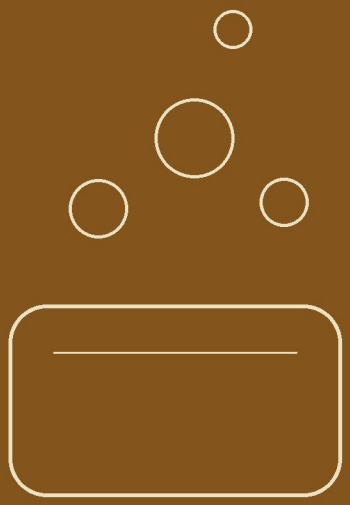
INDUSTRIES OF INDIA

SOAP

Ash, Fat, Foam



KETINENI RAMARAO

INDUSTRIES OF INDIA

SOAP

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Industries of India

SOAP - Ash, Fat, Foam
Ketineni Ramarao

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CONTENTS

Prologue - The bar by the sink 1

PART I - THE RECIPE IN THE CLAY

Chapter 1 - The oldest recipe 4

Chapter 2 - Washing before soap 8

Chapter 3 - The mountain called Sapo 12

PART II - THE CITIES OF SOAP

Chapter 4 - Aleppo and the olive 16

Chapter 5 - Nablus, city of soap 19

Chapter 6 - Castile, the white soap 22

Chapter 7 - Marseille and the king's stamp 25

Chapter 8 - The taxman's tub 28

PART III - THE CHEMISTS' CENTURY

Chapter 9 - Leblanc's ashes 32

Chapter 10 - Chevreul's fats 36

Chapter 11 - What soap actually does 40

Chapter 12 - The geometry of foam 44

PART IV - THE BRAND AGE

Chapter 13 - Sunlight 48

Chapter 14 - The soap that floats 51

Chapter 15 - The hygiene crusade 54

Chapter 16 - The soap opera 57

PART V - THE DETERGENT TURN

Chapter 17 - The synthetics arrive 61

Chapter 18 - One quarter cleansing cream 64

Chapter 19 - The lake that aged fifteen thousand years 67

PART VI - THE MACHINE ROOM

Chapter 20 - How a bar is born 71

Chapter 21 - The sweet principle of fat 73

Chapter 22 - The fat of the land 76
Chapter 23 - The palm question 78

PART VII - SOAP AND THE BODY

Chapter 24 - The doctor who washed his hands 82
Chapter 25 - The cheapest vaccine 84

PART VIII - THE BUSINESS OF CLEAN

Chapter 26 - The giants 88
Chapter 27 - The long tail 91

PART IX - WHAT COMES NEXT

Chapter 28 - The next bar 94
Chapter 29 - The smell of clean 97
Chapter 30 - Reading the wrapper 100
Chapter 31 - The skin's verdict 102
Coda - The meaning of clean 105
Glossary 107

PROLOGUE

The bar by the sink

There is a small object within arm's reach of you right now, or within a few steps, that took four and a half thousand years to arrive. It sits in a dish by the sink, or hangs in a net bag in the shower, or stands in a plastic pump bottle on the counter. It is smooth, faintly scented, worn down at the edges by use, and it costs so little that when it slips down the drain or dissolves to a sliver we throw the sliver away without a thought. It is soap, and it is one of the oldest chemical manufactures on Earth - older than glass, older than iron tools, older than most of the gods whose names we still know [C1].

Consider what has to be true for that bar to exist. Somewhere, a fat had to be rendered from a carcass or pressed from a fruit. Somewhere else, an alkali had to be coaxed out of ashes, or mined from a dry lake bed, or made from salt in a chemical works. The two had to meet in the right proportions, with heat and time and stirring, in a reaction that no one understood for its first four millennia - a reaction that, when it finally was understood, turned out to have built an industry, then a science, then a public health revolution that saves more lives each year than most medicines [C3]. The bar by the sink is the residue of all of that: of Babylonian brewers and Provençal soap boilers, of a French chemist who lost his patent to a revolution, of a Cincinnati candle-maker whose son named a soap after a psalm, of a German war economy that invented a substitute and accidentally invented the modern detergent, of a doctor in Vienna who begged his colleagues to wash their hands and was ignored for decades.

This is a book about that object. It follows the recipe from the clay cylinder it was first written on to the stainless steel column where it is made today, and it follows the idea of cleanliness that the recipe carried with it - an idea so successful that most of us now hold it without noticing we hold it. We will meet the soap cities of the Mediterranean and the Levant, the taxmen who made soap a luxury and the reformers who set it free, the chemists who took it apart and the advertisers who sold it back to us as a dream. We will watch soap lose its name: most of what is sold as soap today is not, chemically, soap at all, and how that happened is one of the strangest stories in this book. And we will end where soap ends every day - at the sink, in the twenty seconds that public health doctors call the cheapest vaccine in the world [C48].

Consider how strange the object is. It is at once a farm product and a chemical, a luxury and a staple, a cosmetic and a medicine; it has been taxed like wine, rationed like bread, worshipped, advertised, mythologised and, in our own century, briefly feared. Empires have been built on it - one of them, Unilever's, is still standing. And yet its recipe is older than the wheel: fat, ash, water, heat. The whole of this book is contained in the distance between those four ingredients and the world they made.

A note on method before we begin. This is a history of a material, not of a nation, so the book follows the soap: Babylon to Rome, Aleppo to Nablus, Castile to Marseille, Merseyside to Cincinnati, and out again to the whole world. Where the sources quarrel with the legends - and they quarrel constantly, because soap attracts foundation myths the way it attracts grease - the sources win. Mount Sapo is in here, but as literature. The truths are better.

This book follows that bar from the clay tablets of Babylon to the pump bottle and back again: through the soap cities of the Mediterranean, the tax ledgers of England, the chemistry that gave the craft a science, the brands that gave it a voice, and the public-health campaigns that gave it a purpose. Along the way the bar becomes, at different times, a luxury, a monopoly, a scandal, a vaccine, an advertising medium, an environmental villain and an environmental hero. It never once stops being fat and alkali. That is the marvel of it.

The story begins, as so many do, with someone cooking something they probably meant to use for something else.

PART I

The Recipe in the Clay

CHAPTER 1

The oldest recipe

The earliest recipe for soap that anyone has found is pressed into clay. Sometime around 2800 BC, in the world of the Sumerians and the early Babylonians, a scribe rolled a cylinder in wet clay and left behind instructions that modern readers parse as fats boiled with ashes - the two halves of soap, named four and a half thousand years before anyone could say why they worked [C1]. Archaeologists sorting through the ruins of Mesopotamian cities have found not just the words but the material: soap-like residues in clay cylinders from the same period, the chemical ghost of someone's boiling pot [C1]. A later tablet, dated around 2200 BC, shows the recipe still in circulation six centuries on - proof that this was a settled technology, passed hand to hand, not a one-off accident [C78]. It is the oldest recipe in this book, and one of the oldest chemical recipes anywhere.

What the tablets do not say is what the stuff was for. The natural modern assumption - that it was for washing bodies - is probably wrong. The evidence points instead at cloth: at the greasy raw wool that had to be scoured before it could be spun, dyed and woven, and at the oily straining cloths of the perfume makers [C3]. That distinction matters more than it seems. The first soap was probably an industrial material, made for the textile workshops that were the heavy industry of the ancient world, and only later a toilet article. Soap was born in a factory before it ever reached a bathroom.

The Egyptians left the clearest early hint of a more personal use. The Ebers papyrus, a medical scroll from about 1550 BC, describes combining animal and vegetable oils with alkaline salts to make a preparation for treating skin diseases and for washing [C1]. Egyptian bathing customs were regular and elaborate, and their alkaline salts - natron, the same salt used in mummification - were harvested from the dry lake beds of Wadi El Natrun and traded up and down the Nile. But the word-soup of the ancient texts makes certainty impossible. The same terms get used for alkalis, for soap-like pastes and for the act of cleansing itself, so that a modern reader can never be quite sure whether a given line describes true soap or merely a cleansing lye [C3]. Scholars of the period are careful: they speak of proto-soaps, substances with the right ingredients and some of the right behaviour, and they leave a gap of nearly two thousand years between those proto-soaps and the first

unambiguous written mention of soap as a known commodity, in the works of Galen and Pliny [C3].

How did anyone stumble onto the recipe at all? The popular imagination offers accidents: ashes blown into a pot of fatty soup, or the fat and ash of sacrificial altars washed together by rain. These stories are charming and almost certainly false - at least one beloved version, a recipe attributed to the physician Galen, turns out to have been written no earlier than the sixteenth century [C3]. A British experimental archaeologist, Sally Pointer, recently approached the question the other way round: instead of retelling the legends, she gathered the earliest actual mentions of proto-soaps, asked where in the ancient world the ingredients would repeatedly meet in the right proportions, and then tried to make soap under those conditions [C3].

Her answer is the perfume shop. The ancient perfumers steeped aromatics in purified fats and oils, then strained the scented grease through woven cloth. Those cloths, caked with expensive fat, were valuable and were laundered for reuse - and laundering greasy cloth is done, then as now, in strong alkali, with heat and stirring [C3]. Boil a fat-heavy cloth in wood-ash lye for long enough, stirring as you go, and the fat does not merely lift off the cloth: some of it reacts with the lye and becomes soap, there in the pot, foaming visibly on the surface. Pointer made her own lye the medieval way, percolating rainwater through a barrel of ashes, tested its strength by floating an egg in it - the traditional soapmaker's gauge, since a fresh egg sinks in weak lye and floats in lye strong enough to make soap - and then simmered tallow-soaked linen in it [C3]. In the strongest lye, the experiment produced exactly what her scenario predicted: an impressive head of good-quality soap foam that, as she puts it, could not have failed to be commented on in antiquity [C3].

The beauty of the scenario is that it needs no luck beyond repetition. Perfume making was widespread and routine; laundering was a recognised profession, often done by men in the great textile cities of Mesopotamia; the same pots, the same lye, the same greasy cloths met week after week [C3]. Somewhere in that repetition, someone noticed that the foam scoured better than the lye alone, and that the thick curd left in the cooled pot had a power of its own. It is a deeply human way for a science to begin: not a flash of insight but a slow dawning, over generations, that the washing water itself had become a thing worth keeping. The empirical principles were probably known for centuries before anyone thought to

concentrate the product and separate it from the free lye, Pointer writes - the moment soap stopped being an accident of the wash pot and became a product [C3].

