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THE WORLD COOKING SYSTEMS ATLAS · CHAPTER 4

Broths, Stocks, Extraction

The three contracts, and the extraction-then-reduction cycle

After this chapter, the next time a stock turns cloudy, a dashi tastes thin, a pan sauce never gels, or a bone broth comes out greasy — you'll know which time-temperature contract was broken, and which phase of the extraction-then-reduction cycle the recipe was trying to complete.

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From The World Cooking Systems Atlas

> *After this chapter, the next time a stock comes out cloudy when you wanted it clear, thin when you wanted it deep, bitter when you wanted it round, or tastes like water that has been near some bones — you will know which of three numbers (temperature, time, ratio) was out of spec, and which of the world's stock traditions you were unwittingly trying to make.*

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1 · A stock is a contract, not a recipe

There is a quiet category error in how home cooks approach stock. They treat it as a recipe — a list of ingredients to combine and a number of hours to wait — when it is actually a *contract* between the cook and the pot. The contract has three terms: a temperature, a time, and a ratio of solid to water. Honor the contract, and the stock comes out the way the cuisine intended. Break any one term, and the stock comes out wrong in a specific, diagnosable way.

This is why "make a stock" is one of the most failure-prone phrases in home cooking. The cook follows a list of ingredients but does not know what the contract actually is, so they read "simmer two hours" and translate it, kindly, as "boil for two hours" — because boiling is faster and they have things to do — and at the end of two hours they have a cloudy, fatty, slightly bitter liquid that is not what the recipe was promising.

The thesis of this chapter is short. A stock is the deliberate extraction of soluble matter — gelatin, glutamate, inosinate, free amino acids, fat-soluble aromas — from a solid into water, at a temperature low enough that nothing bitter, cloudy, or off-flavored is extracted alongside it. The contract is the temperature-and-time window inside which only the things you want come out, and the things you don't want stay in.

Cuisines have negotiated different versions of this contract. The Japanese version (dashi) extracts in five minutes at just-below-boil. The French version (fond brun, fond blanc) extracts in three to four hours at a steady, lazy simmer. The bone-broth tradition extracts in ten to sixteen hours at a temperature so low the surface barely moves. Three contracts. Same machine. Different settling time, different yield, different finish.

If Chapter 2 taught you that fat does three independent jobs and Chapter 3 taught you that moisture is a transaction, this chapter teaches you that **stock is a contract** — and that deglaze, pan sauce, reduction, jus, demi-glace, and the whole concentration family are the *second half* of the same cycle. Extraction loads the carrier; reduction concentrates it. Two motions, one machine.

2 · The three contracts — fast, medium, slow

There are three useful settings on the same machine. They differ in temperature, time, and the kind of solid they extract from. The numbers below are the working window, not a single point.

Fast contract — dashi (95°C, ~5 min)

The Japanese version of the contract is the fastest stock in the world. Kombu (dried kelp) goes into cold water and is heated to just below boiling — around 60°C is the classic kombu-extraction window for the most refined kombu-dashi, but the working home version pushes to about 80–85°C and pulls the kombu as the surface starts to shimmer. The water is then brought up briefly to roughly 95°C, the heat is cut, and katsuobushi (shaved dried bonito) is added. Within thirty to ninety seconds, the inosinic acid in the bonito and the glutamic acid already extracted from the kombu are in solution. Within five minutes, the flakes have surrendered what they have to give. The dashi is strained and never returns to the heat.

This is the fast contract because the substrate is already maximally pre-extracted. Kombu has been sun-dried and matured; katsuobushi has been smoked, fermented, and shaved into translucent ribbons that release their soluble matter on contact. The cook does not have to break down structure. The cook only has to invite what is already loose to come into the water.

The science behind why dashi tastes the way it does is not subtle: glutamate from kombu and inosinate from bonito are the two amino-acid-derivative compounds whose combination produces an umami signal several times stronger than either one alone. The contract is short because the substrates are pre-loaded. The temperature is held *below* a hard boil because boiling kombu releases bitter alginates and slimy mucilage that turn the dashi from clean to muddy in under a minute. (See `/journal/basic-dashi` for the worked recipe and the temperature ceiling explained in plain terms.)

Medium contract — chicken / vegetable stock (88–92°C, 2–4 h)

The European version of the contract sits in the middle. Raw or lightly roasted bones, a mirepoix of carrot-celery-onion, sometimes leek and parsley stems, a few peppercorns, water that just covers the solid. The pot is brought to a simmer and then *held below the simmer* — a barely-moving surface with the occasional lazy bubble breaking, not a rolling motion — for two to four hours.

