Rhizopus**, and **Mucor** join in, Aspergillus bringing the amylases and more proteases that Japanese koji would later be bred to specialize in. Over weeks these organisms drive their enzymes into the bean brick, cleaving the storage proteins **glycinin** and **β-conglycinin** into peptides and free amino acids. By the time the meju is ready it is a hard, gray-brown, powerfully savory block — a slow-release enzyme reactor and a reservoir of liberated glutamate, waiting.



Soybean, boiled and bound into meju in the old way — the enzyme reactor every Korean sauce is born from.

Then comes the split. The meju bricks are lowered into a brine — salt water, strong — in a breathing **onggi** jar, and left in the sun and weather for months. Two things happen at once. The water-soluble savor leaches out of the bricks into the brine, which slowly darkens and deepens into a liquid of extraordinary glutamate density: this is

ganjang, Korean soy sauce, drawn off and aged further, the clarified upper register of the savory. What remains — the softened, broken-down solids of the meju — is worked and salted and packed back down to ferment on, into **doenjang**, the paste: rougher, funkier, lower and darker on the palate, carrying the body and the kokumi where the ganjang carries the brighter glutamate note. One submersion, two products. The cuisine uses them for different jobs, and a cook who understands the split understands the savory architecture of every Korean dish: **guk-ganjang** (soup soy sauce), pale and salty, to season a clear broth without clouding it; **jin-ganjang**, darker and rounder, for braises and dips; and doenjang for the stews and the dressings where you want the deep, muttering floor.

Read the split through the Index and it is a lesson in the two halves of gamchilmat. The ganjang is **IFI-U** forward — glutamate-dense, clarified, the savor lifted clear — reading near **2,100** on umami with a real but lesser **IFI-K** near 1,200. The doenjang is the reverse weighting — **IFI-K** forward, the body and continuity, reading kokumi near **1,600** with umami a shade behind. The two together describe the whole of the savory floor, which is why a Korean kitchen keeps both on the shelf and why many dishes use a little of each. This is the same logic by which the platform scores any ferment: not one "savory" number but two, the note and the sustain, because the tongue reads them on two different receptors and a cook needs to aim at both.

PRODUCT	FRACTION	LEADING AXIS	IFI-U	IFI-K	JOB IN THE KITCHEN
Ganjang (guk)	the brine, clarified	umami note	2,100	1,000	season clear soups
Ganjang (jin)	aged darker	umami, rounder	1,900	1,300	braises, dips
Doenjang	the solids, re-fermented	kokumi body	1,600	1,600	stews, dressings
Gochujang	its own ferment (Ch. 7)	multi-axis	1,500	1,400	the chili jang, everywhere

The engineering transfer is clean and it sits, as ever, at the source. Our soybean host — the **360-construct** library routed for **U** and **K** — is built to carry both halves of the savory before it ever reaches the meju brick: the lifted glutamate pool of Chapter 2 and the γ-glutamyl kokumi route of Chapter 3. A meju made from that bean starts its ferment with a higher floor on both axes, which means the finished ganjang and doenjang reach their target depth faster and hold it to a coefficient of variation of **seven percent or less**, batch to batch. We are emphatic about what this does and does not do. It does not shortcut the microbes — the *Bacillus* and the *Aspergillus* give a soybean complexities of aroma and flavor that no gene edit reproduces, and the onggi months are where the soul of the jang is made. What it does is make the starting bean a more generous raw material and the finished jang more reliable, so a two-thousand-year-old craft gains a floor it can stand on in a factory as surely as on a rooftop. The split stays. The patience stays. We simply hand the meju a better bean to begin with.

> One brine, two sauces: the clear savor poured off the top, the deep body packed down below. The kitchens that keep both have been reading umami and kokumi as separate axes for a thousand years — they just called them ganjang and doenjang.

Chapter 5 · Gochu — *Korea's warm fire.*

IFI-H · TRPV1 · Pun1/CS · the phenylpropanoid branch

Over the deep savory floor comes the color and the heat, and the heat is a particular one, unmistakably Korean. Taste the chili in a good kimchi or a bowl of tteokbokki and notice what it is *not*: it is not the searing, breath-stealing attack of a superhot, nor the bright green bite of a fresh Thai chili. It is warm, broad, a little sweet and distinctly fruity, with a smoky depth from sun-drying, and it builds and holds rather than stabbing. Korea has a word for the sensation a good spicy soup gives — **eol-kal-han** (얼큰한), a bracing, warming, almost medicinal heat that clears the head and comforts at once — and the whole aesthetic of **gochu** (고추), the Korean chili, is tuned toward it. This is heat as a *warmth*, laid over the savory as a glowing coal is laid in a hearth, not thrown on as a dare.

The molecule is the same one that runs every heat on the Index: **capsaicin**, binding **TRPV1**, the non-selective cation channel on the trigeminal nerve endings 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 the nerve reports a fire that is not there. On the Index this is **IFI-H**, anchored so that the half-activation of the native reference reads 1,000. What makes Korean heat distinctive is not a different molecule but a different *shape* and a different *dose* — and both are things the Index and the platform can read and set exactly.



Gochu — the Korean chili, bred and dried for a warm, fruited, smoky heat rather than a searing one. The fire this cuisine lays over its savory floor.

The shape of the burn is set in the plant's biosynthesis, and it is worth naming the pathway because it is the same one our platform engineers and the same one that runs, in part, through every vascular plant. Capsaicin is the condensation of two halves. The aromatic half, **vanillylamine**, descends from phenylalanine through the **phenylpropanoid branch** — **PAL → C4H → 4CL → HCT → COMT** — the universal route that every plant runs to build its lignin and its aromatics, capped in the pepper by **pAMT**, the aminotransferase that turns vanillin into vanillylamine. The aliphatic half is a branched-chain fatty acid, built by **BCAT** and the **KAS** fatty-acid synthase from

valine or leucine, its length and saturation set by the plant. The two are joined by **Pun1/CS** — the capsaicin synthase acyltransferase, encoded at the *Pun1* locus — the terminal enzyme that assembles and labels the molecule. Our flux model predicts the principal control sits upstream in the phenylpropanoid pathway, at **4CL** and **HCT/CCoAOMT**, not at this final step; Pun1 makes the capsaicin, it does not govern the rate. And here is the point for a Korean chili: the **length and saturation of that acyl chain set the balance between capsaicin and dihydrocapsaicin**, and that balance sets the *shape* of the burn — how fast it arrives, how fruited it reads, how it blooms and how cleanly it leaves. Korean gochu is bred toward a rounder, more capsaicin-forward, fruitier profile, and the sun-drying that makes **gochugaru** (고춧가루, chili flake) layers in smoky, slightly caramelized notes on top.

The dose is the other half, and Korean cooking lives, deliberately, low on the ladder. Our ten flagship superhot cultivars are a reference built gene by gene — the altitude the platform can reach when it wants to — but a Korean dish almost never climbs them. It ladders *down* from them, using a measured trace of a high, clean, fragrant chili rather than a heavy hand of a muddier one. The ladder is the yardstick; the cooking happens near its foot.

CULTIVAR	SKU	PREDICTED SHU	IFI-H	AXES
Ember	SS-0087	~866K	1,570	2/8
Cinder	SS-0088	~1.05M	2,290	3/8
Blaze	SS-0091	~1.72M	2,630	4/8
Wildfire	SS-0092	~1.96M	2,930	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

SHU values are computational predictions from our flux model, not certified measurements.

Most Korean heat sits far down this ladder, in a warm and generous band — a dish-level **IFI-H between 300 and 1,200** — where the fire has room to be fruity and smoky and you can still taste *through* it to the ferment beneath. A gochugaru heat you cannot taste past has crowded the gamchilmat out of the room, and a Korean stew with its savory floor drowned under chili is a failure of balance, not a triumph of nerve. The precision that makes the superhot summit possible is exactly the precision that lets us specify a *gentle* heat and hit it every time: the summit was reached by two AI-found substitutions in the Pun1 enzyme — **S39L · L345G**, scored by a protein language model for predicted catalytic efficiency and fold stability, then written in with CRISPR — and the same careful routing that our model predicts reaches approximately 2.95 million SHU at a batch CV design target of ≤7% is what lets a condiment brand ship a gochujang whose warmth reads the same, jar after jar.

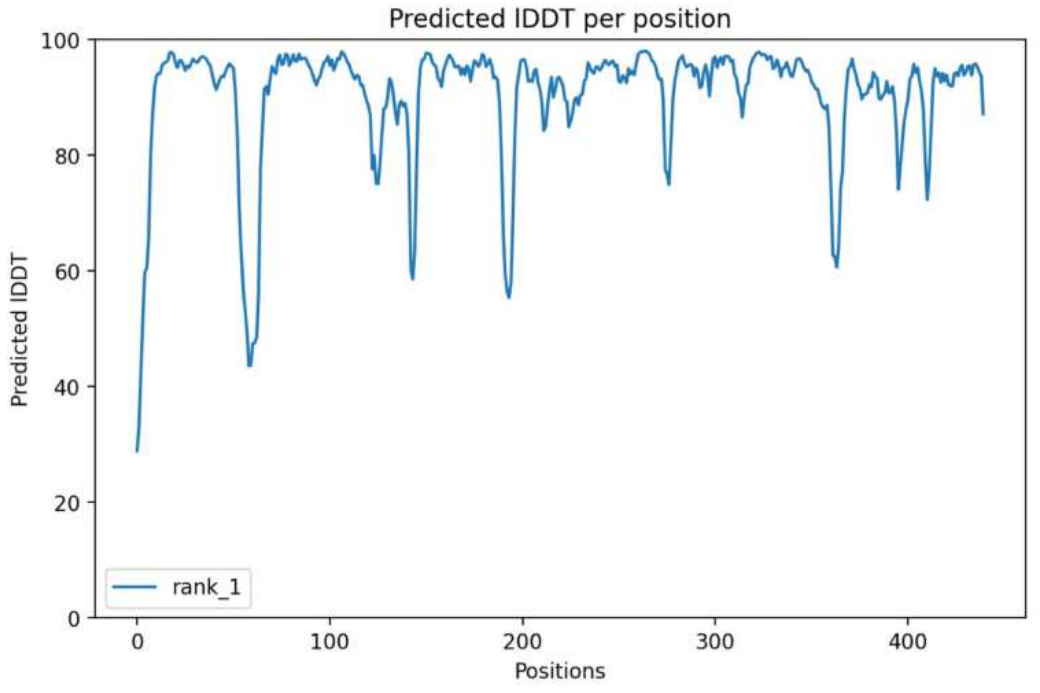


FIG. 5 — the Pun1/CS capsaicin-synthase model, coloured by pLDDT confidence; the binding domain and active-site cleft that the two substitutions tune are the high-confidence core.

SUBSTITUTION	EFFECT	ΔΔG
S39L	binding affinity ↑ (N-term)	−2.1
L345G	steric relief, active-site cleft	−1.8
C175S†	disulfide-misfold prevention (structural annotation)	−0.9

† C175S is a structural annotation from our modelling; it is not included in the shipped construct. The shipped double variant is S39L + L345G.

A word on how we hold the heat, here as everywhere. Fire is a pleasure, not an assault, and nowhere is that more native than in Korea, where the spicy soup is a comfort food and the word for its heat, *eol-kal-han*, carries warmth and well-being in it. We design for the *shape* of the burn — where it lands, how it blooms, how cleanly it leaves — because a heat you can taste through is a heat that feeds the meal instead of ending it. Korea has believed this for centuries, since the chili arrived and the cuisine folded it into the ferment rather than letting it shout over the top. We only gave the warmth a column, and the shape of it a set of mutations.

> Korean heat is the coal in the hearth, not the match thrown in the room: a warm, fruited, smoky fire laid over the savory and laddered low on purpose, so you taste through it to the jang beneath. The plant that could reach three million Scoville is the same platform that lets us set a gochugaru to a gentle, fragrant eight hundred — and hit it every jar.

Chapter 6 · The sharp and the sweet — *garlic, ginger, and the balancing hand.*

IFI-P · TRPA1 · the alliums · and IFI-S, with the sour outside the eight

Two more axes complete the Korean chord, and a cook must know where they live. The first is the **sharp** — the bright, pricking pungency of garlic, ginger, and scallion that threads through nearly every Korean dish and lifts the warm heat of the gochu into something lively. The second is the **sweet** — the quiet, balancing sweetness, from Asian pear and rice syrup and onion, that keeps the fire and the ferment from tiring the palate. And at the edge of both sits the one great taste this book must be honest about not measuring: the **sour**, the lactic brightness that the ferment itself provides, which lives outside the eight axes of the Index on purpose.