The cylinders' recipe is matter-of-fact, which is precisely what makes it astonishing: fats, wood ash and water, combined - somebody in Mesopotamia, four and a half thousand years before the patent office, recording an industrial formula for other people to copy [C1]. The Egyptians picked the art up early - the Ebers papyrus of about 1550 BC prescribes soap-like mixtures of animal and vegetable oils with alkaline salts for washing and for treating skin diseases [C1][C78]. The pattern of the whole book is already present: a medical use, a toilet use, a laundry use, and a recipe travelling further than any empire's army.

The scholarly caution deserves respect, because the gap is real. Sumerian, Babylonian and Egyptian texts speak of proto-soaps for over two millennia before the Greek and Roman authors give us the first unmistakable references - Galen in the Method of Medicine, Pliny in the Natural History, Martial in the Epigrams [C3]. Between those poles lie twenty centuries in which the words for alkali, soap and cleansing slide into one another, so that every claim of early soap has to be interrogated one text at a time [C3]. What survives the interrogation is still extraordinary: the properties of fats and alkalis were understood, in writing, over four thousand years ago [C3].

One modern theory deserves special mention because it relocates the invention entirely. The archaeologist Sally Pointer's survey of the evidence notes the suggestion - Cassidy's - that the first soap was observed not in anyone's wash-pot but in the scouring of fleece: alkali was undoubtedly used to degrease wool, and where a reasonable quantity of fat met that lye and fully saponified, visible soap could have formed by accident at industrial scale [C3]. It is only a theory, and wool-washing does not usually produce the conditions - but it has the right smell: soap discovered not by a cook or a priest but by the ancient world's biggest industry, textiles [C3].

The recipe, once found, proved extraordinarily stable. Fat plus alkali, heat, time, stirring: every soap in this book, from a Babylonian curd to a French milled bar to the contents of a modern continuous plant, is that same reaction wearing different clothes. The proportions and the understanding changed; the recipe never did. What changed first was what people thought to do with it. For its first two thousand years soap belonged to the workshop - to the fullers who finished cloth and the launderers who cleaned it, to the physicians who smeared

it on sores, to anyone but the ordinary person who wanted to be clean. The story of how soap escaped the workshop begins with how people washed without it.

CHAPTER 2

Washing before soap

To understand what soap changed, start with the astonishing amount of ingenuity that went into washing without it. Dirt is two problems at once. Part of it is mineral - dust, grit, ash - and water alone carries much of that away. But the part that matters is greasy: the oils and sweat of the skin, the fat in a fleece, the grime that water slides off because water and oil refuse to mix. Every pre-soap method of cleaning is an attack on that greasy half of the problem, and the ancient world tried nearly all of them.

The Romans, whose baths were the wonder of their world, cleaned the body with no soap at all. The bather oiled the skin, worked the oil in, and then scraped it off again with a strigil - a curved metal blade with a handle, drawn across the body like a scythe, carrying oil, sweat and dirt away together [C4]. The whole elaborate architecture of the thermae, the hot rooms and warm rooms and plunges, worked around that simple scraping. It worked reasonably well. But it is telling that when Romans wrote about soap at all, they wrote about it as a foreign curiosity and a medicine, not as part of the bath: Pliny the Elder, chronicling the first century AD, calls soap an invention of the Gauls and notes its use against scrofulous sores, while in Germania, he reports, the men use it to redden their hair more than the women do [C4]. The greatest bathing civilisation of the ancient world owned soap for centuries before it thought to wash with it.

Cloth had a harder problem than skin, and a bigger industry around it. Raw wool comes off the sheep loaded with grease and suint, and it cannot be spun or dyed until the grease is gone; newly woven cloth must be scoured and fulled - cleaned and thickened - before it is fit to wear. The Roman fullonica, the laundry-and-finishing workshop, attacked the grease with what it had: hot water, wood-ash lye, stale urine (whose ammonia cuts grease well enough that fullones collected it from jars on street corners), and fuller's earth, a clay that absorbs oils [C3][C4]. The fuller trod the cloth in vats, beat it, rinsed it, raised its nap and bleached it in the sun. It was heavy, skilled, smelly work, and it sat near the centre of the urban economy: excavated fullonicae survive across the Roman world, most famously at Pompeii - where, not incidentally, a misunderstood find would later be reported as a soap factory and the error would echo through the literature for a century [C3].

The deeper toolkit was the ash itself. Hardwood ashes, leached with water, yield potash - a mixture of potassium compounds that is strongly alkaline and cuts grease on contact [C3]. Mineral alkali came from the desert: natron from Egypt's Wadi El Natrun, soda from the barilla plants of the Mediterranean shore, both harvested, traded and taxed [C6]. Ash lye could clean, but it could not lather, and it bit the hands; used strong, it damaged the very cloth it cleaned. What ash lye could not do was the subtle thing soap does - lift grease off a surface and then hold it suspended in the water so it can be rinsed away instead of settling back. That is the difference between scrubbing with a chemical and washing with a soap, and it is why the discovery, once made, was irreversible.

There were plant routes too. Soapwort, a wayside herb whose roots are loaded with saponins - natural compounds that foam in water - gave early civilisations a gentle wash for wool and skin long before anyone boiled fat with ashes [C5]. Saponins are a kind of natural soap, chemically unrelated but functionally similar, and their existence hints at how visible the problem was: people went looking for lather in hedgerows.

The laundry, in particular, was a technology before it was a chore. By the nineteenth century the classic kit was the dolly tub - a tall barrel in which the wash was stirred and beaten with a long-handled dolly - and the factory-made washboard with its metal or glass scrubbing surface, which spread around the world in the industrial decades; cheap bars of soap were plentiful by the late 1800s, resting in the washboard's built-in soap rest between bouts of scrubbing [C58]. Those without the strength or the day to spare could send the bundle out: the wet wash or bag wash took your laundry and returned it clean and damp for home ironing, while the mangle woman pressed sheets through her box mangle for pennies [C58]. The image of the solitary washerwoman at the tub is true, but the wash was also an economy - services, piece-work, shared equipment - and every part of it ran on the price of soap.

By the high Middle Ages the craft had regrouped where industry always regroups - in the towns. Thirteenth-century Britain made its soap in Bristol, Coventry and London, each town with its own variety, and the demand for wood ash to feed the kettles burned through so much woodland that winter fuel itself grew scarce [C10]. The product of those town workshops went overwhelmingly to the cloth trade, not the bath: soap scoured wool for dyeing, as it had since Sumer, and personal hygiene remained the least of its markets [C10]. Italy, Spain and France were the quality centres, their olive oil and barilla ash giving them a

natural advantage the north could not match [C10]. Three broad grades sorted the market by the sixteenth century: coarse soap from train oil - rendered whale blubber - sweet soap from olive oil, and speckled soap from tallow, the last so rank and so hungry for candle-fat that its manufacture was for a time forbidden outright [C10].

Nor was the washtub the only frontier. The body itself was cleaned, when it was cleaned, by abrasion and oil - the strigil's scrape, the bath's soak [C4]. Cloth had its own chemistries: soapwort, a plant whose roots lather when mixed and agitated with water, gave early civilisations a cleaning agent before true soap existed [C5], and the Roman fullonica - the high-street laundry, so often mistaken in the ruin at Pompeii for a soap factory - did its degreasing without any soap at all [C3]. Against that baseline, soap was not an improvement on cleanliness. It was the invention of cleanliness as we understand it: portable, repeatable, mild, and available in a wrapper.

The Sumerian slurry hid a secret mechanism, and the historian Hugh Salzberg spotted it. The alkali in an ash solution reacts with some of the grease on the object being washed and converts that grease into soap on the spot; the new soap then dissolves the rest of the dirt and grease - and the more grease the solution dissolves, the more soap it contains and the better it cleans [C10]. People using such solutions repeatedly would notice them losing potency, and would notice, too, that a little added grease improved them. From that observation to deliberately boiling fats in the alkali before cleaning is one small, world-changing step [C10]. Even Cleopatra, for the record, made do without soap - essential oils and fine white sand as an abrasive were the best the ancient world's most famous bather could command [C10].

The medieval craft, such as it was, lived in the cloth towns rather than the bathhouses. Artisans worked their recipes in secret, refined by trial and error, handed down from master to apprentice and father to son - and the product was aimed overwhelmingly at the cloth industry, at preparing wool for the dye, not at human skin [C10]. Personal washing was an afterthought of the trade for most of soap's first four thousand years. The body would have to wait for the chemists, the tax repeals and the advertisers [C10].

Stand back and the pattern is plain. By the time soap arrived, every major civilisation had already built its own elaborate, labour-intensive answer to the grease problem - blades and oils, urine vats and clay, ash lyes and foaming herbs. The demand was old; the product was missing. Washing was a chore that consumed fuel, water, time and often skin. That is the

human necessity soap walked into. It did not create the desire to be clean. It made cleanliness cheap.

CHAPTER 3

The mountain called Sapo

Every industry deserves a founding myth, and soap has a beautiful one. On a hill above the Tiber called Mount Sapo, the story goes, animals were sacrificed and burned. Rain washed the melted fat and the wood ash of the altars down the slope together, and downstream, where women washed clothes in the river, the water around that outflow made the wash come easier and whiter. The hill gave its name to the substance: sapo, soap [C1].

It is a perfect little chemistry lesson disguised as a legend - fat, alkali and water do make soap - and it is, in every particular, invented. There is no Mount Sapo. No ancient source mentions the hill, no trace of it exists, and the story cannot be found before the modern retellings that repeat it [C5]. Even the American Cleaning Institute, the industry's own body, presents it only as an ancient Roman legend [C1]. The true origin of the word is quieter and more interesting: sapo was in all likelihood borrowed into Latin from a Germanic or Celtic word, a cousin of the Latin sebum, tallow - which is to say the word remembers what soap is made of, not where it was found [C4].