Two things are happening in that window. First, collagen in the bones is hydrolyzing into gelatin, which is what gives a finished stock its body. Gelatin extraction is gradual and accelerates above about 80°C; by 90°C the extraction is steady, and by full boil it becomes violent enough to also emulsify fat and break loose particulate matter that should have stayed behind. Second, the glutamate-rich vegetables and the inosinate-rich meat are slowly releasing the soluble amino-acid compounds that give the stock its savor. Three hours is roughly the point at which the extraction curve flattens for a standard chicken-bone stock; longer than four hours and the cook is mostly extracting bitter compounds from the marrow and minerals from the bone.

The temperature ceiling matters. At 90°C, the stock will finish clear, golden, and lightly gelled when cold. At 100°C, the same ingredients yield a stock that is cloudy, paler, and never sets. This is not aesthetics; the cloudy stock has emulsified fat suspended in it, and that fat carries no aroma — it only carries weight. (See `/journal/chicken-stock-classic` for the worked recipe and the visual cue — "shimmering, not rolling" — that tells the cook the contract is on-spec.)

Slow contract — bone broth, demi-glace (82–88°C, 8–16 h)

The third setting trades speed for depth. Roasted bones, sometimes joints or feet (high in collagen), occasionally a charred onion for color, water, and a temperature so low that the surface barely shows motion are held for eight to sixteen hours. Demi-glace pushes this further — a chicken or veal stock that has been reduced by half, then enriched with a second extraction, then reduced again, sometimes over two days.

The slow contract works because collagen breakdown into gelatin is a function of time as much as temperature. At 85°C, every hour past the third hour adds a measurable amount of gelatin to the finished broth. The trade is that other extractions slow correspondingly. The flavor profile of an eight-hour broth is meatier, mineraller, and rounder than a three-hour stock, but it is also more fragile to bitterness: any boil, any aggressive bubble, any rendered marrow that emulsifies into the liquid pushes the broth toward an off-flavor that the long extraction cannot wash out.

Vietnamese pho-bo is the cleanest worked example of the slow contract pushed for clarity. The bones are blanched first to remove surface blood and impurities, then re-covered with fresh water, brought to the slowest possible simmer, and skimmed continuously for the first hour. Aromatics — charred ginger, charred onion, star anise, cinnamon stick, cloves, fennel seed — are added later, in a window calibrated so the volatile aromas don't cook out. The contract here is *long, low, skimmed, and aromatically late*. The broth that emerges is clear, beef-deep, and unmistakably perfumed. (See `/journal/pho-bo`.)

Three contracts, one machine.

3 · What over-temperature destroys

A stock held above its temperature ceiling does not simply cook faster. It cooks *differently*, and the differences are mostly bad.

Albumin denatures and coagulates around 70°C. This is the soluble protein in the bones and meat that the cook wants to keep loose, ideally to be rafted up to the surface and skimmed off. At a steady 88–90°C, the albumin floats up as gray-brown scum that the cook removes. At a rolling boil, the same albumin is whipped back into the liquid and bound up with emulsified fat, where it cannot be removed. The result is a cloudy stock with grayish particulate suspended in it.

Fat emulsifies into the stock above ~95°C if the surface is moving. A gentle simmer lets rendered fat rise to the top as a yellow cap, where the cook can spoon it off or chill the stock and lift it as a solid disk. A rolling boil mechanically whips that same fat into droplets fine enough to stay suspended. Those droplets carry no aroma — they were rendered at low temperature from bone marrow and connective tissue, and they have no flavor to give — so they only contribute weight and a slick mouthfeel. A boiled stock tastes "heavy without depth" because the fat is in the wrong phase.

Marrow over-renders past four hours at high heat. Bone marrow is a fat-rich tissue that releases its fat slowly at low temperatures and floods out at high ones. A stock that has been boiled at full heat for two hours has often released most of its marrow fat into the liquid, which is then emulsified by the boil itself. Restraint is rewarded: lower heat, longer time, and the marrow contributes a modest, savory background instead of a greasy foreground.