Begin with the sharp, because Korea may love raw garlic more than any cuisine on earth — crushed into kimchi by the head, sliced raw to wrap with grilled meat, pounded into every dressing. The pungency has a precise chemistry. Intact garlic holds an odorless precursor, **alliin**, and a separate enzyme, **alliinase**, kept apart in the cell; crush the clove and the two meet, and alliinase converts alliin into **allicin**, a reactive sulfur compound (a thiosulfinate) that is the source of garlic's bite and much of its aroma. Allicin and its relatives activate **TRPA1**, the sharp channel — the same irritant-sensing channel that reads mustard's isothiocyanates and the pungency of wasabi — and the Index scores that as **IFI-P**, pungency. Ginger plays the same channel through a different molecule, **gingerol** (and, when cooked or dried, the hotter **shogaol**), which opens both TRPA1 and TRPV1, giving ginger its warm-and-sharp double character. Scallion and Korean garlic chives, **buchu** (부추), round out the allium family's contribution.



Garlic — crushed, the clove's alliinase forges allicin in seconds, the sharp that threads every Korean dish. The platform's kokumi-and-pungency host, at 560 constructs.

Garlic is one of our better-developed hosts — **560 constructs**, primary axes **K** and **P** — and that pairing is the whole point of it: garlic is both sharp *and* deep, carrying pungency on TRPA1 and kokumi on CaSR at once, which is exactly why it is the foundation of

so many savory cuisines and why a Korean dressing of crushed garlic, doenjang, and sesame tastes so complete. We can route the plant to lift its allicin yield for a cleaner, more reliable sharp, or its γ-glutamyl kokumi for more body, or hold the two in a set ratio — and because allicin is volatile and fickle, degrading as a cut clove sits, a specified garlic note is one of the more useful things the platform offers a condiment maker, giving a sharp that reads the same in the first batch and the hundredth.



Ginger in cross-section — gingerol and shogaol, the warm sharp that opens both the pungency and the heat channels at once.

Now the sweet, and the Korean genius for using it as counterweight rather than indulgence. Korean food is not a sweet cuisine, but it is a *balanced* one, and a measured sweetness is how the cook keeps a spicy, funky, salty plate from fatiguing: a grated **Asian pear** melting into a bulgogi marinade, a spoon of **jocheong** (조청, rice syrup) or **mulyeot** rounding a stew, the slow sweetness of onion cooked down, the faint sugar a long kimchi ferment leaves behind. On the Index this is **IFI-S**, sweetness, the taste of the **TAS1R2·TAS1R3** receptor — and it is an axis the platform can lift *without* a sugar load, through the designed-sweetness routes that run in our **stevia** host (**910 constructs**), our **monk fruit** (80), and the brazzein-class sweet proteins, each of which drives TAS1R2·R3 far more loudly, gram for gram, than sucrose. For a cuisine that wants the *balance* of sweetness without the weight of it, this is a real gift: a tteokbokki or a galbi marinade can keep its dan-mat, its sweet-savory poise, while shedding most of the sugar it used to need. The sweetness is read from receptor loudness, not from grams on the tongue.

AXIS	MOLECULE(S)	SOURCE IN THE CUISINE	RECEPTOR
IFI-P · Pungency	allicin, gingerol	garlic, ginger, scallion, buchu	TRPA1
IFI-S · Sweetness	glucose, maltose; designed glycosides/proteins	pear, rice syrup, onion; engineered	TAS1R2·R3
sour	lactic & acetic acid	the kimchi ferment, vinegar	*acid-sensing — outside the eight*

Which brings us to the honest edge of the Index. The two great tastes it does **not** number are **sour** and **salt** — the proton-sensing and sodium-sensing channels that read the acid of fermentation and the salt of the brine. We leave them out of the eight on purpose, because they are the cook's hand and the ferment's clock, not a construct we design, and we would rather tell you plainly where our

measure stops than pretend a number covers the whole tongue. In Korean food this matters more than in almost any cuisine, because so much of its character is *sour* — the lactic tang a kimchi develops as it ages, the brightness that cuts the richest stew, the whole second life a ferment takes on as it turns. We will name the sour on every scorecard where it leads, and mark it *by hand* or *by the ferment*, outside the eight. Leaving it off the card would be pretending the dish is only what we can measure. It isn't, and saying so is a form of respect — to the cook, to the microbe, and to the reader who deserves to know exactly where the instrument ends and the craft begins.

> Garlic and ginger bring the sharp; pear and rice syrup bring the sweet; and the ferment itself brings a sour we do not number, because it belongs to the microbe and the clock, not to us. The eight axes are the floor plan of the Korean mouth — but the sour and the salt are load-bearing walls, and we will never pretend we poured them.



PART II OF IV

The Pantry

gochujang · doenjang · ganjang · yuksu · ssamjang — the engineered jang, built to a number

Chapter 7 · Engineered gochujang — *the flagship, reimagined.*

IFI-H × IFI-U × IFI-K × IFI-S · the multi-axis construct in a crock

If a single jar can hold a cuisine, it is this one. **Gochujang** (고추장) is the fermented chili paste that is to a Korean kitchen what nothing in any other cuisine quite is — at once a condiment, a seasoning, a marinade base, and a flavor unto itself, a deep brick-red paste that is savory and sweet and warm and funky all at the same time. It is also, read through the Index, the most beautiful object in this book: a **multi-axis construct built by hand in a crock**, four sensations fermented together into one, the thing our platform designs gene by gene arrived at centuries early by a cook with soybeans, chili, rice, malt, salt, and time. This chapter is both a recipe and a thesis, because to make gochujang is to compose four axes at once, and gochujang reimagined is simply gochujang whose four axes you can *read*.

Understand the ingredients as axes and the paste explains itself. **Gochugaru** brings the heat — **IFI-H**, laddered warm and low. Fermented soybean, as **meju-garu** (메주가루, powdered meju), brings the deep savory — **IFI-U** and **IFI-K**, the glutamate note and the kokumi body, the same gamchilmat floor of Part I. Glutinous rice, **chapssal**, brings the starch that becomes the sweetness — and here is the clever part, the step that makes gochujang *gochujang*: the rice starch is converted to sugar by the amylase in **yeotgireum** (엿기름, barley malt powder), the enzyme cleaving the starch chains into **maltose**, which feeds the ferment *and* leaves the paste with its signature gentle sweetness on **IFI-S**. Salt sets the ferment's bounds and the microbes do the rest over months, the *Bacillus* and *Aspergillus* enzymes from the meju deepening the savor and knitting the γ-glutamyl kokumi while the paste ages in the sun. Heat, savor, body, sweet — four axes, one crock. The recipe below is a real, workable home gochujang; the "engineered" part is that every one of those four axes can be set, and held, at the source.



Gochu in cross-section — the chili whose warm, fruited heat is fermented into the paste, one of the four axes a crock of gochujang composes at once.

Engineered Gochujang

Makes two jars · 1 hour active, then weeks to months of ferment · the four-axis paste, built to a number

The traditional paste ferments for months to years; this home version is built to be usable in weeks and to deepen for as long as you let it. The design logic is to set each axis deliberately: a warm, fruited gochugaru at a laddered **IFI-H near 800**; a meju or designed soy base carrying the savory floor at **IFI-U/IFI-K near 1,500/1,400**; the malt-converted rice holding the sweet at **IFI-S near 700**; and the salt and the time doing what only they can.

You need

1	cup	glutinous rice flour (chapssal)
4	cups	water
1/2	cup	barley malt powder (yeotgireum) — the amylase
2	cups	gochugaru (warm, fruity; designed IFI-H ~800), fine
1	cup	fermented soybean powder (meju-garu) or designed soy base
1/2	cup	fine sea salt, plus more to seal
2	tbsp	ganjang (soy sauce), optional, for depth

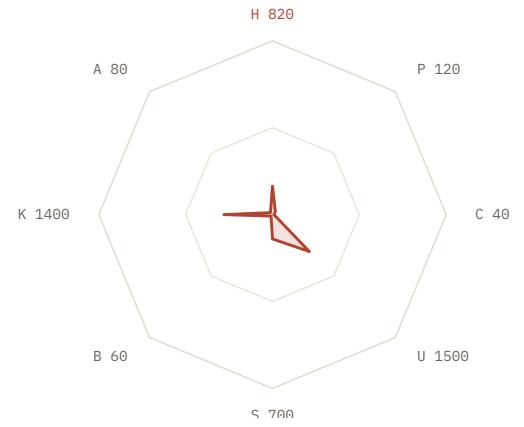
Make it

1. Whisk the barley malt powder into the 4 cups of cool water and let it steep 1 hour; strain and keep the cloudy liquid. This is your amylase bath — the enzyme that will turn the rice starch into sweetness.
2. Whisk the glutinous rice flour into the malt water and warm it gently, stirring, holding it below a simmer at a steady, hand-hot temperature for 30–40 minutes. **Do not boil it yet.** In this warm window the amylase cleaves the rice starch into maltose, and you will taste the mixture turn from bland to distinctly sweet — that is IFI-S being built in real time, enzymatically, the same way the old kitchens did it.
3. Now bring it to a gentle boil for a few minutes to thicken and to stop the enzyme, then cool it to barely warm. Hot paste kills the next step.
4. Into the cooled rice base, stir the meju-garu (or designed soy base), the gochugaru, the salt, and the optional ganjang until smooth and glossy and deep red. It should be thick enough to mound on a spoon.
5. Pack it into sterilized jars, leaving headroom, and smooth a layer of salt over the top to seal the surface. Cover with cloth and ferment at cool room temperature; in a traditional onggi it would breathe in the sun by day and cool by night. Taste at two weeks, then monthly. It is usable young and better aged; it keeps, refrigerated, for a year and deepens for the first several months.

Why it works — Read the scorecard and you are reading the paste's architecture. The heat is laddered warm and low so it glows rather than stabs, built on a gochugaru whose capsaicin-forward, fruited shape (set in the Pun1 acyl chain of Chapter 5) is the Korean signature. The savory floor is the full gamchilmat of Part I — glutamate liberated from the soy for the note, γ-glutamyl peptides knit over the ferment for the body — which is why good gochujang tastes *deep* and not merely hot-and-sweet. The sweet is enzymatic, not poured: the malt's amylase builds maltose from the rice, so the sweetness is woven into the ferment rather than stirred in as sugar,

and in the engineered version it can be lifted further through designed sweetness without a sugar load. And the salt and the months are the cook's hand and the microbe's clock — outside the eight, and essential. Four axes, composed and aged into one red paste; this is the whole platform, in a crock, arrived at by tradition long before we could draw it.

IFI PROFILE





AXIS	SCORE	
IFI-U · Umami	1,500	the fermented-soy glutamate note
IFI-K · Kokumi	1,400	the aged body, the γ-glutamyl continuity
IFI-H · Heat	820	warm, fruited, laddered low
IFI-S · Sweetness	700	malt-built maltose, not poured sugar

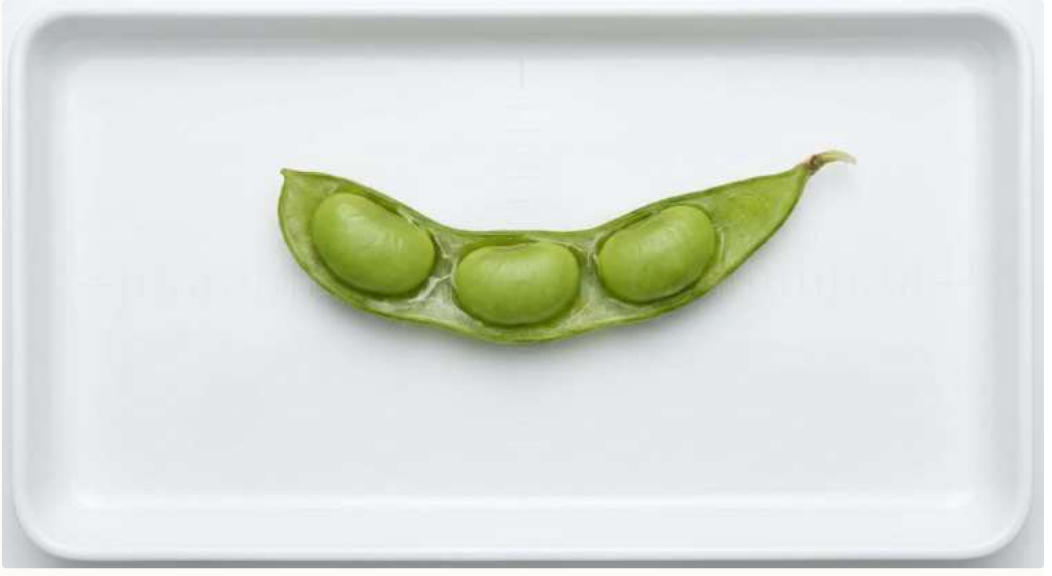
This is the first and most important of the house jars — the one everything downstream reaches for. With a good gochujang on the shelf, half the recipes in this book are a matter of spooning, not cooking.