The myth is worth keeping anyway, for what it hides. The real first western records of soap are better than the legend. Pliny the Elder, in his Natural History, gives the earliest detailed account: soap is made, he writes, from tallow and ashes - beechwood ash and goat fat are named as the best - and it comes in two forms, hard and soft, both found among the Gauls and the Germans [C4]. A century or so later, Aretaeus of Cappadocia describes the Celts, men called Gauls, rolling alkaline substances into balls and calling the product soap [C4]. Galen, the most famous physician of the Roman world, mentions soap as a cleanser and medicine - though readers should beware the flowing soap recipe attributed to him in later centuries, which turns out to be a sixteenth-century forgery wearing his name [C3].

Picture what the Romans were describing. Not a Mediterranean luxury but a barbarian craft: hard cakes of goat fat and beech ash, made in the forests of Gaul and Germania, valued by Romans first as a hair pomade - Pliny is specific that the Germans used it to redden their hair, the men more than the women - and by physicians as a salve for skin disease [C4]. The civilisation of the bath learned soap from the peoples it called unwashed. There is a

humility in that which the Mount Sapo story, with its sacrificial altars, was probably invented to cover.

And yet the myth's chemistry kept coming true in unexpected places. Fat and alkali really were meeting on hillsides and in cook-fires all over the ancient world; the ingredients were ubiquitous wherever animals were slaughtered and wood was burned. What the legend gets right is the feeling of the discovery - the sense that soap must have been found rather than made, somewhere ordinary, by someone doing laundry. The experimental evidence agrees with the feeling if not the place. The likeliest cradle was not a sacred mountain but the perfume makers' wash pot, where greasy straining cloths boiled in lye over and over until somebody noticed the foam [C3].

What the Romans actually used on their bodies was not soap but oil and the strigil - the curved metal scraper with which bathers planed away the oil, sweat and grime of the day [C4]. Soap, when it enters Latin literature at all, enters as a curiosity of the barbarians: Pliny the Elder records it as an invention of the Gauls, a pomade for giving a reddish tint to the hair, and Aretaeus of Cappadocia mentions balls of the stuff among the northern peoples [C4]. Even the word is theirs: Latin sapo comes out of a Germanic root, saipo, which tells you the direction of the borrowing - Rome learned soap from the peoples it called unwashed [C5]. And the famous soap factory of Pompeii, still repeated in a hundred popular accounts, is a myth: the building excavated there was a fullonica, a laundry, and the story of its vats of soap collapses on inspection, as the archaeologist Sally Pointer has shown in forensic detail [C3]. Mount Sapo, in other words, is only the most decorative of the origin stories. The truth is stranger: soap existed at the edges of the Roman world for centuries, and Rome largely declined the gift.

Martial, at least, jokes about the stuff as a gift for a balding friend - a pomade to fix what time had taken [C3]. Read the classical references together and a consistent picture emerges: Rome knew soap as a Gallic and Germanic hair preparation, tolerated it as a medicament, and went on scraping itself clean with the strigil regardless [C4]. The empire that aqueducted water into every city somehow left the soap to the barbarians. It is one of history's quiet jokes that the phrase clean as a Roman should properly be a warning.

One more myth deserves burial here, because it is repeated everywhere: the soap factory of Pompeii, complete with finished bars, uncovered in the ruins of the city Vesuvius buried in 79 AD [C5]. There is no such find. What Pompeii has are fullonicae - laundries and cloth-

finishing shops, unmistakable with their treading vats and rinsing basins - and a century ago one of these was misreported as a soap works, a mistake that has been faithfully copied ever since [C3]. The correction matters beyond pedantry. The fullonica was soap's first workplace, the industry that would adopt the new product fastest, and the truth of Pompeii - no soap factory, but half a dozen laundries waiting for one - tells the story better than the myth. When soap finally did come to the Roman world at scale, it was not the Romans who scaled it. That fell to the cities of the olive.

PART II

The Cities of Soap

CHAPTER 4

Aleppo and the olive

If soap has a first great city, it is Aleppo. Somewhere in the long centuries between the Roman mentions and the Crusades - the record is too thin to say when, and the proud claims that Cleopatra and Zenobia used it are unverifiable legend - the soapmakers of this Syrian trading city perfected a product that would define quality soap for a thousand years [C7]. Their secret was geography. Aleppo sat between two harvests: the olive groves of the Mediterranean hills to its west, and the laurel berries of the mountains, whose fragrant oil gives the soap its name. Sābūn ghār, the Arabs call it - bay laurel soap [C7].

The making of it was a season's work, done the slow way. Olive oil, water and lye went together into a great in-ground vat over a fire and boiled for three days, while the oil and alkali slowly married into a thick liquid soap. The precious laurel oil went in at the end, so its perfume survived the boil. Then the batch was poured out onto the factory floor - a vast green slab, still soft - and workers with planks strapped to their feet walked over it to press it smooth and even [C7]. Once hardened, the slab was cut into cubes, each cube stamped with the maker's mark, and the cubes were stacked into tall, staggered towers with air moving through them, in cellars where the soap would age for six months to a year. In the cellar the last of the free alkali slowly mellowed, the moisture left, and the outside of each cube oxidised to pale gold while the inside stayed deep green - the unmistakable look of a bar of true Aleppo soap [C7].

Consider what that process embeds. The soap is a store of value: an entire harvest of olive oil, perishable and bulky, converted into a hard, dry, odourless-keeping cube that travels. The aging is a quality control no machine can hurry - the chemistry of the bar finishing itself in the dark. The stamp is a brand, centuries before branding existed as an industry. And the laurel oil, added in proportions from two to twenty per cent, priced the soap in grades, a premium line for those who could pay: higher laurel content is still taken as the mark of the better soap, and most of it, especially the good stuff, is exported [C7].

Aleppo's soap fed an economy. Caravans and galleons carried it across the Middle East and into Europe; the city became a byword for the best of the craft. It is often said that the Crusaders carried soap-making home from the Levant in the eleventh and twelfth centuries,

and there is truth in the route if not the founding: Europe had known of soap since Rome - Zosimos of Panopolis was describing soap-making around 300 AD - but the Crusades threw open a door between the Levantine cities and the Mediterranean ports, and the olive-oil hard soap of Syria became the template the West would imitate [C7].

The imitation is the important part. Aleppo soap is the ancestor, direct and documented, of the two great European soap styles that followed: the Castile soap of Spain and the Marseille soap of France, both of which are, at bottom, Aleppo soap made without the laurel - olive oil and lye and nothing else [C7][C8]. An entire European industry grew out of trying to copy a Syrian cube.

The city kept making it through everything. Through Mongols and Mamluks and Ottomans, through the twentieth century's wars and then the twenty-first century's catastrophe, when the Syrian civil war damaged the old soap district and scattered its masters. Some of the soap now sold as Aleppo is made in exile, by Aleppans in Turkey and beyond; modern cold-process versions add herbs and essential oils the old boilers never knew [C7]. And then, in December 2024, in the middle of a new war, UNESCO inscribed the craftsmanship of Aleppo ghar soap on its list of the intangible cultural heritage of humanity - a battlefield recognition that a thousand-year-old vat of boiling oil is a treasure of the species [C7].

The making is a slow ritual. The olive oil - today often the pressing left over from table-oil production - goes into the vat with water and alkali and boils for three days, the master soap-maker watching the surface as generations of his family have watched it; then comes the laurel oil, anywhere from two to twenty per cent of the batch, and the scent that fills the old city is unmistakable [C7]. The hot soap is poured onto a waxed floor in a shallow sheet, and while it is still soft the workers walk across it on wooden planks strapped to their feet, cutting it into cubes; each cube is stamped with the maker's mark, stacked into open towers to dry, and aged in the cellar vaults for months - six to nine at minimum - while the outside of the bar cures to gold and the heart stays laurel green [C7]. In December 2024 UNESCO inscribed the traditional craftsmanship of Aleppo soap on its intangible heritage list - recognition, at last, for the oldest branded product in the world [C7].

The recipe's age is venerable even by the standards of this book. Zosimos of Panopolis, writing around AD 300, already describes soap-making in terms recognisably close to the Aleppo method, and the line from those late-antique texts to the vats of the modern Old City is effectively unbroken [C7]. War, though, is harder on soap than time is. The Syrian

conflict scattered the master soap-makers; production migrated, some of it across the Turkish border, and the question of what counts as true Aleppo soap - the oil, the method, or the city - became a live and painful argument [C7]. The laurel itself has opinions: the oil that gives the bar its scent and its prestige comes from the same hillsides that armies fight over.

The bar's virtues are the recipe's virtues. Olive oil gives a mild, slow-curing soap; the laurel oil brings the scent and the reputation; the long boil and longer aging do the rest - a young bar is soft and caustic, a properly aged one mild as milk [C7]. The two-tone bar - golden rind, green heart - is simply the chemistry made visible: oxidation cures the outside first [C7]. Nothing in the process could be hurried then and nothing can be hurried now, which is why the true soap was always expensive and the imitations always plentiful. Time is the ingredient the label does not list [C7].

The vat itself is a tuned instrument: too little alkali and the soap stays greasy; too much and it burns the skin - the master judges by taste and texture, as masters always have [C7][C3]. Laurel content became the bar's own denomination, two per cent for the everyday block, up to twenty for the premium, and the price followed the oil [C7].

The olive made one more soap city, poorer and stranger and, in the end, even more stubborn. East of Aleppo, in the hills of Palestine, the city of Nablus built its whole economy on a soap so plain it carried no scent at all.

CHAPTER 5

Nablus, city of soap

Nablus made soap the way other cities made bread: constantly, everywhere, as the defining work of the place. The ingredients were the plainest in the world - virgin olive oil from the terraced hills around the city, water, and an alkali the locals made themselves from the ashes of qilw, the barilla plant that grew along the banks of the Jordan, powdered and mixed with lime [C6]. No laurel oil, no perfume, no dye: the finished soap was ivory-coloured and almost scentless, and its makers held that purity to be the whole point. A Syrian historian, Muhammad Kurd Ali, wrote in the 1930s that Nablus soap was the best and most famous there was, for it was, he thought, unadulterated and well produced [C6].