Bitter compounds extract from aromatics held too long. Onion held in stock for more than about two hours starts to contribute a faint sulfur-bitter note. Carrot held past three hours sweetens, then turns vegetal-flat. Celery held past four hours releases a green-bitter compound. The Japanese tradition pulls the aromatics fast (kombu out before the boil, bonito out within minutes) because the substrate is so dense that long extraction is unnecessary. The French tradition adds the mirepoix in the last 60–90 minutes of a long stock for the same reason — to take what the aromatic has to give before it starts giving things you don't want.

The general rule of over-temperature: **a stock above its contract ceiling extracts everything faster, including the things you didn't ask for.** Cloudiness, bitter undertone, emulsified fat, off-aromas — these are not signs of "stronger" extraction.

They are signs of *indiscriminate* extraction. The contract is a filter as much as it is a yield.

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4 · The extraction-then-reduction cycle

A stock is half a cycle. The other half is reduction, and the cook who reads them as one continuous machine has access to a layer of cooking the recipe-follower misses.

Extraction loads the carrier. The cook moves soluble matter from a solid into water at a controlled temperature over a controlled time. Reduction concentrates the carrier. The cook drives off water from the loaded liquid, leaving the soluble matter more densely present per spoonful.

This is the same cycle that produces:

- A deglaze. The fond — the caramelized fond stuck to the pan after a sear — is solid soluble matter. Water, wine, or stock added to the pan and brought to a quick boil extracts the fond in minutes. The liquid is then reduced to a glaze that drapes the protein it came from. Extraction plus reduction, in one pot, in three minutes.
- A jus. Pan drippings from a roast, deglazed with wine or stock, then reduced and strained. Same cycle, slightly longer time, the meat acts as its own substrate.
- A pan sauce. Same as a deglaze but more ambitious: a small mirepoix may be sweated in the rendered fat first, then deglazed, then reduced, then mounted with cold butter at the end (the *monter au beurre* of Chapter 2).
- A mentsuyu. Dashi (the fast contract) is reduced with soy and mirin to a syrupy condiment that is then *diluted again* at the moment of use, but the reduced base concentrates the dashi's umami into a shelf-stable form. (See `/journal/mentsuyu`.)
- A demi-glace. A veal stock is reduced by half, fortified with a second extraction, reduced again, sometimes a third time, until what was eight liters of stock becomes one liter of glossy, lip-sticking sauce that gels firmly when cold.
- A bouillabaisse rouille base. Fish stock is reduced to concentrate the saffron-tomato-aromatic carrier before the fish goes in.

The principle: **reduction multiplies what extraction gathered.** It cannot create what was not there. A weak stock reduced is a weak stock concentrated — slightly more present per spoon, but still missing what the extraction step never put in. The cook who tries to fix an under-extracted stock by reducing it harder ends up with a salty, slightly bitter syrup. The fix is upstream: another bone, another hour, another degree.

The other principle: **reduction reveals what extraction picked up indiscriminately.** A stock that was boiled instead of simmered will, when reduced,

concentrate not just the gelatin and glutamate but also the emulsified fat and the bitter compounds. A simmered stock concentrates cleanly. A boiled stock concentrates muddily. The contract decides the reduction's ceiling.

Two motions, one machine, one cycle.

5 · The aroma-base layer

Every stock tradition adds a volatile-aromatic layer on top of the base extraction. The names differ. The function is the same.

The French mirepoix — onion, carrot, celery, in a 2:1:1 ratio by weight — is the canonical European aroma-base. The Italian soffritto adds garlic and sometimes pancetta. The Cajun trinity replaces carrot with green pepper. The Spanish sofrito starts with tomato. The Latin American recaudo adds peppers and herbs. The Japanese tradition uses 香味野菜 — aromatic vegetables, usually negi (long onion) and ginger — added at a different moment and pulled at a different moment. The Vietnamese aroma layer in pho is charred whole spice and charred allium, added late.

These aromatics share a property: their volatile compounds are temperature-sensitive in two directions. They will not release at all in cold liquid (the cook has to heat them in fat first, or hold them in hot stock for at least twenty minutes), and they will *cook out* if held too long. The window is roughly thirty to ninety minutes of contact with hot liquid, depending on the vegetable.

The cook's job is to time the aroma layer separately from the base extraction. In a long stock, the bones go in cold and stay for hours; the aromatics arrive in the last sixty to ninety minutes. In a fast stock like dashi, the substrate is itself the aroma-base, and there is no separate layer. In a stock-built-in-one-pot like the bourguignon (see `/journal/boeuf-bourguignon`), the mirepoix is sweated in fat first to load the carrier (Chapter 2 §2), then the meat is browned in the same fat, then wine and stock cover everything, and the slow cook does extraction and integration at once.