Chapter 8 · Doenjang and ganjang — *the savory floor, at home.*

IFI-U × IFI-K · the aged soybean

Where gochujang brings heat and sweetness to the savory, **doenjang** (된장) and **ganjang** (간장) are the savory itself, unadorned — the deep, funky, fundamental floor of the Korean kitchen, the pure gamchilmat the rest of the cuisine is laid over. Doenjang is the soul of the everyday stew and the backbone of **ssamjang**; ganjang seasons everything from clear soups to braises. They are harder to make quickly at home than gochujang, because their whole character is time, but the process is worth understanding even if you buy the jars, because it is the clearest possible picture of the two halves of gamchilmat being built and then *separated*.

Recall the split from Chapter 4: meju bricks go into brine, the savor leaches into the liquid to become ganjang, and the broken-down solids are repacked to become doenjang. At home, without rafters to hang meju in, you work with purchased meju powder or blocks and a shorter clock, but the logic holds. Below is a home doenjang-style paste that gives you the deep savory floor in weeks rather than years — a working approximation of the real thing, honest about being one.



Soybean cross-section — the protein-dense interior whose glutamate and γ-glutamyl peptides are the entire substance of doenjang and ganjang.

Home Doenjang-Style Savory Paste

Makes one jar · 30 minutes active, then 3–6 weeks · the deep floor, borrowed from the long ferment

You need

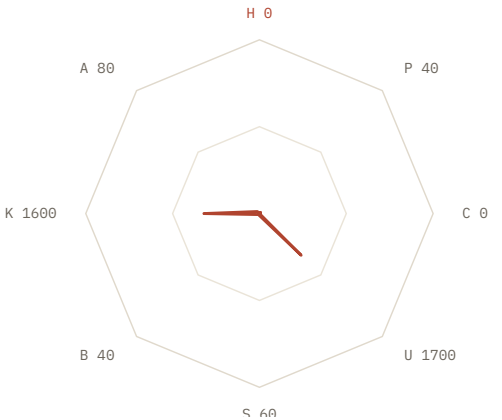
2	cups	fermented soybean powder (meju-garu) or designed soy base
1	cup	cooked soybeans, mashed (or extra-firm tofu, pressed)
3/4	cup	fine sea salt
2	cups	water, cooled boiled
2	tbsp	ganjang (soy sauce), for depth
		a clean jar; cloth and band

Make it

1. Mash the cooked soybeans (or pressed tofu) to a rough paste. Fold in the meju powder or designed soy base — this is your enzyme-and-glutamate reservoir.
2. Dissolve the salt fully in the cooled boiled water. Work enough brine into the bean mash to make a thick, spreadable paste; stir in the ganjang.
3. Pack firmly into the jar with no air pockets, smooth the top, and dust the surface with a little extra salt to seal it. Cover with cloth.
4. Ferment at cool room temperature 3–6 weeks, tasting weekly. It will darken, deepen, and funk up as the enzymes work; the longer it goes, the more the kokumi knits. Refrigerate when it tastes right to you; it keeps for months and keeps improving.

Why it works — This is Chapters 2 and 3 made edible. The meju's *Bacillus* and *Aspergillus* enzymes cleave the soy proteins, liberating free glutamate (the IFI-U note) and, by transpeptidation over the weeks, knitting γ-glutamyl peptides (the IFI-K body). A young paste reads bright and thin on umami with little kokumi; as it ages, the kokumi climbs and the whole thing rounds into the deep, continuous savor that makes a doenjang stew taste like it has been cared for. The designed soy base is the shortcut that isn't a shortcut: a bean routed to carry both halves at the source gives you a floor near IFI-U/IFI-K **2,000/1,700** from the first day, so even a short home ferment lands somewhere a traditional one would need a year to reach — and holds it to a coefficient of variation of **seven percent or less**, jar to jar.

IFI PROFILE



IFI-H	0
IFI-P	40
IFI-C	0
IFI-U	1,700
IFI-S	60
IFI-B	40
IFI-K	1,600
IFI-A	80

AXIS	SCORE	
IFI-U · Umami	1,700	the liberated-glutamate floor
IFI-K · Kokumi	1,600	the aged body, built or grown-in
salt	*by hand*	*the brine — outside the eight, essential*

Doenjang is the second house jar. Gochujang for the red dishes, doenjang for the deep ones, and between them the savory architecture of nearly every Korean plate is on your shelf.

Chapter 9 · Yuksu — *the synergy, made liquid.*

IFI-U · the glutamate × nucleotide multiplication, in a pot

Before a great many Korean soups and stews there is a stock, **yuksu** (육수), and it is the single clearest place in any kitchen to watch the umami synergy of Chapter 2 do its work. A proper yuksu is almost embarrassingly simple — a few dried things and twenty minutes — and it tastes like far more than it has any right to, because it is engineered, by tradition, to exploit the glutamate-times-nucleotide multiplication at the T1R1·T1R3 receptor. This chapter gives you two stocks, a garden one and a sea one, written with equal respect, because the synergy runs both ways and the vegetarian pot is not a lesser version of anything.

The architecture is the receptor physics. **Dasima** (kelp) brings the **glutamate** — the floor. The synergist that multiplies it is a **5′-ribonucleotide**, and you have a choice of which: **dried shiitake** carries **GMP** (guanylate), **dried anchovy** (**myeolchi**) carries **IMP** (inosinate). Either one wedges the receptor shut and makes the kelp's glutamate read many times louder. GMP is, if anything, the more potent synergist, which is why a well-made vegetarian dasima-shiitake stock can read every bit as deep as an anchovy one. The cook's only real jobs are to coax the glutamate out of the kelp *without* bitterness (kelp over-boiled goes bitter and slimy — an IFI-B problem) and to add the nucleotide source so the multiplication can happen.



Soybean specimen beside the stock pot's logic — the glutamate the kelp brings, waiting for the nucleotide that will make it ring.

Yuksu, Two Ways — Garden and Sea

Makes about 1.5 litres · 25 minutes · the broth that tastes simmered all day

You need — the garden stock (vegetarian)

1	litre	cold water
1	sheet	dasima (kelp), 10 cm square — the glutamate
4		dried shiitake — the GMP synergist
1	chunk	mu (radish), thick-sliced — roundness, a little sweet
1		onion, halved, skin on — body

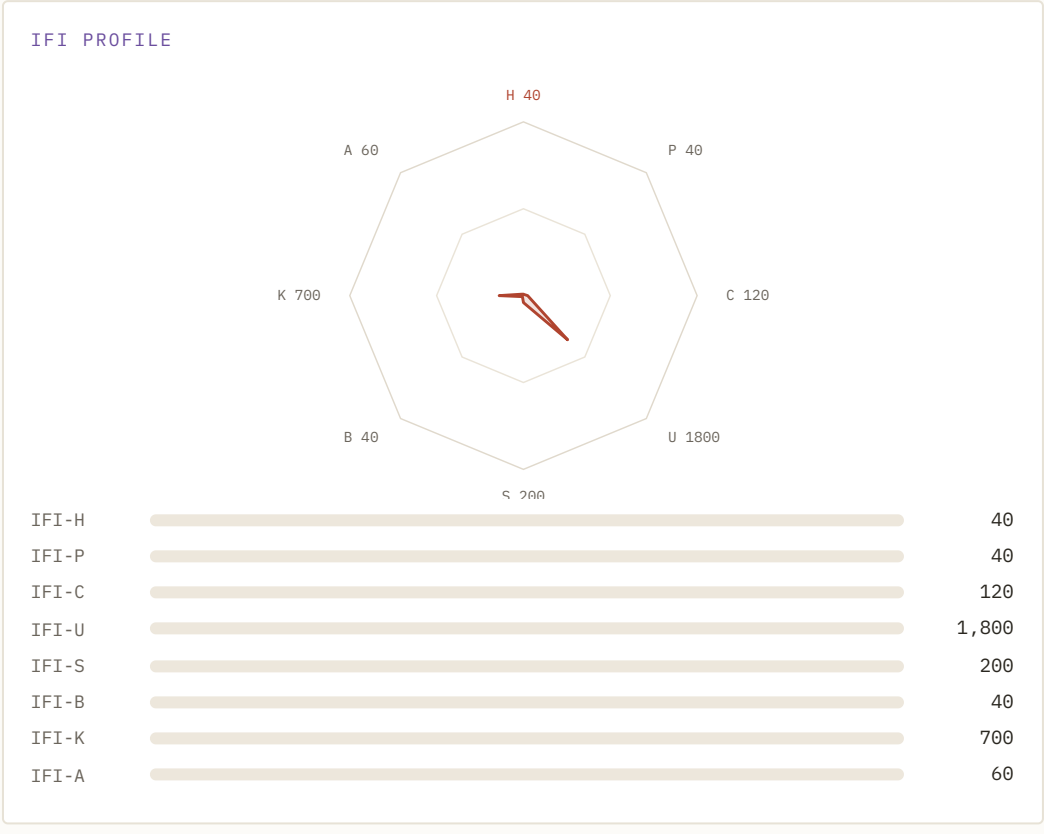
You need — the sea stock

```
1   litre   cold water
1   sheet   dasima (kelp), 10 cm square — the glutamate
12          dried anchovies (myeolchi), heads and guts removed — the IMP
1           green chili or a little gochugaru, optional — a warm note
            2 scallion roots, a few peppercorns
```

Make it

1. **For either stock:** put the dasima in the cold water and bring it slowly toward a simmer. Pull the kelp out **just before the water boils** — this is the one rule that matters, because kelp held at a rolling boil leaches bitterness and slime. You want the glutamate, not the IFI-B.
2. Now add the synergist and the aromatics: the shiitake, radish, and onion for the garden stock; the anchovies and aromatics for the sea stock. Simmer gently, uncovered, 15–20 minutes. For the sea stock, toast the anchovies in a dry pan first for a cleaner, rounder savor.
3. Strain. Taste: it should read deep and savory far beyond its few ingredients. That extra depth is the synergy — the nucleotide multiplying the glutamate.

Why it works — This is IFI-U mathematics in a pot. The kelp alone, pulled before the boil, gives you a glutamate broth that reads perhaps IFI-U 600. Add the shiitake's GMP or the anchovy's IMP and the glutamate's effective EC_{50} at the T1R1·T1R3 receptor falls as much as **eight-fold** — so the same glutamate now reads IFI-U near **1,800**, with nothing added to the glutamate side of the ledger. The receptor was simply wedged shut. The engineered contribution sits upstream and off to the side: a glutamate-lifted dasima or a designed soy base added late can raise the floor the synergy multiplies from, so the stock lands deeper and more reliably. But the beautiful part is ancient and needs no help — the Korean stock pot is a receptor experiment that has been running, perfectly, for a thousand years.



AXIS	GARDEN	SEA	
IFI-U · Umami	1,800	1,850	glutamate × nucleotide synergy
IFI-K · Kokumi	700	650	a little body from the long dried things
IFI-B · Zero-Bitter	—	—	*only if you boil the kelp; then it climbs*

The two stocks are the same physics from two larders. We default to the garden stock through most of this book and reach for the sea stock without apology where the cuisine calls it home — the anchovy's IMP is written with the same respect as the shiitake's GMP, because the receptor does not care which sea or soil the key came from.

Chapter 10 · Ssamjang and the sauce shelf — *the pantry, composed.*

IFI-U × IFI-K × IFI-H × IFI-P · the dipping sauces

With gochujang, doenjang, and a yuksu on the shelf, the last of the pantry is a matter of *composing* them — and the Korean sauce shelf is where a cook's hand shows most. Two sauces earn their own place. **Ssamjang** (쌈장) is the thick, savory dipping-and-wrapping sauce that marries doenjang and gochujang and carries them to the table beside grilled things and lettuce leaves; **cho-gochujang** (초고추장) is its bright opposite, gochujang loosened with vinegar and sweetness into a sour-sweet-spicy dip for cold vegetables and raw fish. Between the two of them, and the honesty about the sour that cho-gochujang forces, you have the whole range of the Korean condiment in miniature.