The industry was old and oddly social. Nabulsi soap began as women's work, a household craft, long before the first small factories appeared around the tenth century [C6]. Its supply chain ran through the desert: the Bedouin alone could furnish the alkaline soda the process demanded, and trade with them was indispensable to the soap-boilers of Nablus and Hebron [C6]. By the fourteenth century soap was a significant industry in the city; by the nineteenth it was the centre of production for the whole Fertile Crescent. John Bowring, passing through in the 1830s, found Nabulsi soap highly esteemed in the Levant; in 1907 the city's thirty factories were turning out nearly five thousand tons a year, over half of all the soap made in Palestine [C6].

The making was slow and a little mystical. Oil and the alkaline liquor went into large copper vats set over fermentation pits, and were heated through a series of forty cycles spread over eight days, while the liquid was stirred without pause with a great oar-shaped wooden paddle the workers called a dukshab [C6]. The cooked soap was spread in wooden frames to set, cut into the city's classic cubes, stamped with the maker's seal, and then stacked into hollow-centred towers, ceiling-high, through which the air could circulate - there to dry and cure for anywhere from three months to a year [C6]. Soap for the local market was wrapped by hand in paper waxed on one side; export soap went naked into stiff sacks. A Nablus soap factory was less a plant than a slow pantry of hardening towers.

The twentieth century broke it. The Jericho earthquake of 1927 wrecked much of the Old City, soap factories included; the wars and occupations that followed did worse, and by the

2000s the towers were falling quiet. In 2005 soap still accounted for more than two-fifths of Nablus's exports; by 2020 one of the surviving firms, the Nablus Soap Company, was making a few hundred kilograms a day where it had once made three tons [C6]. As of 2022, at least five al-masaben - soap factories - still operated in the city, and in December 2024 UNESCO listed the tradition of Nabulsi soap-making as intangible cultural heritage in need of urgent safeguarding: the same honour given to Aleppo, in the same month, for the same reason - that a living chain of knowledge a thousand years long had come within sight of its end [C6].

The chemistry was its own discipline. Nablus soap is olive oil, water and qilw - an alkaline ash liquor made from the barilla plant, strengthened with lime - boiled through some forty cycles over eight days in the dukshab, the great vat, then poured, cut and stacked [C6]. At its zenith in 1907 the city's thirty factories produced nearly 5,000 tons a year, over half of all soap made in Palestine, and travellers agreed on its quality: John Bowring in the 1830s called it highly esteemed in the Levant, and the Syrian historian Muhammad Kurd Ali wrote in the 1930s that Nablus soap is the best and most famous, its secret being that it is unadulterated and well produced [C6]. The twentieth century was merciless to it: the 1927 earthquake shattered the Old City, the wars and the occupation did the rest - military raids in the Second Intifada destroyed several factories in the historic quarter, and the checkpoints strangled what remained [C6]. The Touqan family's manager put it plainly in 2008: before 2000 their factory made 600 tons a year; under the physical and economic obstacles of the occupation, barely half [C6]. Yet soap still accounted for 41.5 per cent of Nablus's exports in 2005, and at least five factories were still working as of December 2022 [C6]. The vats are older than most states in the region, and they have outlasted several.

Competition, when it came, came from both directions at once. Under the Mandate, cheaper rival soaps from the Jaffa-Ramla works - linseed and coconut oil instead of olive - fought Nablus on price and lost; a Jewish-owned firm in Haifa, Shemen Industries, dyed its cheaper soap red to resemble the Arab product and marketed it as being as refined as Nablus soap, and still the city held its market [C6]. Quality turned out to be a moat. In December 2024 UNESCO recognised what the market always knew, inscribing the traditional craftsmanship of Nablus soap alongside Aleppo's on the intangible heritage list [C6]. The inscription does not lift a single checkpoint. But it records, officially and for the world, that the olive-oil soap of this one small city is part of the heritage of all humanity.

The soap is stacked like masonry - great open towers of pale cubes airing in the upper rooms, each stamped with the factory's seal - and the towers are the city's skyline in miniature [C6]. Ivory-coloured and almost scentless, Nabulsi soap has no laurel to perfume it and no wrapper to sing its praises; its reputation was carried entirely by performance and by the word of travellers like Bowring [C6]. In an industry that would later invent modern advertising, Nablus remained a product that advertised itself simply by being better [C6].

The craft detail that survives from the Levantine tradition reads like a recipe card passed down through the centuries. Olive oil went into a copper cauldron and boiled for days, with alkali ashes and a little quicklime added as the boiling progressed, the mixture stirred constantly and kept tepid until it began to trace - the soapmaker's word, still used, for the moment the brew thickens enough to leave a trail across its own surface [C4]. Then it was poured into moulds, left to cool and harden for a fortnight, and cut into cakes, with aromatic herbs stirred in at the end for fragrance: yarrow, lavender, germander [C4]. Every element of that paragraph is still a live instruction. A home soapmaker in 2026 follows the same sequence, watches for the same trace, and reaches for the same lavender.

The alkali itself had a terroir. Across the Southern Levant the soap-boilers burned the salt-loving plants of the dry country - species of Salsola, the saltwort Seidlitzia rosmarinus, Anabasis - and leached the ashes for their potash, then cooked it with olive oil in the copper cauldron [C4]. Desert plants and hillside olives: the whole geography of Palestine is in the bar, which is why no other place on Earth makes soap quite like it [C4][C6].

Why do these two cities matter so much? Because Aleppo and Nablus are the proof that soap had already found its perfect industrial form centuries before Europe industrialised it: a standardised, stamped, stackable, exportable unit, made in batches that could be priced and taxed and traded, from a recipe so stable that a cube made in 1800 and a cube made today are recognisably the same object. When Europe finally built its own soap cities, it did not invent this. It inherited it - first through Spain, where the olive groves of Castile grew the soap that taught England what a premium bar could be.

CHAPTER 6

Castile, the white soap

The story Europeans usually tell is that the Crusaders brought soap home with them in the eleventh and twelfth centuries, and like most such stories it is half right. Soap was never unknown in Europe - Pliny had described it, Zosimos had written down the making of it around 300 AD - but the Crusades opened the road, and down that road came the Levantine idea of a hard, white, olive-oil bar [C8]. The soapmakers of the Mediterranean copied Aleppo's product and quietly dropped the ingredient they could not get: the laurel oil. What remained - olive oil, alkali, patience - was Castile soap, named for the Crown of Castile, whose groves and works made it in quantity and exported it across Europe [C8].

The Spanish version perfected one trick that changed the look of soap forever. The boilers cooked local olive oil with barilla - the impure sodium carbonate leached from the ashes of salt-loving shore plants - and then, at the right moment, threw brine into the boiling liquor. The brine drove the soap out of solution: the pure soap curd floated up, and the boiler could skim it off the top, leaving the excess lye and the dark impurities behind [C8]. The result was probably the first white hard soap the world had seen, and it whitened further as it aged without ever going grey. Aleppo's soap was green; Castile's was white, and white, in a market that equated purity with colour, meant luxury [C8]. Apothecaries stocked it under Latin aliases - sapo hispaniensis, sapo castilliensis - and English records show it coming through Antwerp into London as early as 1567; an English poem lists Castile soap among desirable imports as early as the 1430s [C8].

Then Castile soap did something no soap had done before: it became a scandal of state. In the 1630s the cash-strapped government of Charles I sold a monopoly on soap to a company backed by Spanish, Catholic manufacturers - in Protestant England, at a moment of high religious temperature. The uproar was immediate and total. The rivals fought back with what may be the earliest negative advertising campaign in the soap business: washerwomen were enlisted to demonstrate publicly how much better the honest local tallow soap was than the foreign Catholic bar [C8]. The affair ended with the monopolists stripped of their grant, but the episode fixed Castile soap's meaning in the English mind. It was the soap worth fighting over - the imported premium against which all domestic soap would be measured for the next two hundred years.

That measurement mattered, because English soap was a different animal. The north had no olive groves; it had cattle, and its soap was boiled from tallow - a soft, strong, brownish product, excellent for scouring cloth and poor for the face. The two soaps divided the market by class: Castile for those who could pay, tallow for everyone else, and between them a social idea was being planted that would drive the industry for centuries - that the quality of a person's soap said something about the person [C8]. It is no accident that the legend later grew that Queen Elizabeth I herself prized Nabulsi soap: the claim is unverifiable, but its currency tells you that by her reign, imported olive-oil soap was already a marker of refinement [C6].

The formula travelled north and ran into politics. When Antwerp - the great soap port of the Low Countries - fell to the Spanish in 1567, its Protestant soap-makers fled north and carried the white-soap craft into Holland and beyond [C8]. By the seventeenth century the rival product was so good that the English crown tried to monetise it: in 1634 Charles I granted the newly formed Society of Soapmakers a monopoly, and the monopolists defended their New White Soap with certificates from foure Countesses, and five Viscountesses, and divers other Ladies and Gentlewomen of great credite and quality, besides common Laundresses - an advertising campaign three centuries before the phrase existed, answered furiously by the old tallow soap-boilers and their own army of washerwomen [C4]. The episode reads like a parody of the Stuart monopolies, but it proves the point: by the 1630s soap was valuable enough to fight over, and respectable enough for countesses to testify for. The name Castile, meanwhile, detached itself from the map and became a category: any hard, mild, vegetable-oil soap was castile soap, and the word still carries the association on a thousand wrappers today [C8].

What made Castile supreme was a process as much as a place: the repeated boiling and brining that lifted a pure white soap from the kettle, leaving the impurities behind in the lye - a refining step the tallow soaps of the north could not match [C8]. White soap became the international benchmark of quality, and the word castile its guarantee. The commerce rewired the Mediterranean: olive oil that might have fed lamps and tables went into the kettles, and ships carried the finished bars north to Antwerp and London, where the name alone commanded a premium [C8]. Even the English documentary record bows to it - one of the earliest known mentions of soap in English household accounts, in the fifteenth-century Libelle of Englyshe Polycye, is already complaining about the trade [C8].