The glossary terms here — mirepoix, aroma-base, 香味野菜, fond, chinois — all refer to one of two moments in the cycle: either *loading the aroma* before the extraction proper begins, or *layering the aroma* late so it does not cook out. The cook who can name which moment a given aromatic addition belongs to writes recipes whose flavor lands instead of evaporates.

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6 · Worked examples from the catalog

Basic dashi — the fast contract

(`/journal/basic-dashi`) Kombu in cold water, heated slowly to 80–85°C, pulled before the surface boils. Water brought briefly to 95°C, heat off, katsuobushi added, infused for two to three minutes, strained immediately. Total cook: five minutes. The clearest expression of "contract as filter": every other minute the cook holds the flakes in the water is a minute of bitter extraction creeping in. The dashi is the base of miso soup, chawanmushi, oyakodon, sukiyaki, nimono, and a hundred other dishes — the entire savory side of Japanese cuisine rests on a five-minute contract.

Chicken stock classic — the medium contract

(`/journal/chicken-stock-classic`) Bones (with skin and joints, ideally including feet for gelatin), mirepoix, peppercorns, parsley stems, cold water just to cover. Brought to a simmer, immediately reduced so the surface shimmers without rolling, skimmed for the first thirty minutes, held at 88–92°C for three hours, strained through a chinois, cooled, and either used immediately or refrigerated overnight (where the fat will rise and set as a removable cap). The finished stock should gel softly when fully cold — the gelatin test that confirms the contract was on-spec. A stock that does not gel at all was under-extracted or held too short; a stock that gels rubbery was reduced too aggressively after straining.

Tonjiru — extraction + finish in one pot

(`/journal/tonjiru`) Pork belly is browned briefly to load fat into the pot. Aromatics — burdock, carrot, daikon, konnyaku, sometimes potato — go in, are coated in the rendered pork fat (carrier loading), then water and dashi are added. The pot simmers for forty to sixty minutes — a short version of the medium contract — and the pork's connective tissue softens while its glutamate joins the dashi's. The finish is miso, whisked in at the end with the heat low so the fermentation aromatics survive (Chapter 1 §3 on late-acid logic applies to late-miso too). Tonjiru is a stock built and finished in one pot in under an hour — the medium contract miniaturized.

Boeuf bourguignon — stock built and reduced in one vessel

(`/journal/boeuf-bourguignon`) Bacon lardons render fat. Beef is browned in the fat (Maillard surface, carrier loaded). Mirepoix sweats in the fat. Wine deglazes, reduces. Stock covers. The whole pot goes to a low oven (around 150°C, which holds the

liquid at about 90°C — the medium contract) for three to four hours. The cook does not make a stock separately; the stock is *built around the meat* and reduces against it through the cook. By the end, the braising liquid has extracted gelatin from the chuck's connective tissue, has concentrated through evaporation, and has absorbed aromatics from the mirepoix and the wine. One vessel, both halves of the cycle, no separate stockpot.

Bouillabaisse — fish stock as the entire dish

(`/journal/bouillabaisse`) The Marseillaise classic puts the contract front and center. Small bony rockfish — rascasse, weever, gurnard, conger — are sweated in olive oil with leek, fennel, and tomato, then drowned in water and brought to a vigorous simmer (the one stock that wants more agitation than usual, because the cook is deliberately breaking down the rockfish into the broth) for thirty to forty-five minutes. The broth is pushed through a chinois with a wooden press, extracting both soluble matter and pulverized fish solids. Saffron, garlic, and tomato concentrate the carrier. Larger fish — monkfish, sea bass, sometimes shellfish — are added at the end and poach in the finished broth. The stock is the dish; the fish that lands on the plate is a second event. Bouillabaisse is the fast contract scaled up to a meal — every minute counts, the fish goes in late, and the broth's identity was set in the first hour.

French onion soup — caramelized onion as a second stock

(`/journal/french-onion-soup`) The onion soup is two extractions stacked. Onions are sliced thin and held over medium-low heat with butter for forty-five to seventy-five minutes, during which their cell walls collapse, their sugars caramelize, and their volatiles compound into something the raw onion contained none of. This is the *second stock* — a solid-phase extraction performed by patience and dry heat (the wet-into-dry of Chapter 3 § wet-into-dry, ironically, since the onion provides its own moisture). Beef or chicken stock is then added, and the soup simmers another thirty minutes so the caramelized onion's loaded compounds bridge into the broth. Gruyère and toasted bread finish on top. The soup that fails almost always fails because the cook hurried the onions — fifteen minutes of high-heat browning is not the same extraction as sixty minutes of slow caramelization. The first produces bitter onion. The second produces the second stock.