Ssamjang

Makes one bowl · 10 minutes · the wrap sauce, where doenjang and gochujang meet

You need

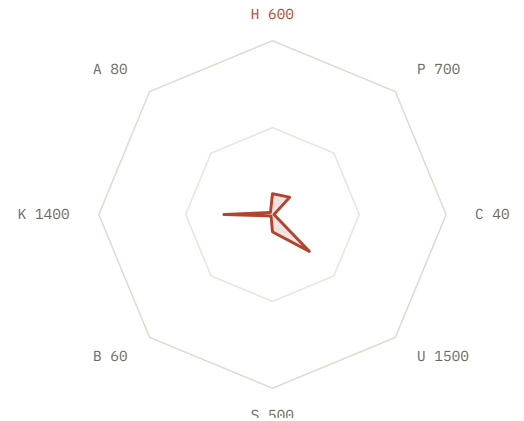
3	tbsp	doenjang (Chapter 8)
1	tbsp	gochujang (Chapter 7)
1	tbsp	sesame oil · 1 tbsp toasted sesame seeds, crushed
2	cloves	garlic, minced (raw — the sharp)
2		scallions, minced
1	tsp	jocheong (rice syrup) or designed sweetener
1	tsp	yuksu or water, to loosen

Make it

1. Stir the doenjang and gochujang together — the deep savory floor meeting the sweet-warm red paste.
2. Beat in the sesame oil and crushed seeds, the raw garlic and scallion, the rice syrup, and just enough stock to make it spoonable but still thick.
3. Let it sit ten minutes for the raw garlic's sharp to bloom and marry. Serve in a small mound, for wrapping grilled mushroom or meat and a leaf of lettuce or perilla.

Why it works — Ssamjang is a composition of the two house jars plus the fresh sharp of raw garlic and the richness of sesame, and the scorecard shows a near-complete savory chord: the doenjang's deep IFI-U/IFI-K floor, the gochujang's warm IFI-H and sweet IFI-S laid over it, and a lively IFI-P from the raw garlic's allicin — the sesame bringing still more kokumi body and fat to carry it all. It is the pantry, composed into one spoon.

IFI PROFILE



IFI-H	600
IFI-P	700
IFI-C	40
IFI-U	1,500
IFI-S	500
IFI-B	60
IFI-K	1,400
IFI-A	80

Cho-Gochujang

Makes one small bowl · 5 minutes · the bright sour-sweet-spicy dip

You need

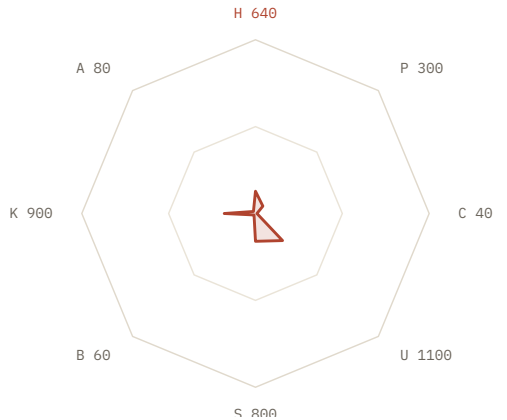
3	tbsp	gochujang (Chapter 7)
2	tbsp	rice vinegar — the sour, by hand
1	tbsp	jocheong or designed sweetener
1	tsp	toasted sesame · 1 tsp minced garlic

Make it

1. Whisk everything smooth. Taste and chase the balance: it should hit sour first and brightest, then sweet, then the warm gochujang behind. Use it on cold blanched vegetables, cucumber, or raw fish (*hoe*).

Why it works — Here the lead is the **sour**, and the sour is *yours* — placed by hand, with the vinegar, and sitting honestly outside the eight axes. It does the one job no engineered axis can: cutting the richness and lifting the whole dip so it refreshes. Behind it the scored axes do their work — the gochujang's warmth, savor, and sweetness — but the architecture of the dip is the acid, and we score what we can and name what we can't.

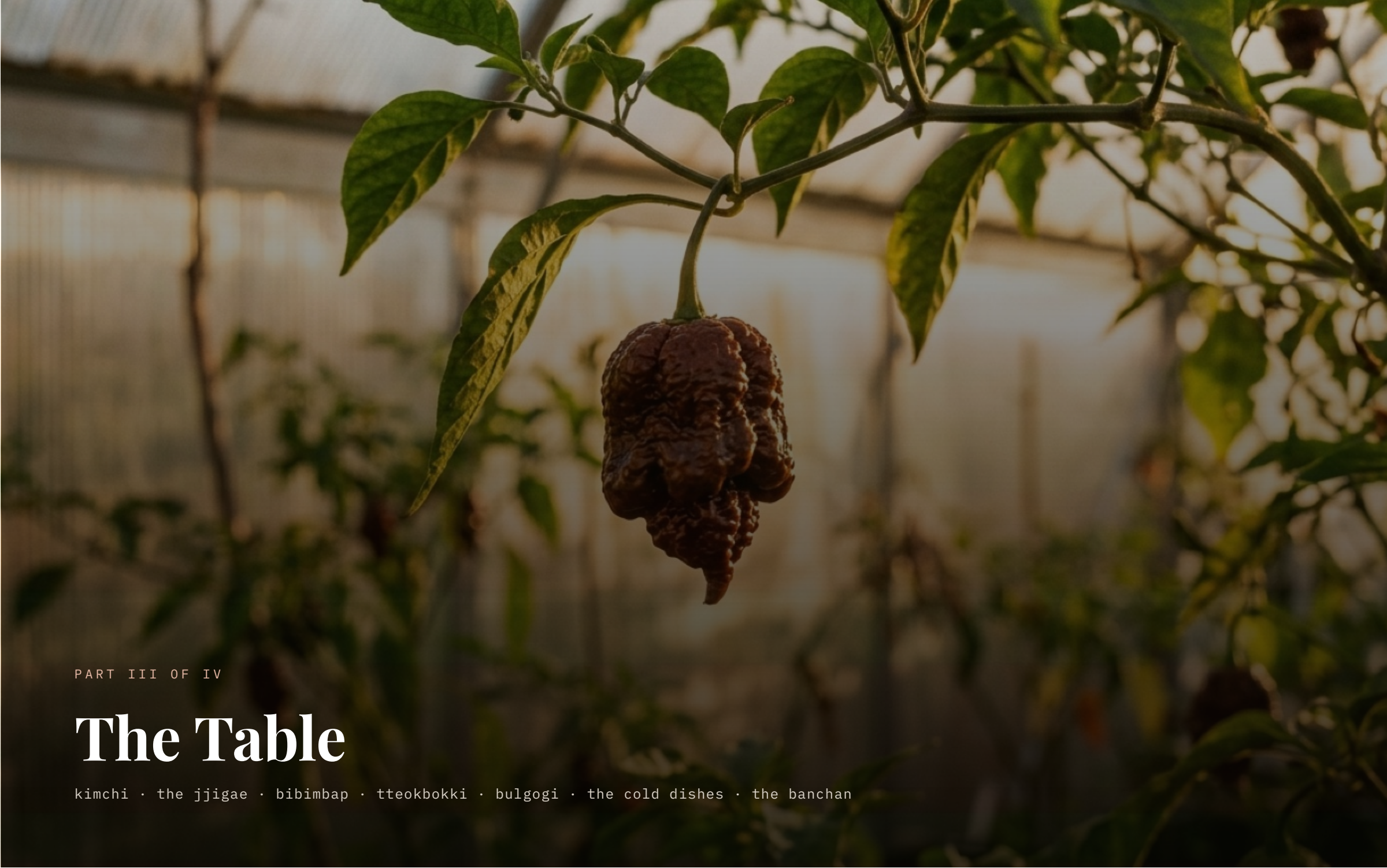
IFI PROFILE



IFI-H	640
IFI-P	300
IFI-C	40
IFI-U	1,100
IFI-S	800
IFI-B	60
IFI-K	900
IFI-A	80

AXIS	SCORE	
IFI-S · Sweetness	800	the bright sweet half of the balance
IFI-U · Umami	1,100	the gochujang's savory behind it
IFI-H · Heat	640	the warm red note
sour	*by hand*	*rice vinegar — outside the eight, leading the dip*

Two sauces, two keys: ssamjang the deep savory wrap, cho-gochujang the bright sour lift. With the pantry of Part II on the shelf — three jars, a stock, two sauces — the dishes of Part III are built by reaching more than by cooking.



PART III OF IV

The Table

kimchi · the jjigae · bibimbap · tteokbokki · bulgogi · the cold dishes · the banchan

Chapter 11 · Kimchi — *the living ferment.*

IFI-U × IFI-K × IFI-P × IFI-H · and the sour the microbe makes

No dish is more Korean, and none is a better teacher of everything this book is about, than **kimchi** (김치). It is not one recipe but a whole genus — hundreds of them, by vegetable and region and season — and at its most iconic it is **baechu-kimchi**, napa cabbage salted and dressed in a red seasoning paste and left to ferment into a living, changing, gloriously sour-savory thing. Kimchi is where the Korean genius for fermentation is most visible, where the hidden umami of the sea most quietly does its work, and where the one taste we do not measure — the sour — becomes the whole second life of the dish. To make it well is to conduct a microbial succession; to read it is to watch gamchilmat and pungency and a microbe-made sourness rise together over days.

Start with the architecture, because kimchi is built in two moves. First the **salt**: the cabbage is salted and left to wilt, which draws out water, seasons the leaves, and — crucially — sets the osmotic stage so that salt-tolerant lactic acid bacteria will outcompete everything that would rot the vegetable. Then the **yangnyeom** (양념), the seasoning paste, worked into every leaf: **gochugaru** for the warm heat and color; raw **garlic** and **ginger** for the sharp; **scallion**, often **mu** (radish) in matchsticks, sometimes **buchu**; a little sweetness from grated **Asian pear** or a cooked rice porridge (which also feeds the bacteria); and — the hidden engine — **jeotgal** (젓갈), salted fermented seafood, as **saeujeot** (새우젓, salted shrimp) or **myeolchi-aekjeot** (멸치액젓, anchovy fish sauce). Then you pack it down, exclude the air, and wait.



Baechu — napa cabbage, salted and dressed and packed down to begin the succession that turns a vegetable into kimchi.

What happens next is one of the loveliest microbial stories in food. Kimchi is a spontaneous **lacto-fermentation**, and it proceeds as a *succession* — a relay of organisms. In the first days, in the cool and the salt and the still-present oxygen, **Leuconostoc mesenteroides** leads: a heterofermentative bacterium that produces lactic acid *and* carbon dioxide (the faint fizz and prickle of young kimchi) *and* **mannitol**, a sugar alcohol with a cool, slightly sweet taste that gives

fresh kimchi its clean, lifted character. As the ferment goes anaerobic and acid builds, the baton passes to more acid-tolerant species — **Lactobacillus** (now often reclassified, but the old name is how most cooks know them) and **Weissella** — which drive the pH down further and deepen the sourness. Across the whole succession the bacteria also produce **bacteriocins** that suppress spoilage organisms, which is why a well-made kimchi keeps for months and only gets more interesting. The sourness is not decay. It is the microbe's signature, written in lactic acid, and it is the one axis of kimchi the Index leaves, deliberately, to the clock.

Baechu-Kimchi

Makes a large jar · 1 hour active, then 1–5 days to ripen · the living dish

You need

```
1   large   napa cabbage (baechu), halved or quartered
1/2 cup     coarse sea salt, for brining
1   litre   water
— the yangnyeom —
1/2 cup     gochugaru (warm, fruity; designed IFI-H ~800)
6   cloves  garlic · 1 tbsp ginger, both grated (the sharp)
1           Asian pear, grated (the sweet)
3   tbsp    myeolchi-aekjeot / saeujeot  — OR —  designed soy aekjeot + 1
tbsp doenjang (vegetarian)
2   tbsp    cooked rice porridge (feeds the ferment)
1   bunch   scallions · 1 cup mu (radish), in matchsticks
```

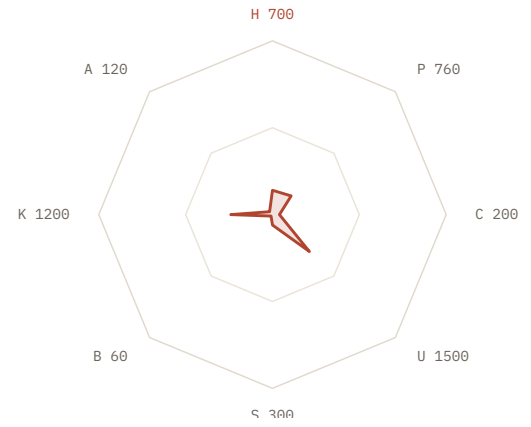
Make it

1. **Brine.** Dissolve the salt in the water and submerge the cabbage (or salt between the leaves and add a little water); weight it and leave 1–2 hours, turning once, until the leaves are bendy and wilted, not crisp. Rinse well and drain — this step sets the whole ferment up for success. Taste a leaf: pleasantly salty, no more.
2. **Dress.** Mix the yangnyeom into a loose, brick-red paste: gochugaru, garlic, ginger, pear, your choice of jeotgal or the vegetarian soy aekjeot, the rice porridge. It should smell savory, sharp, and warm all at once. Fold through the scallion and radish.
3. **Coat.** Wearing gloves, work the paste into and between every leaf, thoroughly. Pack the dressed cabbage *tightly* into a jar, pressing to exclude air and bring the brine up over the top. Leave headroom; it will bubble.
4. **Ripen.** Leave at cool room temperature 1–5 days, pressing it down daily to keep it submerged, until it tastes pleasantly sour and lively — faster in warmth, slower in cool. Then refrigerate. It is good young and crisp and keeps fermenting slowly for months, turning deeper and more sour, perfect for the stews to come.