The Spanish monopoly never held, of course, because the recipe would not sit still. Savona and the other Italian ports had their own white-soap traditions older than Spain's claims; the refugees of Antwerp seeded Amsterdam; Marseille codified its own version in the next century; and by the time the word castile reached the modern wrapper it meant a method, not a city - vegetable oil, long boil, white hard bar [C8][C9]. The formula that crossed the Atlantic with the colonists became the American standard too, and it is the direct ancestor of every pure vegetable-oil bar on the market, from the artisan's olive block to Dr. Bronner's liquid castile [C8][C55].

Spain's olive soap had one great rival left. On the French Mediterranean, a port city with its own groves and its own ambitions was about to receive the full attention of a king who wanted everything made in France to be the best in the world - and who was prepared to legislate a recipe to get it.

CHAPTER 7

Marseille and the king's stamp

Marseille had everything soap needs: the Mediterranean at the quay, olive groves at its back, salt in its marshes and barilla burning down to soda ash on its shores. Soap-boilers were working there by the fourteenth century - the first documented soapmaker of the city appears in the records around 1370 - and for four hundred years they made a sound provincial product [C9]. Then, in 1688, Louis XIV's minister Colbert issued an edict that did something no government had done for soap before: it defined one. The name Savon de Marseille could be carried only by soap made in the region, from olive oil, by the approved method. Everything else was just soap [C9].

It is hard to overstate how modern that move was. The Edict of Colbert is one of the earliest protected designations in manufacturing - an appellation for a chemical product, a century before champagne had one. It put the French state's credibility behind a bar of soap, and it put Marseille's rivals on notice that quality was now a matter of law. The making, as codified, was a ritual that took two weeks to a month: Mediterranean sea water, olive oil and the alkaline ash of sea plants, charged into a cauldron of about eight tons, heated and stirred for days, rested, poured into moulds, cut while soft, stamped, and left to harden [C9]. The stamp eventually carried the famous number - 72% - the declared minimum of fatty acids in the bar, a purity claim pressed into the soap itself. The law has since been amended to admit other vegetable oils, and two Marseille soaps now exist side by side: the original green, made with olive oil, and a white made from palm and coconut [C9].

The industry the edict protected became enormous. By 1913 the region was producing 180,000 tons of soap a year; in 1924, 122 soap-making companies worked in Marseille and Salon-de-Provence combined [C9]. The city's soap went out on the same sea lanes that had brought Aleppo's in, full circle: France had copied the Levant, then out-produced it. As of 2023 only four traditional makers remained, gathered in a defensive association, the Union des Professionnels du Savon de Marseille, fighting imitations that borrow the name the edict made valuable - and the savon de Marseille has had its revenge on fashion, becoming a cult object of the plastic-weary: a cube with no bottle, no pump and no ingredient list longer than a sentence [C9].

Colbert's edict of 1688 is one of the great documents of soap: the Sun King's minister, tidying French industry, decreed that the name soap of Marseille could go only on bars made in the city, boiled in the cauldron, from pure olive oil - no other fat, no shortcuts - at a minimum of seventy-two per cent fatty matter [C9]. The number is still stamped into every genuine block: 72%, the oldest quality mark in continuous use anywhere in consumer goods. The industry that the edict policed became immense - in 1913 Marseille produced some 180,000 tonnes of soap, and as late as 1924 the basin counted 122 soap firms [C9]. Then came the long contraction as detergents and liquids took the household, until the trade association of Marseille soap-makers, the UPSM, counted just four true savonneries still boiling the traditional block in 2023 [C9]. Four firms guarding a three-hundred-year-old recipe against the whole modern world - and guarding, too, the green cube that perfumed the childhood of a nation.

The city's hold on the recipe was always partly myth - soap was made across Provence - but the myth was the point. Marseille turned a municipal product into an appellation, and defended it with the same ferocity for three centuries; the modern union of Marseille soap-makers, the UPSM, exists precisely to police which bars may carry the name, and its membership - four firms as of 2023 - shows how narrow the gate has become [C9]. The green-and-white cube itself remains unmistakable: 72 per cent stamped on its face, faintly of olives, improving as it dries. No package designer ever did better [C9].

The numbers chart the arc with unusual clarity. First recorded maker: 1370. Edict: 1688. Peak: 180,000 tonnes in 1913. Contraction: 122 firms in 1924 dwindling through the detergent decades to four [C9]. A six-hundred-year industry compressed into five figures. And yet the four survivors are not a museum: the cube sells precisely because nothing about it changed - the cauldron, the olive oil, the stamp, the week-long boil - and the market that rediscovered it in the natural-products wave found it exactly where Colbert's inspectors left it [C9].

The cube itself became the standard-bearer. The classic block - six hundred grams of greenish or off-white soap, stamped on its faces - has been poured and cut around the city for about six hundred years, and family firms like Marius Fabre still sell it in exactly that form [C9]. Holding one is holding the whole argument of this book's early chapters: oil, ash, water, time [C9].

Step back from the three cities and a pattern emerges, the first industrial lesson of this book. Aleppo, Nablus, Castile, Marseille: every great soap centre was built on a local fat - olive oil - and a local alkali - barilla, qilw, kelp ash - and every one of them exported far beyond the reach of those raw materials. Soap was among the earliest products to be made in one place, to a standard, under a name, and sold in places that could not make it. The recipe was portable; the reputation was the asset. What none of these cities could solve was the other half of the equation: alkali was still scraped from plants and ashes, scarce and expensive, and in the one country that taxed soap hardest, it was about to become the subject of a century-long argument between the Exchequer and the nation's face.

CHAPTER 8

The taxman's tub

In England, soap grew up next to a rival for the same raw material, and the rivalry tells you what soap was made of. The raw material was tallow - the rendered fat of cattle and sheep, stripped from the carcass at slaughter, cracked, pressure-cooked and centrifuged out of the remains [C73]. Tallow lit the country: it was dipped into candles, and candles were the only light most people had. It also washed the country, boiled with lye into a hard, strong, smelly brown soap. Every kettle of soap was, in effect, a candle that would never burn, and Tudor governments worried about exactly that. For a time the making of speckled soap - the common tallow kind - was actually forbidden, not only because it stank but because soap-boiling depleted the national tallow and drove candles beyond the reach of the poor [C10].

The English soap trade sorted itself into three products, and the sorting was social. There was coarse soap, made from train oil pressed out of whale blubber - cheap, rank and destined for the scouring of cloth. There was sweet soap, the fine olive-oil kind, essentially imported Castile and its imitators. And there was speckled soap from tallow, the everyday English bar [C10]. Perfumed soaps arrived from Italy for those who could afford to smell of something other than the wash house. Soap, in short, was a luxury hierarchy rendered in fat - and the state treated it accordingly, taxing it heavily, as it taxed wine and silk [C10].

The tax made soap expensive for a very long time. Well into the nineteenth century, soap in England and several other countries carried a duty that kept it on the shopping lists of the comfortable and off the hands of the poor [C1]. The effects ran deeper than price. A tax on soap is a tax on washing: on clean shirts, clean children, clean hospitals. Reformers made exactly this argument for decades - that the Exchequer was collecting pennies against the nation's health - and the argument finally won in 1853, when Gladstone repealed the duty [C10]. The industry's own historians mark the repeal as a watershed: freed soap became ordinary soap, and cleanliness standards across society rose with its availability [C1].

The mechanics of the tax were as degrading as the rates. Because soap was taxed at manufacture, every soap-boiler worked under the exciseman's eye - the pans, the tallow, the very process licensed and inspected, the trade frozen by regulation into its oldest habits. OpenLearn's history puts the social result in one line: soap was heavily taxed and became a

luxury item only readily available to the rich [C10]. The poor made do with chamber lye and wash-water; the respectable classes washed; and the market responded exactly as economics predicts - market forces virtually eliminated the sweeter soaps in favour of the coarse grades, because only the coarse could bear the duty [C10]. When Gladstone finally repealed the tax in 1853, the effect was immediate and electric: the industry flourished, and it was made even more profitable in the same year by an accident of chemistry - Nobel's dynamite, made from the glycerine that soap-makers had been throwing away [C10]. The repeal of the soap tax is one of those rare fiscal events with a smell: within a generation, Britain was the cleanest society that had ever existed.

It is hard, now, to imagine a government taxing cleanliness itself; the Victorians found it harder. The soap duty was hated precisely because everyone understood what it taxed: not a luxury but a boundary - between the washed and the unwashed, between respectability and its opposite. Campaigners argued for decades that the state was taxing the poor out of health and decency at once, while the perfumed soaps imported from Italy floated over the duty for those who could pay [C10]. The repeal in 1853 landed in a Britain already transformed by Leblanc alkali and steam power, and the combination - cheap alkali, free trade, no duty - detonated the industry: within decades the great Merseyside and London soap houses were exporting to the Empire, and the bar had completed its journey from luxury to necessity [C10][C11]. The taxman's tub stands as the book's standing warning: the difference between a luxury and a necessity is very often nothing but a law.

The repeal did not arrive from abstract principle. It came from a chancellor reading the country's mood: Gladstone's 1853 budget is remembered for many reforms, but the soap duty's abolition was the one that reached every washtub in the kingdom [C10]. The industry felt it within the year, and the working-class bathroom within the generation. A tax can delay a technology; it cannot defeat one the world wants this much [C10][C1].

The repeal met a second revolution already in progress. Steam power and machinery had brought economies of scale to the boiling shops; better soaps and - just as important - advances in plumbing, running water and the drainable bathtub together made bathing the social norm rather than the annual event [C10]. The untaxed bar arrived in the same decades as the bathroom built to receive it. Cheap soap, hot water on tap and somewhere to drain it away: the modern idea of a daily wash needed all three, and by the end of the century an ordinary household had them [C10].

The industry grew up on fuel. By the thirteenth century English soapmaking centred in the large towns - Bristol, Coventry, London - each boiling its own variety, and the demand for wood ash was so great that large areas of woodland were destroyed to feed the soap-pots, causing a country-wide shortage of winter fuel [C10]. Cleanliness and warmth were competing for the same forests; the taxman, when he arrived, was only the latest of the industry's burdens [C10].