Pho bo — the slow contract pushed for clarity

(`/journal/pho-bo`) Beef bones are blanched in boiling water for five to ten minutes, then drained and rinsed — this is a sacrificial extraction whose only job is to wash out surface blood and the fast-rising albumin scum that would cloud the broth. Fresh water

is brought to a slow simmer with the rinsed bones, oxtail, sometimes brisket. The temperature is held barely visible — 82–86°C — for six to eight hours, with skimming continuous through the first hour and intermittent thereafter. Aromatics — charred ginger, charred onion, star anise, cinnamon, clove, fennel, coriander seed — are added in the final 60–90 minutes, sometimes in a sachet to keep them from clouding the broth. Salt comes at the end. The finished pho-bo broth should be clear, beef-deep, lightly aromatic, and unmistakably stable on the palate. It is the slow contract executed for maximum clarity rather than maximum depth — a different choice from the demi-glace tradition, which uses the same temperature window to push for body instead.

Mentsuyu — concentrated stock as condiment

(`/journal/mentsuyu`) Dashi is combined with soy sauce, mirin, and sometimes sake, and reduced gently until the liquid is roughly half its starting volume. The mentsuyu is then bottled and used as a base for noodle dipping sauces, simmering liquids, and finishing splashes. The point of mentsuyu is *that the extraction was already complete in the five-minute dashi*, and the reduction is a concentration of an already-clean base into a shelf-stable carrier. The dashi-mentsuyu pair shows the extraction-then-reduction cycle at its most explicit: the fast contract loads, the slow reduction concentrates, and the result is a household condiment that can be diluted back to drinking strength at any moment. This is the same cycle that produces demi-glace; the substrate is just different.

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7 · Reading your own pot

The skilled stock cook reads the pot the way a baker reads a dough. There are five visual and tactile cues that tell the cook whether the contract is on-spec.

Surface motion. A correct medium-contract simmer shows a *shimmering* surface — the liquid is moving but no bubbles are breaking. Occasional small bubbles rising and breaking is acceptable; a continuous bubble carpet is too hot. A motionless surface is too cool. The shimmer is the visual signature of 88–92°C. A slow contract should show *less* motion than that — almost a stillness with occasional tiny bubbles. A dashi at the moment of bonito addition should not be moving at all.

Color depth. A chicken stock at hour one is pale and watery. At hour two, gold. At hour three, deep amber. At hour four, slightly darker, and beyond that, no further deepening — the extraction curve has flattened. Color is the cook's clock for medium-contract stocks. A stock that is still pale after two hours is being held too cold; a stock that is dark brown at hour one is being boiled.

Skim color. The scum that rafts to the surface in the first hour should be gray-brown and easily removable with a ladle. A scum that is yellow-white and emulsifying back into the liquid is the sign that the surface is too active and the albumin is being whipped back in. The cook should reduce the heat and start over with the skim.

Gel test. A finished medium-contract stock, refrigerated overnight, should gel softly — a spoon dragged across the surface leaves a clean track that slowly closes. A stock that is liquid cold was under-extracted (more time, more bones, or both); a stock that gels rubbery and won't cut cleanly was reduced too aggressively after straining. The slow-contract bone broth gels firmly enough to hold a spoon upright. The fast-contract dashi does not gel — it has no collagen substrate, and its body comes entirely from amino acid compounds.

Fat globule size. When the stock is at its working temperature, the fat that has risen to the surface should be in a continuous yellow film or in large droplets that join easily. Many small droplets that refuse to coalesce — a stippled, emulsion-like surface — mean the boil has whipped the fat into the liquid and the cook is losing both clarity and clean mouthfeel. Reduce heat immediately; the situation only worsens from here.

The cook who learns to read these cues stops checking the timer and starts checking the pot. The contract is being negotiated visually in real time. Two hours in one pot is not

the same as two hours in another; the cook adjusts to what the pot is showing, not to what the recipe was hoping for.