Why it works — Kimchi is nearly the whole book in one jar. The warm IFI-H of the gochugaru, the sharp IFI-P of raw garlic and ginger, and the deep IFI-U/IFI-K of the jeotgal (or the engineered soy) are all present from day one; and then the microbe adds what we do not measure — the lactic **sour** that is the point of a ripened kimchi, rising over days as Leuconostoc gives way to Lactobacillus. The jeotgal is the hidden lesson in umami: a spoon of anchovy sauce or salted shrimp is pure synergist and glutamate, and it is why kimchi

tastes savory far beyond its vegetables. The vegetarian route is not a substitution but a true second path — a designed soy aekjeot and a little doenjang bring the same glutamate-and-kokumi floor from the garden, so a vegan kimchi reads as deep as any, and in our kitchen it is the default. The sourness, always, belongs to the clock; we name it on the card and leave it where it lives.

IFI PROFILE



IFI-H	700
IFI-P	760
IFI-C	200
IFI-U	1,500
IFI-S	300
IFI-B	60
IFI-K	1,200
IFI-A	120

AXIS	YOUNG	RIPE	
IFI-U · Umami	1,400	1,600	jeotgal or designed soy, deepening
IFI-K · Kokumi	1,000	1,300	the ferment knitting body
IFI-P · Pungency	820	600	raw garlic sharp, mellowing with time
IFI-H · Heat	700	700	the warm gochugaru, steady
sour	*light*	*leading*	*lactic acid — outside the eight, the clock's gift*

Kimchi is the one dish that is never finished — it is a population, not a product, and it reads differently every week. Young, it is crisp and sharp and barely sour; ripe, it is deep and tangy and built for the pot. The scorecard is a snapshot of a living thing, which is exactly why we date it.

Chapter 12 · The jjigae — *the stew that the floor carries.*

IFI-U × IFI-K × IFI-H · doenjang, kimchi, and sundubu

If gamchilmat is the soul of the cuisine, the **jjigae** (찌개) is its clearest expression — the bubbling, communal stew, thicker and more intense than a soup, that anchors the everyday Korean table. Three are canonical: **doenjang-jjigae**, built on the deep soybean floor; **kimchi-jjigae**, where ripe sour kimchi meets the pot; and **sundubu-jjigae**, the silken-tofu stew finished with a flood of chili oil. All three are proof of the same thesis — that a dish built on a fermented floor can carry real heat and real intensity and still read as nourishment rather than assault, because the savory depth beneath holds the fire up.

The lesson of the jjigae is that the floor does the work. You start with a **yuksu** (Chapter 9), melt in a fermented base — doenjang, or ripe kimchi, or both — and the stock's synergistic umami plus the paste's deep IFI-U/IFI-K give you a broth that tastes long-simmered in twenty minutes. The chili comes in low and warm, laddered to let the savor through. Vegetables and tofu are poached in it. It is one of the fastest deep-tasting dishes in any cuisine, and the speed is entirely a gift of the ferment: you are not building savor from scratch in the pot, you are *melting in* a savor that months of fermentation already built.



Gochu specimen — the warm chili note that a jjigae ladders low, so the fermented floor beneath can carry the heat.

Kimchi-Jjigae

Serves 4 · 30 minutes · ripe kimchi's second life

This is the dish that ripe, sour kimchi was waiting to become — the older and more sour the kimchi, the better the stew, which is the whole Korean philosophy of waste-nothing ferment in one pot.

You need

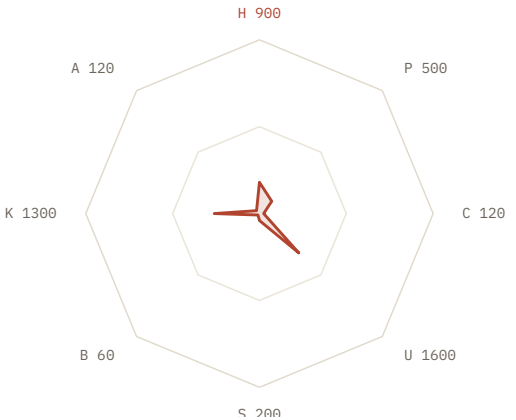
2	cups	ripe (sour) kimchi, chopped, plus 1/2 cup of its brine
1	litre	yuksu (Chapter 9, garden or sea)
200	g	firm tofu, cubed · 150 g mushrooms, torn
1	tbsp	gochugaru · 1 tbsp gochujang (Chapter 7)
1	tsp	doenjang (Chapter 8) · 1 tsp sesame oil
1		onion, sliced · 2 scallions · 2 cloves garlic
		(traditional: pork belly or tuna; see the note)

Make it

1. In a little sesame oil, soften the garlic, onion, and the chopped ripe kimchi for five minutes, until the kimchi turns glossy and its edges caramelize — frying the ferment awake deepens everything.
2. Stir in the gochugaru, gochujang, and doenjang and let them bloom in the fat for a minute. Pour in the yuksu and the kimchi brine.
3. Simmer 15 minutes to marry, then add the tofu and mushrooms and simmer gently 5 more. Taste: the ripe kimchi's **sour** should lead and lift, the fermented floor should be deep beneath, the heat warm and tastable-through.
4. Finish with scallion. Serve fiercely hot, with rice. *(To cook it the classic way, brown a little pork belly or fold in canned tuna at step 1; the method does not change, and the respect is the same.)*

Why it works — Read the card and you see why kimchi-jjigae feels *complete*: the fermented floor (IFI-U/IFI-K, from the kimchi, the doenjang, and the synergistic stock) carries a warm, laddered heat, and over all of it the ripe kimchi's lactic **sour** does the lifting that keeps a rich, spicy stew from tiring. It is the clearest argument in the book that heat built on a savory floor is a pleasure, not a dare — and that a sour, months-old kimchi is not past its prime but arriving at its purpose.

IFI PROFILE





AXIS	SCORE	
IFI-U · Umami	1,600	kimchi + doenjang + synergistic stock
IFI-K · Kokumi	1,300	the deep, carrying body
IFI-H · Heat	900	warm, laddered to taste through
sour	*leading*	*the ripe kimchi's lactic lift — outside the eight*

Swap in doenjang as the base and drop the kimchi and you have doenjang-jjigae — the same floor, quieter and earthier, built for everyday. Flood a silken-tofu pot with red chili oil at the end and you have sundubu. One architecture, three stews, and the ferment doing the heavy lifting in every one.

Chapter 13 · Bibimbap — *the whole Index, mixed.*

IFI-F · the composed bowl, and the full-spectrum plant it echoes

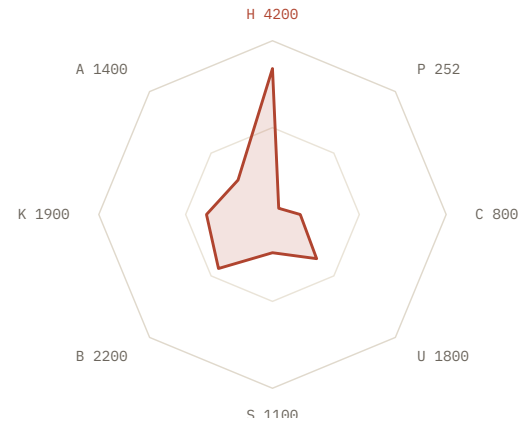
Korea has a dish whose very name is an instruction: **bibimbap** (비빔밥), *bibim* "mixed" plus *bap* "rice" — a bowl of warm rice crowned with a careful ring of seasoned vegetables, each a different **namul** (나물), a spoon of gochujang, a slick of sesame oil, often an egg, sometimes meat — all of it *stirred together* at the table into one warm, savory, gently spicy, textured whole. It is the Korean table's composition dish, the one where the scattered banchan philosophy collapses into a single bowl, and read through the Index it is something remarkable: **nearly every axis on one spoon**, held in a proportion where none wins. Bibimbap is the dish that says *all tastes at once* — and it echoes, almost exactly, the most ambitious thing our platform has ever built.



Rice — the warm floor of the bibimbap bowl, the neutral ground every seasoned element is mixed into.

Because we built a plant that does the same thing in a single fruit. **Phoenix** — SS-0096 — is the only cultivar we have ever designed to register on **all eight axes at once**, the first in history to do so. You would never eat it on a plate; it is the summit the entire heat ladder is designed from, an extreme by design. But read its profile and you are reading the bibimbap principle written in receptors — a full spectrum, every pathway lit, no axis standing alone:

IFI PROFILE



IFI-H		4,200
IFI-P		252
IFI-C		800
IFI-U		1,800
IFI-S		1,100
IFI-B		2,200
IFI-K		1,900
IFI-A		1,400

*Two AI-designed substitutions in the Pun1 gene — **S39L · L345G** — found with a protein language model, ranked by predicted efficacy and fold stability, and written in with CRISPR. The substitutions made the towering predicted heat possible; the genome-scale flux-balance model made the other seven axes coherent around it. Phoenix is the plant our model designs to say "every axis at once"; bibimbap is the dish that says it back, in a bowl you can actually eat.*

Bibimbap

Serves 4 · 45 minutes · the bowl you stir into one

The genius of bibimbap is that each element is seasoned *separately* and correctly — each namul is its own small, complete thing — and the diner composes the final flavor by how they mix. It is modular design on a plate.

You need

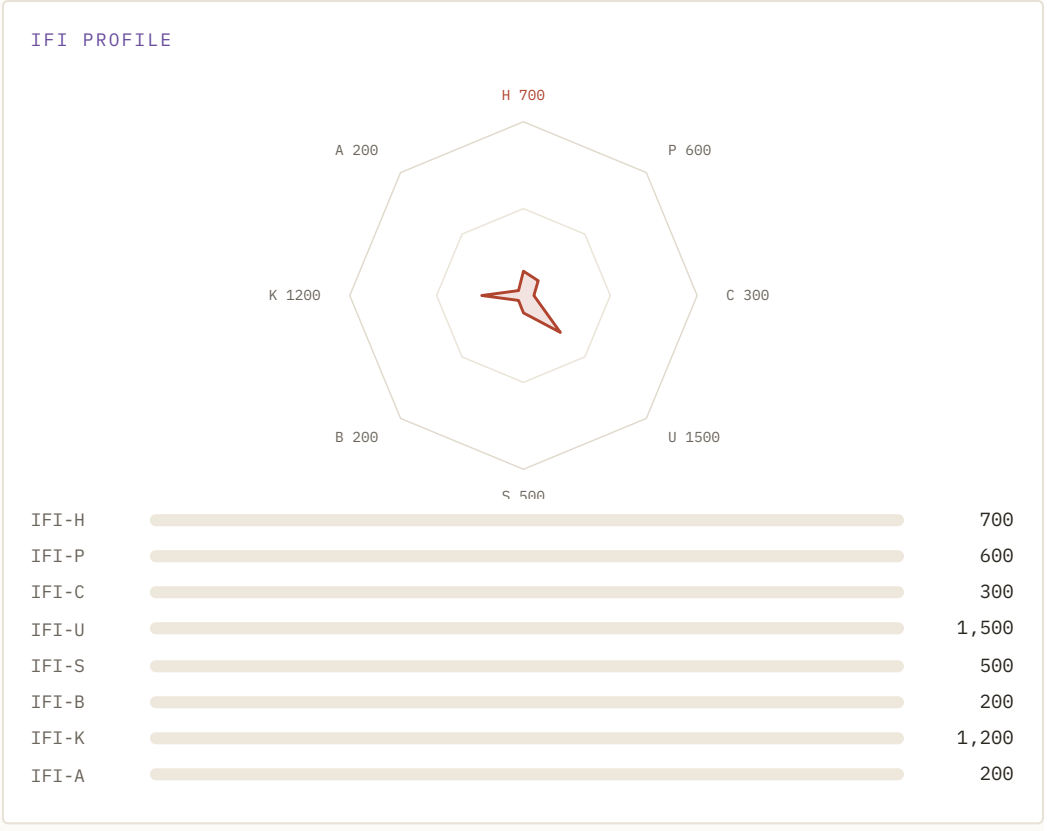
```
4   cups    warm cooked rice (short-grain)
— a ring of namul, each seasoned apart —
1   cup     spinach, blanched, dressed with sesame oil, garlic, salt
1   cup     bean sprouts, blanched, dressed likewise
1   cup     carrot, julienned and quickly sautéed
1   cup     mushrooms (shiitake/oyster), sautéed with ganjang
1   cup     courgette or cucumber, salted and sautéed
            + optional: sautéed greens, fernbrake (gosari)
— to finish —
4           eggs, fried sunny-side (or omit, for vegan)
4   tbsp    gochujang (Chapter 7), thinned with sesame oil + a drop of
vinegar
            toasted sesame oil; toasted sesame seeds
```

Make it

1. Prepare each namul separately — blanch or sauté, then dress each one individually with sesame oil, a little garlic, and salt. This is the whole discipline: each element correct on its own. Keep them in their own piles.
2. Mound warm rice in each bowl and arrange the namul in a ring on top, colors apart, with the mushrooms for their deep IFI-U. Center an egg if using.