The century and a half before repeal had not been wasted, on the chemistry side. From the early seventeenth century, chemists and soap manufacturers together attacked the industry's problems, and over the next 150 years produced a working understanding of the process - greater manufacturing efficiency, a wider variety of more fragrant and colourful solid and liquid soaps, and milder soaps fit for the finest lace and linens [C10]. The tax held back the market; it could not hold back the knowledge. When repeal came, the industry was ready to explode [C10].

Two accidents of timing compound the year. The same 1853, Alfred Nobel's work on nitroglycerine was turning soap's troublesome waste product - glycerine - into the raw material of dynamite, and a by-product the boilers had poured away became an industry of its own [C10]. And the decades around the repeal brought steam power and plumbing: economies of scale in the soap works, and, in the better-off houses, running water and drainable bathtubs that made daily washing physically easy for the first time in history [C10]. The tax had kept soap scarce; the machine made it abundant. Within a generation the smelly trade of the tallow men would be a science-led, branded, global industry - but between the taxed past and the branded future there is one more story to tell, because none of it could happen while alkali still came out of a barrel of ashes. For that, England and the world needed a chemist, a war, and a process named after a man who never profited from it.

PART III

The Chemists' Century

CHAPTER 9

Leblanc's ashes

For four thousand years, soap had a supply problem no recipe could fix. The fat was easy - the world is full of fat. The alkali was not. Potash came out of wood ashes, and by the thirteenth century Europe had burned so much of its forest that alkali had to be imported from wherever trees still stood: potash from Russia, Scandinavia and North America, barilla soda from the shores of Spain and the Canaries, natron mined from Egypt's dry lakes [C11]. In Britain the only local source was kelp, gathered off the Scottish and Irish coasts [C11]. Every kettle of soap, every pane of glass, every bolt of bleached cloth competed for the same scarce grey powder. The limit on cleanliness was the price of ash.

The crisis, when it came, was political. France in the late eighteenth century was a great power whose alkali supply ran through other people's forests and Britain's goodwill, and in 1783 King Louis XVI and the Academy of Sciences offered a prize of 2,400 livres for a way to make alkali from the one feedstock France had in unlimited quantity: sea salt [C11]. The man who solved it was Nicolas Leblanc, physician to the Duke of Orléans. In 1791 he patented a two-stage process - treat salt with sulphuric acid to make sodium sulphate, then fire that salt cake with coal and limestone to make sodium carbonate, soda ash - and built a works at Saint-Denis producing 320 tons a year [C11].

Then the Revolution took everything. Leblanc's patron went to the guillotine; in 1794 the revolutionaries seized the Saint-Denis plant and, worse, published his trade secrets, so that anyone could build a Leblanc works and no one owed him a sou. The prize money was never paid. Napoleon returned the plant to him in 1801, but Leblanc had no capital to rebuild it and no protection against the competitors his own published process had spawned. In 1806 he walked into a poorhouse and shot himself [C11]. The man who freed the world's alkali died penniless inside it.

His process, however, went on to build the modern chemical industry - not in France, but in Britain. The first British Leblanc works rose on the Tyne in 1816, though a steep salt tariff kept the economics marginal until its repeal in 1824 [C11]. Then the industry exploded. James Muspratt, an Irish chemist, built works at Liverpool and Flint; Charles Tennant built near Glasgow; and the Mersey basin, with Cheshire salt, St Helens coal and Derbyshire

limestone all within a day's haul, became the alkali capital of the world [C11]. By 1852 Britain was making 140,000 tons of soda a year to France's 45,000; by the 1870s British output exceeded the rest of the world combined [C11].

For soap, the effect was liberation. The boilerman's other raw material was now an industrial commodity, cheap and standardised, available by the shipload rather than the ash-barrel. It is not a coincidence that the golden age of the British soap industry - the age of Sunlight and Pears and the great Merseyside soap works - opens exactly as Leblanc alkali floods the market. By 1850, soap-making had become one of America's fastest-growing industries too, riding the same cheap alkali and the new power machinery [C1].

The Leblanc process also wrote the first chapter of environmental law. It was a filthy business: for every 8 tons of soda it vented 5.5 tons of hydrochloric acid gas and left 7 tons of reeking calcium sulphide waste - galligu - heaped around the works, weathering into the smell of rotten eggs [C11]. The countrysides around the alkali towns scorched and blistered; an 1839 lawsuit records gardens failing, trees becoming rotten naked sticks, cattle drooping, and householders afflicted with coughs and pains in the head [C11]. The public anger produced, in 1863, the Alkali Act - no more than 5 per cent of the acid gas could be vented - the first modern air-pollution legislation in the world, complete with its own inspectorate [C11]. The industry that made cleanliness affordable had made breathing expensive, and the state, for the first time, chose the air.

The bitterness of Leblanc's end is sharpened by how close he came. The Academy's prize - 2,400 livres for making alkali from salt - was a direct response to a strategic panic: by the thirteenth century Europe had burned so much of its forest for potash that alkali had become an import commodity, and by the eighteenth the supply lines ran through rivals' territories [C11]. Leblanc solved the chemistry and lost everything else. His patron the Duke of Orléans went to the guillotine; the Committee of Public Safety confiscated the works and published the process; Napoleon handed the factory back in 1801 as a ruin; and on a January day in 1806 the inventor shot himself among the poor [C11]. There is no monument. But every bar of cheap soap made in the nineteenth century - and therefore every chapter of this book after this one - runs on his reaction.

Britain's appetite was the engine. The country had run through its forests early, and its industry - glass, textiles, soap - was alkali-hungry; before Leblanc, the entire supply was botanical or geological: potash from the still-forested empires of Russia, Scandinavia and

North America, barilla from Spain and the Canaries, natron from Egypt, kelp scraped off the Scottish and Irish coasts [C11]. Every one of those supply lines could be cut by war or tariff, and everyone knew it. When the Leblanc works multiplied along the Tyne and the Mersey after 1816, they were not just chemical plants; they were independence machines [C11].

The industry's waste problem was as revolutionary as its product. Each ton of Leblanc soda meant choking hydrogen chloride gas - the 1839 lawsuit's catalogue of blighted gardens, rotten trees, drooping cattle and afflicted householders reads like a gothic indictment - and heaps of galligu, the reeking calcium sulphide residue that no one could shift [C11]. The Alkali Act of 1863 capped the acid emissions at five per cent and created an inspectorate to enforce the cap: the world's first modern air-pollution law, complete with the world's first environmental inspectors [C11]. And in the long run the waste heaps performed their own alchemy, weathering down to lime-rich islands of calcicole flora - at Nob End near Bolton, rare orchids now grow on the dumped residue of the works that supplied the Victorian soap boom, and the site is a protected reserve [C11]. The filth became a garden. It is the book's first environmental parable, and not its last.

Leblanc was not quite the first English-speaking answer to the alkali question. In 1780, eleven years before the French patent, James Keir had established a chemical works at Tipton in the Midlands manufacturing alkali from the sulphates of potash and soda, and added a soap manufactory to it [C4]. Keir's route never conquered the world the way Leblanc's did - the economics of salt beat the economics of sulphate - but it marks the moment the industry's centre of gravity began drifting from the kettle to the chemical works [C4]. The soap-boiler was about to acquire a new master: the industrial chemist.

The Solvay process that ended it was elegance itself: salt and limestone, linked by an ammonia cycle, yielding soda ash with calcium chloride as the only waste - no acid gas, no galligu heaps [C11]. Brunner Mond's works at Winnington, near Northwich, opened in 1874 and carried the fight into the Leblanc heartland; by 1900, ninety per cent of the world's soda was made the Solvay way or won from the trona deposits discovered in Wyoming in 1938 - a mineral so convenient it eventually closed even the Solvay plants, the last American one in 1986 [C11]. Each cleaner chemistry ate the one before. The soap kettle simply drew its alkali from whichever won.

The Leblanc era ended as abruptly as it began. In 1861 a Belgian chemist, Ernest Solvay, found a more direct route from salt and limestone to soda ash using ammonia, cheaper and far cleaner; by 1900, 90 per cent of the world's soda was made his way [C11]. The Leblanc towns declined, and their only monuments are strange ones: a few lime-rich waste heaps that weathered into rare habitat, like Nob End near Bolton, now a protected nature reserve famous for orchids growing on the dumped residue of the industry that fed the world's soap kettles [C11]. The waste outlived the works, and became a garden. But Leblanc had changed the question soap asked of chemistry. Alkali was now a known substance made in a factory. What, exactly, it did to fat was the next mystery - and it fell to a French aristocrat of science to take the bar itself apart.

CHAPTER 10

Chevreul's fats

One evening in Paris, the story goes, a young chemist left a little soapy water in a glass dish, and by morning it had evaporated and left crystals behind. Salt crystals, apparently - but no salt had gone anywhere near the soap. Michel Eugène Chevreul asked himself the question that launches this chapter of the story: where did that salt come from? His answer, worked out over a decade of the most careful experiments anyone had yet performed on a living substance, took the world's oldest recipe apart and founded a new science [C12].

Chevreul had arrived in Paris at seventeen, in 1803, the son and grandson of surgeons from Angers, and walked into the laboratory of Nicolas Vauquelin at the Museum of Natural History [C12]. Chemistry then had barely touched the products of life. Organic substances were thought to be held together by a vital force inaccessible to analysis; the great Fourcroy, surveying fats in 1794, could say only that science knew the action of fire and some reagents upon them. A few things were known. Lavoisier had shown that oils were made of carbon and hydrogen. Berthollet had guessed, from the very existence of soap, that fat must contain something acidic, since it combined with alkalis. And in 1783 the Swedish chemist Carl Wilhelm Scheele, boiling olive oil with lead oxide, had isolated a sweet, syrupy liquid he called the sweet principle of oils - the substance we now call glycerol - without understanding what it was or where it came from [C12].