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8 · The closing principle

Stock is one of the oldest cooking technologies on the planet. Escoffier built the entire grammar of French grand cuisine around the *fonds* — the foundations — and the brigade kitchens that institutionalized that grammar in the late nineteenth century treated stock-making as the most respected work in the kitchen, the work that the most senior cook did personally, because everything that landed on a plate descended from a stock and a stock with a mistake in it could not be rescued downstream.

The home kitchen has mostly lost this seriousness. Stock is treated as something to make if you have time, from leftovers, with the heat too high. The result is a generation of home cooks who have never tasted what their own pot is capable of, and who reach for stock cubes and bouillon powders because their own attempts have always come out thin and cloudy.

The argument of this chapter is that the loss is not necessary. The contract is short, the contract is teachable, and the contract is the same machine across French, Japanese, Vietnamese, Italian, Chinese, and Mexican cooking. The cuisines settled on different temperature-and-time pairs because they were extracting from different substrates and finishing with different aromatic layers. The underlying motion — soluble matter moves from solid to water at a controlled temperature, then water moves out of the loaded liquid at a controlled rate — is universal. The cook who reads stock-making, deglazing, jus-making, mentsuyu-making, and demi-glace-making as variations on a single two-step cycle has the entire savory carrier-system of world cooking in one frame.

A pot of clear, deep, gel-when-cold stock is also one of the most quietly satisfying things a kitchen produces. The cook who has made one will not go back to cubes — not because cubes are bad, but because the contract, once you have honored it once, asks a small thing of you (a temperature you can feel with a wooden spoon, a time you can measure with a clock, a ratio you can eyeball with a ladle) and gives back something the cube cannot deliver: a carrier with the cook's own intention in it. Extraction, in the end, is not a kitchen technique. It is a habit of patience, in the form of a pot.

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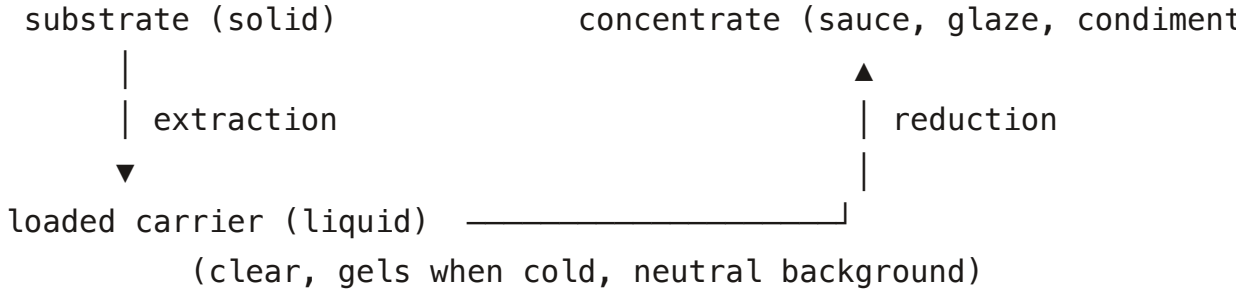
9 · Diagrams and tables (proposed)

The three contracts

| Contract | Temperature | Time | Substrate | Finish behavior | |---|---|---|---|---| | **Fast — dashi** | 80–95°C (kombu pulled below boil; bonito off heat) | ~5 min total | Pre-extracted kombu + katsuobushi | Strained immediately, never reheated to boil | | **Medium — stock** | 88–92°C ("shimmering not rolling") | 2–4 h | Bones, mirepoix, water | Strained through chinois, gels softly when cold | | **Slow — bone broth / demi** | 82–88°C (surface barely moves) | 8–16 h | Roasted bones, joints, feet, late aromatics | Skim continuously; gels firmly; may be reduced further |

The extraction-then-reduction cycle



The full savory cuisine of much of the world lives somewhere on this loop: stocks load the carrier; deglazes, jus, pan sauces, mentsuyu, and demi-glace concentrate it; finished dishes ride on the concentrated carrier. The cook who can locate any recipe step on the loop knows what the step is asking the pot to do.

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10 · What comes next

Chapter 5 steps from the wet side to the dry side and gives the heat-and-browning system the same treatment Chapters 3 and 4 gave moisture and extraction. Maillard, caramelization, fond, crust, the dry crackle of skin, the slow patience of caramelized onion — these are the dry-side counterparts to the extraction cycle, and the cook who can hold both the wet machine (this chapter) and the dry machine (next chapter) in mind at once is the cook who can read any new dish for what its pot is actually doing.

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