3. Add a generous spoon of gochujang loosened with sesame oil (and that drop of vinegar). For the full experience, build it in a hot stone bowl (*dolsot*) so the rice crisps golden at the edges.
4. At the table, **stir everything together, hard**, until the gochujang coats every grain and the elements lose their borders. That stir is the recipe; bibimbap is a verb.

Why it works — Bibimbap is a composition problem the Index reads cleanly, because almost every axis is present and the diner's stir sets the proportion. The gochujang brings warm IFI-H and sweet IFI-S; the mushrooms and sesame bring IFI-U and IFI-K; the garlic in the namul brings IFI-P; the fresh vegetables bring a cool green lift; and the sesame's fat carries all of it long on the palate. Like Phoenix, it is an argument that flavor is fully addressable — that you can light every pathway at once and, if you hold the proportion, the mouth reads not chaos but *completeness*. The platform spent a decade building a fruit that does this; the Korean table has been stirring it together in a bowl for centuries.



Seven axes genuinely in play and the sour a bright drop by hand — bibimbap is the cuisine's quiet claim, like Phoenix, that the whole tongue can be addressed at once. The difference is only that one is a plant and the other is dinner.

Chapter 14 · Tteokbokki — *the sweet-heat street plate.*

IFI-H × IFI-S · the swicy intersection, and the dual-axis library

Not everything on the Korean table is deep and aged; some of it is loud, bright, chewy, and gloriously direct, and no dish says so better than **tteokbokki** (떡볶이) — cylinders of chewy rice cake simmered in a slick, glossy, red sauce that is unapologetically **sweet and spicy at once**. It is street food, comfort food, the after-school snack and the late-night craving, and it is the clearest Korean example of the single most dominant flavor trend in the modern world: **swicy**, the heat-and-sweet intersection, **IFI-H × IFI-S**. The platform keeps its dual-axis work in a library of its own — the **M2** class at **8,400** constructs — and tteokbokki is that library's most joyful citizen.



Rice in cross-section — the starch that becomes the chewy tteok, and, converted by malt, the sweetness that balances the fire.

The swicy intersection is a real design problem, not just a flavor fashion. Heat and sweetness are read by entirely separate receptors — TRPV1 for the capsaicin, TAS1R2·R3 for the sugar — and the pleasure of swicy is in their *interplay*: the sweet softens the leading edge of the heat and makes it approachable, the heat keeps the sweet from cloying, and the two together create a moreish loop that neither achieves alone. The trouble with doing it the old way is sugar: a properly sweet-hot sauce can carry a heavy sugar load, and the balance is fiddly to hold. This is exactly where designed sweetness earns its place — lifting IFI-S through the loud sweet

glycosides and proteins of the stevia and monk-fruit routes, so tteokbokki keeps its signature **dan-mat** sweet-heat poise while shedding most of the sugar, and so a brand can hit the same swicy ratio in every batch.

Tteokbokki

Serves 4 · 25 minutes · chewy, glossy, sweet-and-hot

You need

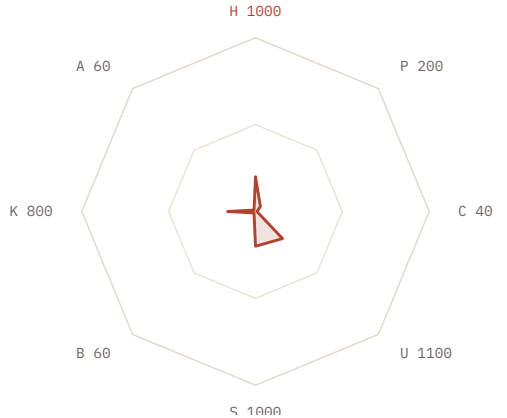
500	g	tteok (cylindrical rice cakes), soaked if dried
3	cups	yuksu (Chapter 9) or water
3	tbsp	gochujang (Chapter 7)
1	tbsp	gochugaru (for a brighter red heat)
1	tbsp	jocheong or designed sweetener (the swicy sweet)
1	tbsp	ganjang (soy sauce)
2		scallions, in batons · 2 cloves garlic
		optional: fish cakes (eomuk), boiled egg, cabbage

Make it

1. Whisk the gochujang, gochugaru, sweetener, and ganjang into the yuksu in a wide pan and bring to a simmer. Taste the sauce now and set the swicy balance — sweet and heat should arrive together, neither winning.
2. Add the soaked rice cakes and the garlic and simmer, stirring often, 10–15 minutes, until the tteok are tender-chewy and the sauce reduces to a glossy, clinging red lacquer. Add cabbage or fish cakes partway if using.
3. Fold in the scallion at the end. Serve immediately, molten and sticky, the chew of the tteok against the sweet-hot sauce.

Why it works — This is the M2 dual-axis library on a plate: IFI-H and IFI-S held in deliberate proportion, the heat warm and the sweet bright, each making the other more pleasurable. Beneath them the yuksu and gochujang lay a quiet IFI-U/IFI-K floor that keeps even this candy-bright street dish from being hollow — the Korean instinct to put gamchilmat under *everything*. And the designed sweetness means the swicy loop can be as moreish as it wants while the sugar comes down, the sweetness read from receptor loudness rather than grams. Chewy, glossy, sweet, and hot: the simplest dish in the book, and a perfect small proof that two axes held in ratio are more than the sum of either.

IFI PROFILE



IFI-H	1,000
IFI-P	200
IFI-C	40
IFI-U	1,100
IFI-S	1,000
IFI-B	60
IFI-K	800
IFI-A	60

AXIS	SCORE	
IFI-H · Heat	1,000	the bright red warmth, the *là* of Korea
IFI-S · Sweetness	1,000	the designed sweet, matched to the heat
IFI-U · Umami	1,100	the quiet floor under the candy
IFI-K · Kokumi	800	enough body to keep it honest

Heat and sweet at a deliberate one-to-one — that is swicy, the world's favorite intersection, and tteokbokki held the ratio long before it had a name. Slide both up for the fierce version, both down for children; the balance is the dish.

Chapter 15 · Bulgogi and galbi — *pear, sweet, and the char.*

IFI-S × IFI-U × IFI-K · the marinade, and the Maillard it feeds

Not all of Korean cooking is red and fermented; some of its most beloved dishes are brown, sweet, and smoky — the grilled meats, **bulgogi** (불고기, "fire meat," thin-sliced marinated beef) and **galbi** (갈비, short ribs), and the whole culture of **gogi-gui**, the tabletop grill. They are built not on chili but on a marinade, and that marinade is a small masterpiece of flavor engineering: a sweet-savory bath, **dan-jjan** (sweet-and-salty), that seasons, tenderizes, and — crucially — *feeds the char*, loading the surface with the sugars and amino acids that the grill's heat will turn into the deep browned flavor of the Maillard reaction. This chapter is a marinade, and a lesson in how sweetness and savor become, over fire, something neither was alone.



Asian pear — the marinade's secret: enzymes that tenderize, and a clean sweetness that feeds the char.

The signature ingredient is **Asian pear**, grated into the marinade, and it does two jobs at once. Its proteases gently tenderize, loosening the muscle so a quick-grilled slice stays soft. And its clean, high sweetness — along with a little rice syrup or sugar — does something more interesting than taste sweet: it is *fuel for the Maillard reaction*, the cascade of browning in which reducing sugars and amino acids condense under heat into hundreds of new roast-and-savor compounds. A marinade rich in sugar and in the glutamate-bearing ganjang chars faster and deeper, which is why

bulgogi develops that lacquered, almost caramelized edge. The sweetness you taste in the raw marinade is only half its purpose; the other half is what the grill makes of it.

Bulgogi Marinade

Marinates ~600 g · 20 minutes plus 1–4 hours · the sweet-savory bath that feeds the fire

Our default below is king oyster and portobello mushroom, whose dense, meaty texture takes the marinade and the char beautifully and whose own IFI-U the platform can lift to carry the dish; the meat version is written beside it with equal respect, because bulgogi is the meat's own home and we cook it that way without apology when the table wants it.

You need

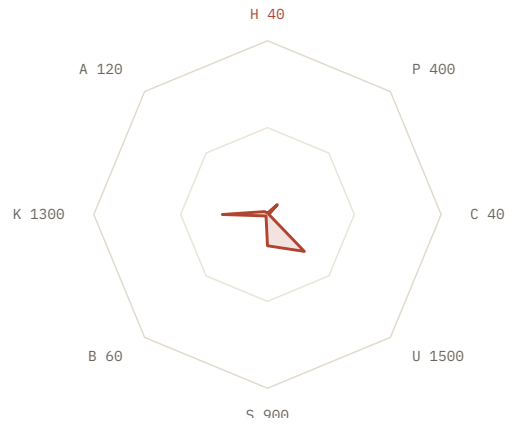
```
600 g       thin-sliced beef sirloin  — OR —  king oyster + portobello,
thick-sliced
— the marinade —
1/2         Asian pear, grated (tenderize + sweet + char fuel)
4   tbsp    ganjang (soy sauce) — the glutamate, the char
2   tbsp    jocheong or designed sweetener
1   tbsp    sesame oil · 1 tbsp toasted sesame seeds
4   cloves  garlic, grated · 1 tsp ginger
2           scallions · 1/4 onion, grated · black pepper
```

Make it

1. Whisk the marinade: grated pear, ganjang, sweetener, sesame oil and seeds, garlic, ginger, grated onion, pepper. Taste — it should read sweet-savory and deeply aromatic.
2. Bathe the sliced beef (or the mushrooms) in it and rest 1–4 hours, no longer for beef — the pear's proteases will over-soften if left overnight.
3. Grill hot and fast — a tabletop grill, a griddle, or a ripping-hot pan — in a single layer, letting the sugar-and-glutamate surface *char*. You want browned, lacquered edges; that char is the whole point. Serve with rice, lettuce and perilla leaves for wrapping, and ssamjang (Chapter 10).

Why it works — The scorecard reads sweet and savory, but the dish's magic is what the grill does to those numbers: the marinade's IFI-S and the ganjang's IFI-U are, under fire, the raw material of the Maillard char, so the finished bulgogi tastes of far more than the marinade did — roasted, deep, almost caramelized. The mushrooms' own umami (lifted, in the engineered version, so a plant carries the savor the beef would) make the vegetarian bowl a true version and not a wistful one. And the kokumi of sesame and ganjang gives the whole thing the long, satisfying finish that makes Korean barbecue so hard to stop eating. Sweetness here is not indulgence; it is engineering — for tenderness, for balance, and for the fire.

IFI PROFILE



IFI-H	40
IFI-P	400
IFI-C	40
IFI-U	1,500
IFI-S	900
IFI-B	60
IFI-K	1,300
IFI-A	120

AXIS	SCORE	
IFI-S · Sweetness	900	pear and syrup — taste, tenderizer, and char fuel
IFI-U · Umami	1,500	ganjang and the lifted mushroom savor
IFI-K · Kokumi	1,300	sesame and soy, the long finish
IFI-P · Pungency	400	the grated garlic's sharp

Swap the thin slices for short ribs and you have galbi; the marinade is the same sweet-savory bath, the fire the same transformer. Meat or mushroom, the dish is the marinade and the char — and the sweetness is doing three jobs, only one of which is tasting sweet.