Vauquelin handed his young assistant a sample of pork fat. Chevreul saponified it - made soap of it, in the ancient way - and then did what no soap-boiler had ever done: he took the soap back apart. Dissolving his pork-fat soap in water, he found that part dissolved and part fell out as small pearly crystals. Treating the crystals with acid, he recovered a solid, acidic fatty substance melting at about 56 degrees, and named it margaric acid, from the Greek for pearl. The liquid part of the soap yielded a second acid, fluid at room temperature, which he called oleic [C12]. Soap, then, was not one thing. It was salts - compounds of the alkali with distinct fatty acids, different for every fat. The ancient bar was a family of chemicals, and Chevreul spent the next ten years at the Museum cataloguing the family: stearic acid from sheep and beef tallow, butyric and caproic and capric acids from butter, the wax chemistry of whale spermaceti, and - from human gallstones - a strange unsaponifiable crystal he named cholesterine: cholesterol [C12].

He settled the mechanism of the whole reaction with an accountant's patience. Fourcroy believed oxygen was needed to make soap; Chevreul saponified fat in the absence of air and disproved it. Then he weighed everything - the fat before, the glycerol and fatty acids after - and found the products outweighed the starting fat by about five per cent. The extra mass was water. Saponification, he concluded, is a splitting: the fat, a union of glycerol's anhydride with fatty acids, takes up water and comes apart, the alkali capturing the acids as salts - the soap - while the glycerol goes free into the liquor [C12]. That is the reaction in the Babylonian cylinder, written at last as chemistry, around 1813. His great book of 1823, Recherches chimiques sur les corps gras d'origine animale, gathered it all and is counted the first treatise of lipid chemistry - arguably, said his contemporaries, the foundation of organic chemistry itself. Berzelius called the work the most complete and best-executed series of experiments yet found in all of chemistry [C12].

The practical fallout arrived quickly and touched every reader of this book this morning. Chevreul noticed that his hardest fatty acid, stearic, made a far better candle than reeking tallow, and with his friend Gay-Lussac he patented the stearic candle in 1825 - the clean-burning modern candle, born of soap science. The patent made him nothing, as he noted dryly; the profits, as usual, went to the industrialist [C12]. And the glycerol his reaction set free, the sweet principle, would within a generation become an industry of its own, in directions - dynamite, medicine, moisturiser - that no one boiling soap had imagined [C10].

The discoveries came in a rush between 1813 and 1823. Working under Vauquelin in Paris - and reportedly curious after watching stray salt crystals grow overnight in a dish of soapy water - Chevreul took soap itself apart [C12][C12]. From pork-fat soap he separated a pearly crystalline acid he named margaric, then the true stearic acid, and the liquid oleic acid, proving that a single potash soap was really two soaps, two distinct salts of two distinct fatty acids [C12]. From the watery remainder he recovered Scheele's sweet principle, named it glycerine, and concluded the great structural truth: a fat is a compound of glycerol with organic acids, and saponification is the alkali displacing the glycerol and taking its place - soap is a salt, and that is all it is [C12]. He said it in 1823 in a book that founded a science, Recherches chimiques sur les corps gras d'origine animale; along the way he had also described cholesterol in gallstones, and would later give the world the stearic candle, a brighter, cleaner light than tallow ever gave [C12][C12]. France knew what it had: when the old man turned a hundred, the city of Paris gave him a banquet for a

thousand guests - lit, fittingly, entirely by the stearic candles his own invention had made ordinary [C12].

Chevreul's life spanned the entire transformation he caused. Born in 1786, trained under Vauquelin, he published twenty-seven scientific notes in his first six Paris years alone; he spent his middle career as director of dyeing at the Gobelins tapestry works, where his studies of colour became classics in their own right, and he died in 1889, aged a hundred and two [C12]. The stearic candle he invented in 1825 with Gay-Lussac - hard, bright, nearly smokeless - lit the boulevards of the Second Empire and made its own contribution to cleanliness: a light that did not coat the parlour in soot [C12]. His final communication to the Academy of Sciences came one year before his death, five months short of his hundred-and-third birthday; he liked to say he had known in his century four kings, two emperors, three republics and four revolutions [C12].

It is worth pausing on what the 1823 book actually established, because everything after this chapter is commentary on it. A fat, Chevreul showed, is not a substance but a partnership - glycerol holding three fatty acids - and saponification is the breakup of that partnership: the alkali takes the acids, the glycerol goes free, and the salts of the acids are the soap [C12]. In one stroke the craft's four-thousand-year-old recipe acquired an explanation, and the explanation had industrial teeth: if soap is a salt of fatty acids, then any fat, analysed and blended, could be engineered into any soap - and the modern industry is built on exactly that freedom [C12][C29]. He also gave chemistry a method as much as a result: fractional crystallisation, melting-point determination, ultimate analysis - the first time the full battery had been brought to bear on an organic material [C12].

The market, meanwhile, was doing its own quiet sorting. The OpenLearn history notes that market forces virtually eliminated the sweet and speckled soaps of the old three-tier trade, despite the difficulty of making an odourless coarse soap - and that perfumed soaps, introduced from Italy, were quick to fill the gap the taxes had made [C10]. The pattern is one this book will meet again at every scale: whenever soap is taxed, regulated or rationed out of reach, something scented arrives from abroad to reclaim the top of the market [C10]. Luxury always finds a way back in through the customs house.

There is a pleasing epilogue. Chevreul lived to 102, gave his last paper to the Academy of Sciences at 101, and at his hundredth-birthday banquet, seated before a thousand guests, the hall was lit entirely by stearic candles, the gift of the manufacturer who had profited from

his patent [C12]. He liked to say he had known four kings, two emperors, three republics and four revolutions. He had also outlived the mystery of the oldest craft: after him, soap-making was no longer a secret of the boiler's hand but a reaction on a page, and industry could now improve it deliberately. The next question was subtler. Chemists knew what soap was. Nobody yet knew how it worked.

CHAPTER 11

What soap actually does

A soap molecule is a diplomatic compromise made of carbon. At one end it carries a long hydrocarbon tail - a chain of twelve to eighteen carbons that behaves exactly like the oil it was made from: it shuns water and dissolves in grease. At the other end it carries a charged head, the carboxylate group left over from the fatty acid, which does the opposite: it is pulled towards water and repelled by oil [C2]. Chemists call such molecules amphiphilic - both-loving - and the whole of soap's power lives in that split personality. Water alone slides off grease because the two refuse to mix. A soap molecule is the go-between: one end at home in the grease, one end at home in the water.

Put soap in water and the molecules arrange themselves to satisfy both ends at once. The tails crowd together into tiny balls with the heads on the surface, facing out into the water - structures called micelles, each a droplet-sized embassy of oil-friendliness surrounded by a water-friendly frontier [C2]. When the soapy water meets a greasy hand or a dirty collar, the micelles open around the grease: the tails bury themselves in the oil droplet, the heads keep hold of the water, and the grease finds itself wrapped in a water-soluble coat. What scrubbing then rinses away is not grease on skin but grease inside micelles, suspended in water - the same dirt that plain water would simply push around [C2]. This is why soap's action is so much gentler than the ash lyes it replaced: the lye destroyed grease chemically and bit the skin doing it, while soap merely escorts it off the premises.

The lather, the scent, the colour, the milled hardness of a good bar - none of these is the cleaning. The OpenStax chemistry textbook puts it flatly: dyes are added for colour, antiseptics for medicated soaps, pumice for scouring, air for soaps that float, but regardless of price, all soaps are basically the same [C2]. Two and a half centuries of branding, which we will meet in the next part of this book, are built on a reaction a Babylonian would recognise.

Soap's weakness is geological. In hard water - water carrying dissolved calcium and magnesium - the soluble sodium soap trades its sodium for the metal and falls out of solution as a greasy, insoluble curd: the ring around the bathtub, the grey tinge on white clothes, the scum that won't lather [C2]. Hard-water districts wasted soap for centuries,

since the first inch of every wash went to softening the water rather than cleaning. The chemist's answer to that failure, the synthetic detergent, is a whole later chapter; here it is enough to note that the sulphonate detergents work by the same micelle diplomacy but refuse to precipitate in hard water [C2].

Soap's second weakness is living skin. Skin defends itself with an acid mantle - a surface film held slightly acidic, at a pH somewhere between 4 and 6 - and true soap, made with a strong base, is always alkaline, typically pH 9 or 10 [C69]. Dermatology reviews are blunt about the trade: alkaline soap disrupts the barrier, dissolves some of the skin's own lipids and lifts its pH, which is why skin can feel tight and squeaky after a true-soap wash [C69]. The modern synthetic cleanser can be blended to the skin's own pH, which is a large part of why it exists. And yet soap persists, even with dermatologists' reservations - partly, the same reviewers observe, because of the negative connotations around anything not perceived as natural [C69]. The bar by the sink sells a feeling as much as a function.

The skin complicates the story, because skin is not cloth. The surface of human skin is mildly acidic - a protective acid mantle around pH 4 to 6 - and traditional soap, at pH 9 to 10, briefly pushes it alkaline, dissolving some of the lipids that keep the barrier sealed [C69]. For most people this is trivial and transient; for eczema-prone or infant skin it matters, and the dermatology literature is blunt that harsh alkaline soaps can disrupt the barrier while mild acidified cleansers preserve it [C69]. This is the scientific root of the whole syndet revolution we will meet later: the discovery that you could build a cleanser to match the skin's own pH. France, characteristically, wrote the distinction into law early - a 1975 act separating the naming of soap from its synthetic rivals [C69]. None of this dethrones the bar; it just disciplines our praise. Soap is magnificent chemistry, but it is alkaline chemistry, and the skin notices.

The micelle is where it all happens. Above a low threshold concentration, soap molecules stop drifting singly and assemble into spheres a few millionths of a millimetre across - tails turned inward to hide from the water, heads outward to face it - and each sphere is a tiny cage into which grease is drawn and locked [C2]. The rinsing water then simply carries the cages away. No scrubbing brush, no solvent, no enzyme matches the elegance of it: the dirt is not dissolved, it is packaged. And the same structure explains soap's one great weakness, hard water - the calcium and magnesium ions in it grab the fatty-acid tails and drag them out of solution as grey, greasy scum, the ring around the bath, useless for cleaning and

miserable to rinse [C2]. Everything the twentieth century did to soap - the builders, the synthetics, the whole detergent industry - begins as an attempt to solve that one inconvenience.