Chapter 16 · The cold and the cooling — *the refreshing counterpoint.*

IFI-C · TRPM8 · naengmyeon, dongchimi, and the summer table

A cuisine this fluent in warm heat and deep ferment needs a counterweight, and Korea's is one of the most refreshing things in all of food: the **cold** dishes, led by **naengmyeon** (냉면), chilled buckwheat noodles served in an icy broth, and the whole family of cooling, barely-fermented water pickles — **dongchimi** (동치미, a brothy winter radish kimchi) and the **mul-kimchi** (물김치, "water kimchi"). They are the summer table and the palate-resetters, and they give this book its chance to speak honestly about the one axis Korean tradition reaches mostly *without* a dedicated molecule: **IFI-C**, cool-burn, the cooling of the **TRPM8** receptor.



Cucumber — crisp, watery, faintly cooling: the vegetable of the Korean summer table and the chilled soup.

Here is the honest account. TRPM8 is the receptor that reads a true chemical coolness — the cold-without-cold of menthol — and the platform engineers it loudly in the mint and eucalyptus hosts for the cooling books. Korean cuisine, by and large, does *not* use those menthol-class compounds; its coolness is built three other ways. First and most simply, by **temperature** — the broth is served iced, sometimes slushy, a real thermal cold that TRPM8 also reads, since the receptor answers to actual cold as well as to menthol. Second, by the **mannitol** and the light acidity of a cool, young ferment: the same *Leuconostoc* that leads the kimchi succession makes mannitol,

a sugar alcohol with a genuinely cooling, clean mouthfeel, and a dongchimi brine is full of it. Third, by *contrast and refreshment* — the crisp water of radish and cucumber, the bright sour, the absence of fat — which the mouth reads as cooling even where no cooling molecule is present. Where a designer *wants* to push the cool further, the platform's TRPM8 route is available as a whisper of true chemical coolness, a perilla-and-cool accent; but we use it sparingly here, because the Korean genius for cold is mostly architecture, not menthol, and the book should say so.

Mul-Naengmyeon

Serves 2 · 20 minutes plus chilling · icy noodles for the hot day

You need

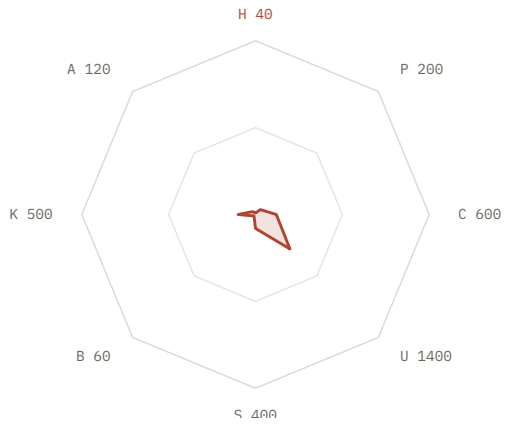
```
200 g       naengmyeon (buckwheat) noodles
4   cups    yuksu (Chapter 9), chilled ice-cold, lightly seasoned
2   tbsp    rice vinegar · 1 tsp mustard (optional, a sharp lift)
1/2         cucumber, julienned · 1/2 Asian pear, sliced
2           boiled egg halves · a little dongchimi brine if you have it
            ice; toasted sesame
```

Make it

1. Chill the yuksu until it is ice-cold — in summer, with a few ice cubes dropped in. Season it lightly and sharpen it with the vinegar; it should taste savory, bright, and barely sweet, meant to be drunk.
2. Boil the noodles until just springy, then rinse them hard under cold running water and ice them until they squeak — cold, clean, and chewy is the whole pleasure.
3. Nest the noodles in a bowl, pour the icy broth around, and top with cucumber, pear, egg, and sesame. Add a splash of dongchimi brine for the cool, mannitol-bright ferment note. Eat cold, fast, and refreshed.

Why it works — The cool here is mostly thermal and architectural: the iced broth hits TRPM8 as real cold, the mannitol of the dongchimi brine adds a genuinely cooling mouthfeel, and the crisp cucumber and bright vinegar refresh the palate without a drop of fat. Under the cold, the yuksu's synergistic IFI-U keeps even this chilled bowl savory and satisfying — the floor is everywhere, even in summer. We score a modest IFI-C and tell you plainly that most of it comes from ice and ferment rather than from a cooling molecule, because honesty about where an axis comes from is the same discipline as measuring it.

IFI PROFILE



IFI-H	40
IFI-P	200
IFI-C	600
IFI-U	1,400
IFI-S	400
IFI-B	60
IFI-K	500
IFI-A	120

AXIS	SCORE	
IFI-C · Cool-Burn	600	mostly thermal + mannitol; a whisper of designed cool
IFI-U · Umami	1,400	the synergistic stock, even iced
sour	*by hand*	*vinegar and dongchimi brine — outside the eight, lifting*

Korea's cold is engineered, but mostly out of ice, radish-ferment, and contrast rather than menthol — a reminder that an axis can be reached by architecture as surely as by a molecule, and that the honest scorecard says which.

Chapter 17 · Banchan and japchae — *the table as composition.*

IFI-U × IFI-K × IFI-P × IFI-S · the many small dishes

The Korean meal is not a plate but a *constellation* — a bowl of rice, a stew, and around them a scatter of small dishes, **banchan** (반찬), each a different seasoned vegetable, pickle, or ferment, replenished freely and shared. It is a philosophy of eating that the Index finds deeply congenial, because each banchan is a small, complete composition — a single element seasoned to its own correct balance — and the meal's flavor is the *sum and the contrast* of many such compositions. This closing chapter of the table gives you a glass-noodle dish that is a banchan grown into a centerpiece, **japchae**, and a simple **namul** to stand for the dozens, so you can see how the small dishes are built.



Sweet potato — whose starch becomes the clear, springy dangmyeon noodles of japchae, one of the Korean table's quiet triumphs of texture.

Japchae (잡채) is built on **dangmyeon**, the clear, bouncy glass noodles made from **sweet-potato starch** — a texture no wheat noodle can match, slippery and springy at once. The noodles are tossed with a rainbow of separately-cooked vegetables, seasoned with ganjang and sesame and a little sweetness, in a dish that is savory, faintly sweet, and endlessly texturally interesting. Like bibimbap, its discipline is that each vegetable is cooked and seasoned *apart* and combined only at the end, so every bite is a slightly different proportion of the same elements.

Japchae

Serves 4–6 · 40 minutes · the glass-noodle banchan that became a feast

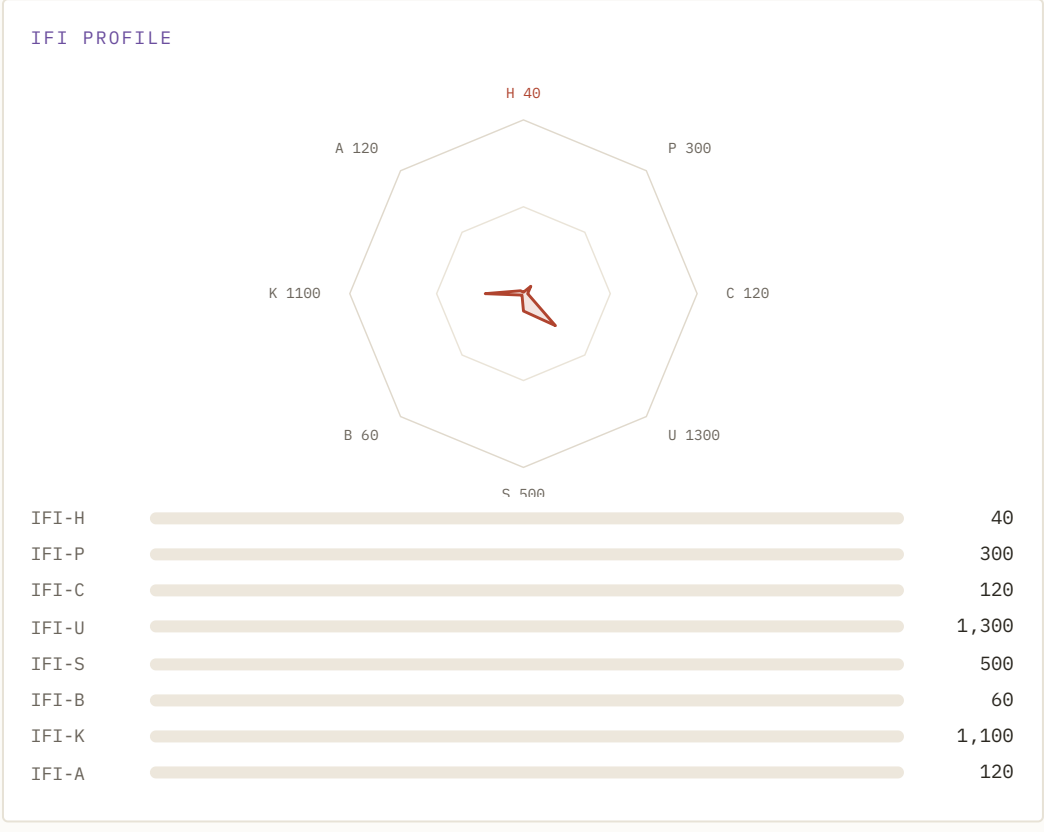
You need

```
200 g       dangmyeon (sweet-potato glass noodles)
— cooked separately, then combined —
1   cup     spinach, blanched · 1 cup mushrooms, sliced
1           carrot, julienned · 1/2 onion, sliced
1           red pepper, sliced · 3 scallions
— the seasoning —
4   tbsp    ganjang (soy sauce) · 2 tbsp sesame oil
1   tbsp    jocheong or designed sweetener
2   cloves  garlic · toasted sesame seeds
```

Make it

1. Boil the glass noodles until clear and springy, drain, rinse, and toss with a little sesame oil and a spoon of ganjang so they season as they cool. Snip them a few times so they are manageable.
2. Cook each vegetable *separately* in a little oil — onion, carrot, pepper, mushrooms, the blanched spinach — each just to tender, each seasoned with a pinch of salt. Keeping them apart keeps their colors and their distinct character.
3. Combine everything in a wide bowl with the remaining ganjang, sesame oil, sweetener, and garlic. Toss thoroughly with your hands until every strand is glossed and seasoned. Finish with sesame. Serve warm or at room temperature.

Why it works — Japchae's scorecard is a gentle, balanced savory: the ganjang and mushrooms bring IFI-U and IFI-K, the garlic a quiet IFI-P, the designed sweetness a specified IFI-S, and the sesame the long, rich finish. But the real lesson is structural — the dish is a *composition of separately-correct parts*, which is the banchan philosophy and, not coincidentally, the platform's own: build each element to its own number, then compose. A Korean table of ten banchan is ten small scorecards, eaten in contrast, and the meal is their sum.



A Namul, for the Table — Sigeumchi-Namul

Makes one small dish · 10 minutes · the simplest banchan, and the template for all of them

1	bunch	spinach, blanched 30 seconds and squeezed dry
1	tsp	ganjang · 1 tsp sesame oil
1	clove	garlic, minced · toasted sesame · pinch salt

Toss it all together, taste, adjust. That is a namul — a single vegetable, a little savor from ganjang, a little sharp from garlic, the richness of sesame — and it is the atom of the Korean table. Multiply it by a dozen vegetables and a dozen small variations and you have the banchan spread: a meal composed, like everything in this cuisine, of many correct small things laid in contrast against a deep savory floor.



Spinach — blanched, squeezed, and dressed in sesame and garlic: the simplest namul, the atom of the banchan table.

The banchan table is the Korean meal's quiet thesis, and ours: that you build a great whole not by forcing one dish to do everything, but by composing many small, correct, separately-scored things. Each namul is a scorecard; the table is the sum; and the diner, reaching from dish to dish, composes the final flavor themselves.



PART IV OF IV

The Spec & the Frontier

the ownable gochujang · the numbers · the next jang · gamchilmat and the body

Chapter 18 · Designing an ownable gochujang — *the spec in the jar.*

IFI-H × IFI-U × IFI-K × IFI-S · the four-axis product, specified

For the cook, gochujang is a jar on the shelf. For a brand — and this book was written with the ferment and condiment makers squarely in mind — it is a **specification**, and the gochujang-and-Korean-sauce aisle is one of the fastest-growing shelves in the world's pantries while remaining, in flavor terms, a fog. Jars compete on "authentic," "spicy," "umami," and a photograph, and almost none can say, in numbers, *what they are*. Everything this book has shown turns the vaguest brief in the category — *make a great gochujang* — into something you can write down, build, hold, and defend. This chapter is for the founder with an idea and a crock.



Phoenix on the microscope stage — the precision instrument behind the promise: a flavor specified to a number and held to it, jar after jar.

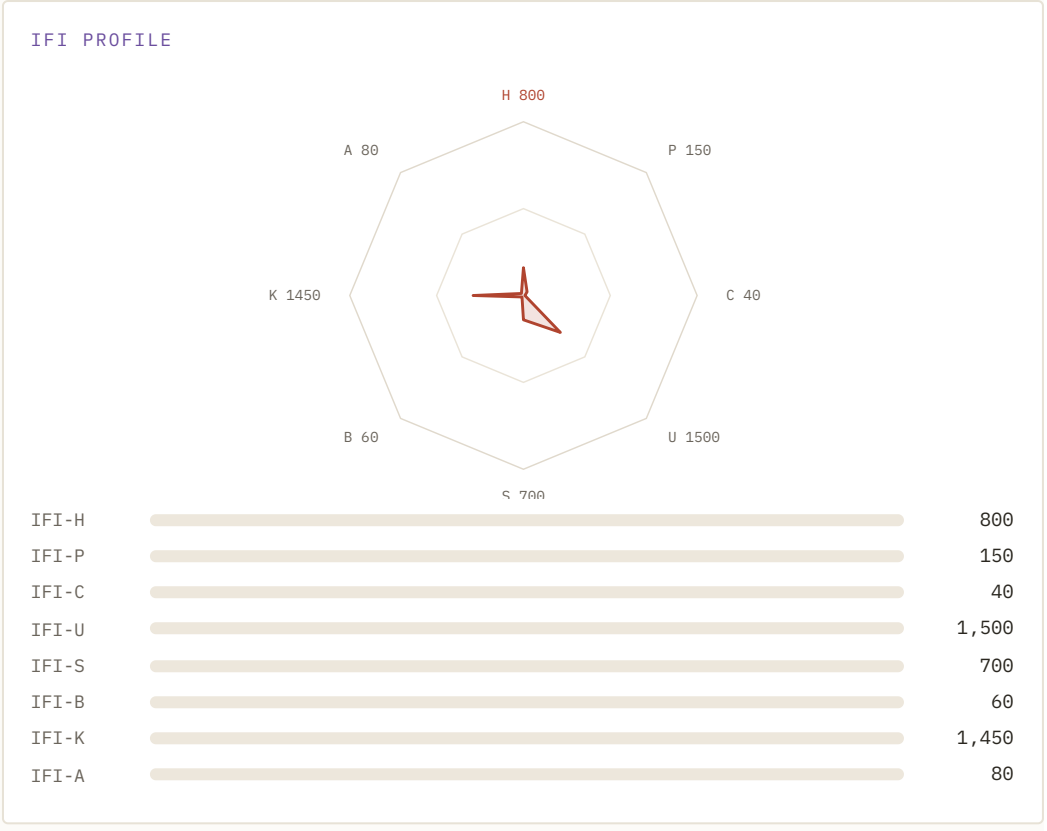
Start where Chapter 7 did: gochujang is a **four-axis construct**, and an ownable one is a deliberate set of four numbers. Name them before you name your ingredients. A bright, sweet-forward dipping gochujang and a brooding, deep, high-heat cooking gochujang can share a category and a shelf and be entirely different products — and the thing that makes them distinct, and reproducible, and *yours*, is the spec:

AXIS	WHAT IT SETS	A "BRIGHT TABLE" GOCHUJANG	A "DEEP COOKING" GOCHUJANG
IFI-H · Heat	the warmth	600	1,000
IFI-U · Umami	the savory note	1,300	1,700
IFI-K · Kokumi	the aged body	1,100	1,600
IFI-S · Sweetness	the balance	900	500

Then build to it, with the pantry of Part II as your palette: a gochugaru whose warm, fruited capsaicin shape (the Pun1 acyl chain of Chapter 5) you have chosen and whose IFI-H you have laddered to target; a meju or designed soy base carrying the gamchilmat floor to your IFI-U and IFI-K; the malt-and-rice step (or designed sweetness) setting IFI-S; and the salt and the ferment time doing what only they can. The engineered constructs are what make the four numbers *hold*: because every construct in the library is specified to a receptor and built to it, your gochujang's four axes can be reproduced batch after batch instead of drifting with the harvest and the weather.

The Signature Gochujang — a worked spec

The product, as a number before it is a recipe



This is a balanced, flagship-style gochujang — warm but tastable-through, deeply savory, aged-tasting in body, gently sweet. Write those numbers on a spec sheet and hand them to a production kitchen and you have done what almost no one on the shelf can: said, exactly, what your gochujang *is*. The thing a brand is really selling sits underneath all of it — **consistency**. Every construct we ship holds its profile to a coefficient of variation of **seven percent or less**, across a library of roughly **225** distinct construct designs — **1,000** product SKUs live and purchasable today, out of **19,500** in the

full catalogue — spanning **42** host organisms and the **8** sensory axes, backed by **3** patents filed and **21** peer-reviewed papers published open-access (Zenodo, CC BY 4.0). A flavor that drifts from jar to jar is a rumor. A flavor specified to four numbers and held to seven percent is a brand.

A note on the label — attributes, never claims. Fermented condiments carry real regulatory and honesty obligations, and we hold to them strictly. A gochujang built on soy and, if you use it, on fish-based jeotgal must say so: **soy** is an allergen, and **fish or shellfish** (anchovy, shrimp) are allergens the moment jeotgal enters the jar — which is one more reason the vegetarian soy-aekjeot route of Chapter 11 is our default, as it keeps the jar free of the sea's allergens while carrying the same savory floor. And the ethos that hums under this whole library stays a **value, never a medical claim**: you may say a gochujang is built on living ferment, whole soybeans, and vegetables, and you may describe what it *is* — fermented, plant-based, lower in added sugar through designed sweetness — but you may not say it *does* anything to the body, because nourishment is an intention we cook with, not a cure we sell. The scorecard measures flavor. The label tells the truth. Neither one reaches past itself.

THE PROMISE	THE NUMBER
Specified flavor	four IFI axes, written on the spec
Reproducibility	CV ≤ 7%, batch to batch
The library behind it	~225 construct designs · 1,000 live SKUs · 19,500 total · 42 organisms · 8 axes
The receipts	3 patents filed · 21 peer-reviewed papers (CC BY 4.0)

This is the whole book as a product: the deep savory of Part I, the pantry of Part II, and the dishes of Part III, specified to four numbers and held there. Say what your gochujang is, promise it will be the same next year, and mean both — that is an ownable jar.

Chapter 19 · The next jang — *the frontier, and the plants we have not built yet.*

the soybean, the gochu, and the Dynasty rice on the roadmap

We will end the technical part of the book where our work actually lives — at the edge of it, looking forward — because a cuisine built on fermentation is, of all cuisines, the one with the most left to build. Korean food's genius is to coax depth from a few humble plants and a great deal of time, and that is precisely the gap the platform exists to close: to make the humble plant more generous and the time less necessary, without ever pretending to replace the ferment or the hand. Here is what is live, what is near, and what is on the roadmap.



Rice — the staple of the Korean table, and, as *Dynasty*, a T4 frontier organism on the 64-concept roadmap.

The soybean is the frontier that matters most here, and it is already an established host in our library — **360 constructs**, routed for the two axes this cuisine is built on, **umami** and **kokumi**, and filed honestly under *frontier* difficulty because soy is harder to engineer than a pepper. Everything in Part I turns on it: a bean that banks a lifted free-glutamate pool and a turned-up γ-glutamyl route carries both halves of gamchilmat to the crock before fermentation begins, so a jang can taste aged without the years. The nearest frontier is simply *more* of this — a soybean so well-routed that a six-month doenjang reads like a three-year one, held to seven percent, so the depth that was once a grandmother's patient secret becomes a reliable floor any kitchen can stand on.

The gochu is the near work — the warm, fruited, smoky heat of Korea, specified in the Pun1 acyl chain. The pathway is the universal one, the phenylpropanoid branch **PAL → C4H → 4CL → HCT → COMT** that runs in every vascular plant, capped by the four pepper-specific terminal enzymes **pAMT · Pun1/CS · KAS · BCAT**; and tuning those terminals is how we set not just *how much* heat but its *shape* — the capsaicin-to-dihydrocapsaicin balance, the fruited front, the clean finish — toward the exact warm glow the Korean table wants.

A gochu bred to a specified shape and dose, sun-dried into a gochugaru that reads the same every harvest, is a near-term thing, not a dream.

And the rice is the long horizon. On the 64-concept **Beyond-Peppers roadmap** — five tiers from the low-hanging Solanaceae to the full synthetic frontier — rice appears at the far edge, in Tier 4, as *Dynasty*: a 10-to-12-gene, multi-year undertaking, the kind of deep synthetic-pathway work that sits at the horizon of what the platform imagines. Rice is the staple the whole Korean table is built around, the ground every dish is served over and the starch that becomes the tteok and the glass noodle and the gochujang's sweetness, and to route it is to reach the base of the cuisine. We name it not as a promise but as a direction, because the honest frontier is a map with a near edge and a far one, and a reader deserves to see both.

ORGANISM	STATUS	CONSTRUCTS	AXES	HORIZON
Soybean	established host	360	U · K	`the floor of every jang`
Pepper (gochu)	native host	1,060	all	`near: the warm-heat shape`
Garlic	established host	560	K · P	`the specified sharp`
Rice (*Dynasty*)	roadmap, Tier 4	—	synthetic	`long: the staple itself`

The through-line is the same one that opened the book. We are not here to replace a two-thousand-year-old craft; nothing we build does what the *Bacillus* and the *Leuconostoc* and the onggi and the patient cook do. We are here to hand that craft a more generous plant and a reliable floor — to make the humble bean carry more of the depth it was always meant to, so the ferment starts higher and lands truer, and so the deep savory of the Korean table can be built as surely in a kitchen with no rooftop and no three years as on a jangdok-dae in the sun. The frontier is not a different cuisine. It is this one, with its floor raised.

A closing note · gamchilmat and the body

We have spent a book on one word — **gamchilmat**, the deep savory — because of what it taught us about this whole project. For years it was the part of Korean food we could feel perfectly and explain not at all: a roundness, a fullness, a savor that stayed, built by cooks who had no receptors to name and no number to aim at, kept alive across centuries in blocks of meju hung in the eaves and crocks of jang aging on the rooftop. That it turned out to be two receptors — free glutamate on the umami flytrap, γ-glutamyl peptides on the calcium sensor — playing a chord the long ferment knits together, did not make it less wondrous to us. It made it more, because it meant the Korean kitchen had been engineering a sensation, precisely and on purpose, for two thousand years before anyone could draw the receptor it rang.

So we did not measure jang to improve it. There is nothing to improve; the balance those cooks hold by hand, the depth an onggi builds in three sunlit years, is the standard the Index measures *against*. We measured it to keep it — to give the deep savory a number so it stops being a grandmother's unrepeatable secret and becomes a floor any kitchen can reach, to let a stew that steadied you once be built again at a table that has never seen the jar, and to let a brand with a true idea for a gochujang say exactly what its gochujang is and promise it will be the same next year. And we measured it with reverence, because a cuisine that coaxed this much depth from a soybean and a season deserves to be understood, not just copied. The scorecard on every dish is not a verdict on the tradition. It is a thank-you, written precisely.



The greenhouse at dusk — the reverence this book was cooked in, and the body it was cooked for.

A word, last, about the body — because this is a cuisine that feeds it unusually well, and about that we want to be both warm and careful. A Korean table, read honestly, is a nourishing thing: living ferments full of lactic bacteria, a scatter of whole vegetables in the banchan, soybeans turned into deep savory, fish and meat used with care and often in small measure, a plate built around rice and plants and the slow chemistry of the crock. We cook it, by default, plant-first — not

out of denial, but because so much of its greatest depth was *always* soybean and cabbage and radish and chili, and because the engineered umami and kokumi let a plant carry the savor that fish or meat once had to. The jeotgal and the grilled meat belong to this cuisine, fully, and we write them with the same respect as every plant, never with apology. And under all of it hums the thing this whole library believes: that food is something you give the body with intention, that a flavor and a nourishment are two halves of one act, that a meal built on living ferment and whole plants is one of the kindest things a kitchen can hand a person. We make no claim of it beyond that — no cure, no promise, nothing the label may not say. We only cook it the way we would want to be fed: toward pleasure and toward the body at once, because in Korean food, as in our own kitchen, those were never two different projects. Gamchilmat, specified and kept — and a table, full of small deep dishes, feeding the people around it the way it always has.

These are computational designs; Scoville Splice's cultivars and constructs have not been experimentally validated in a laboratory.