One more piece of precision, because it is the piece everyone gets wrong: soap does not disinfect. It does something better - it removes. The surfactant lifts the microbe, the grime and the oil together into the rinse water and sends the whole lot down the drain, which is why plain soap and water, mechanically applied with friction and time, outperforms most antibacterials in practice; the FDA said as much in 2016 when it stripped the antiseptic claims from nineteen ingredients [C35]. The bar is not a weapon. It is an evacuation.

And soap's chemical family reaches well beyond the washtub. Swap the sodium for a heavier metal and the character changes entirely: the so-called metallic soaps - lithium, calcium, aluminium stearates - are not cleansers at all but the key thickening components of lubricating greases, a use with ancient precedent, since greases were once made simply by adding lime to olive oil to form calcium soaps [C4]. Metallic soaps even turn up inside artists' oil paint, where they act as rheology modifiers keeping the pigment flowing and sitting properly [C4]. Another whole branch, the resin soaps made when the paper industry's alkaline reagents meet tree rosin, work as industrial emulsifiers [C4]. The amphiphile is too useful an idea to stay in the bathroom. Wherever oil and water must be made to cooperate - in a bearing, on a canvas, in a paper mill - some member of the soap family is doing the work [C4].

One more action deserves naming, because it is the one this century leaned on hardest: soap does not only carry dirt away, it kills. Lathered with a little water, soap disorganises the lipid bilayer of microbial membranes and denatures their proteins - the same membrane attack Pall Thordarson would explain to a frightened world in 2020 - while its emulsifying action lets the running water carry the wreckage off [C4][C49]. The bar by the sink is, in the plainest chemical sense, a disinfectant that predates the germ theory by four thousand years.

Not every bar is gentle, and the craft always knew it. Sand or pumice went into scouring soaps, whose abrasives strip dead cells from the skin's surface - exfoliation, in the modern word - a reminder that the line between cleanser and scourer has always been a matter of dosage [C4]. The OpenStax textbook's flat verdict covers them all: regardless of additives and regardless of price, all soaps are basically the same [C2]. The differences are in the extras; the cleaning is the molecule.

Which raises the last question of this part. If soap is simply a bridge between oil and water, why does it foam - why should a wash produce those astonishing, iridescent bubbles that children chase and mathematicians write papers about? The answer is a small monument of physics, and it belongs to a blind Belgian professor and his brass wire frames.

CHAPTER 12

The geometry of foam

Why does soap water foam when plain water will not? Water's surface is a stretched skin: the molecules at the surface are pulled sideways and downwards by their neighbours and by nothing from above, and the resulting surface tension makes water minimise its surface - gather into drops, refuse to stretch. A soap molecule, with its water-loving head and oil-loving tail, parks itself right in that surface, head down in the water, tail up in the air, and lowers the tension dramatically [C70]. Now the surface can stretch without snapping. Blow air into such water and the film will stretch around the air and hold: a bubble. A soap film is a sandwich two molecules thick - heads pointing into a film of water, tails pointing out - and it is among the thinnest objects you can see with the naked eye. Its famous shifting rainbows are the thickness itself made visible: light reflecting off the front and back of the film interferes, and as the film drains and thins from thousands of molecules to a few, the colours slide through the spectrum before the film goes black and pops [C70].

Bubbles are not a side effect of soap; they are soap's self-portrait. The same split personality that lifts grease is what lets the film exist. And the foam obeys exact mathematical laws, discovered not by a mathematician but by a blind physicist playing with wire frames. Joseph Plateau, professor at Ghent, had damaged his eyes gazing directly into the sun for twenty-five seconds in an experiment on the persistence of impressions on the retina - an experiment he blamed for the blindness that overtook him later in life [C74]. Unable to see properly, he spent the middle of the nineteenth century dipping wire shapes into soap solution, and out of those observations came Plateau's laws Out of those observations came Plateau's laws: soap films are smooth; their curvature is constant across any one piece; films always meet three at a time along an edge, at exactly 120 degrees; and those edges meet four at a time at a point, at the tetrahedral angle of about 109.47 degrees [C71]. No foam anywhere - in a sink, on a wave, in a fire-extinguisher - is allowed to break those rules; any other configuration rearranges itself until the laws hold [C71].

This is why the washing-up bowl is a physics laboratory. The iridescence that so delighted Millais's Bubbles is interferometry you can hold: the colours map the film's thickness contour by contour, and when the draining film thins past the last visible band it turns black - thinner than the wavelengths of light themselves - just before it bursts [C75]. Water drains

down through the film under gravity, which is why old bubble-wrights add glycerine to thicken the mix and slow the fall [C75]. None of it needs a laboratory: a loop of wire, a saucer of soap solution, and you are standing where Plateau stood.

The wire-frame trick has outlived the parlour. Because a soap film instantly finds the least-area shape spanning its boundary, architects and engineers have used soap films as analogue computers - dip a model of a roof or a tent structure in solution and the film draws the optimal surface for you; biologists find the same minimal geometry partitioning living tissue, from the cells of a bone to the walls of a sponge [C70][C71]. The MIT course that teaches all this to schoolchildren needs no apparatus beyond wire, soap solution and glycerine - the same kit Boys handed his audience in 1890 [C70][C76].

It is worth dwelling on the oddity of Plateau's instrument: a soap film is a mathematical object you can hold. Two-dimensional, weightless, self-repairing, costing nothing - for the physicist of 1850 it was the only accessible model of a minimal surface, and for the mathematician of 1976 it was still worth a paper in the Annals [C71]. Jean Taylor's proof finally showed that the rules the blind professor had coaxed from dishwater govern every soap-film-like surface that mathematics can define [C71]. The lag - a hundred and twenty years between observation and proof - is a fair measure of how much harder the mathematics is than the washing up.

The colours deserve their own note, because they are not pigment but physics. A soap film is thin enough - a few hundred nanometres - that light reflecting off its front surface interferes with light reflecting off its back, and the thickness at each point picks out which wavelengths survive: hence the drifting bands of colour, and hence the black patch that appears where the film has thinned almost to nothing just before it bursts [C75]. Gravity complicates the picture by draining the film: the water inside slides downward between the two surfaces, so a bubble thins from the top until the top fails [C75]. Every iridescent swirl above a washing-up bowl is a measurement of the film's thickness, written in light [C75].

Bubble-blowers learn two of the film's secrets young. The water inside a soap film drains downward under gravity, thinning the top until it fails - which is why a little glycerol in the mixture, thickening the water, makes longer-lived bubbles [C75]. And there is an ultimate height a film can climb, set by the capillary length: for soap films about four metres, though in principle the length a horizontal film can reach is unlimited [C75]. The parlour tricks and the mathematics meet in the same shimmering skin.

The professional bubble-men found the poetry in it without breaking the physics. Tom Noddy, the bubble performer, compares the colours on a bubble to the contour map of its surface - each band a line of constant thickness, drawn in light [C75]. Read that way, every bubble is a survey of itself: the mountains where the film still holds water, the dark plains where it has thinned to the edge of failure [C75].

Plateau's laws look like a parlour curiosity, and in Victorian parlours that is exactly what they were: C. V. Boys' three lectures on soap-bubbles, delivered to a juvenile audience at the London Institution over the New Year of 1889-90 and published as a little book, made the soap film a classic of public science [C76], and it has never really left the classroom - MIT still teaches the physics of soap bubbles online [C70]. But the bubbles were doing real work. A soap film is nature's laziest object: it settles instantly into the shape of least area, and mathematicians realised that Plateau's wire frames were solving, in soap, optimisation problems too hard for the mathematics of the day. The whole field of minimal surfaces grew up around the sink. Plateau's laws themselves were not proved in full generality until 1976, when Jean Taylor proved them using geometric measure theory - a century after a blind man found them with wire and dishwater [C71]. The foam in a beer, the structure of a bone, the cells of a metal foam and the walls between bubbles in a sponge all obey the same four rules. The humblest object in the house turned out to be one of the exactest.

PART IV

The Brand Age

CHAPTER 13

Sunlight

In 1884 a grocer's son from Bolton named William Hesketh Lever did something that looks obvious and was, at the time, close to insane: he decided that soap, a commodity sold anonymous and grey from the grocer's barrel, should have a name, a wrapper and an advertisement. With his brother James he bought a small soap works in Warrington, teamed up with a Cumbrian chemist named William Hough Watson who had devised a soap made from glycerine and vegetable oils rather than tallow, and registered a trademark in February 1884: Sunlight [C16][C19]. The brothers did not sell soap; they sold Sunlight. The distinction built an empire.

The product was genuinely good - a free-lathering vegetable-oil bar in a country used to harsh tallow - but the revolution was the packaging. Sunlight came as a standard bar, stamped and wrapped, in cartons from 1886, identical every time, with the maker's name and reputation literally printed on the goods [C19]. Lever then marketed it with a ferocity the trade had never seen: the first advertisements went up on railway stations across the north of England in 1885, and the spending never stopped [C19]. Demand followed. Production reached 450 tons a week by 1888, and the works outgrew Warrington; Lever bought marshland at Bromborough Pool on the Wirral and began, in 1888, to build a new factory - and next to it, a village [C16][C19].

Port Sunlight is the physical manifesto of the branded age. Between 1888 and 1914 the Levers housed their workforce in good quality houses at high architectural standards, with community facilities, gardens and an art gallery - welfare capitalism in brick, decades before the phrase [C16]. The same company, it must be said plainly, ran its Belgian Congo palm subsidiary, the Huileries du Congo Belge, on forced labour between 1911 and 1945; the palm oil in the soap had two very different histories, and the archive records both [C16]. By 1911 Lever Brothers owned its own oil palm plantations in the Congo and the Solomon Islands - vertical integration from plantation to wrapper, the whole material chain of a bar of soap under one firm's control [C16].

Meanwhile the brand marched. Sunlight yearbooks and almanacs from 1895; the United States from 1895, with a factory at Cambridge, Massachusetts from 1898; acquisition after

acquisition of the old English soap houses - Pears, Gossage's, Crosfield's, Hudson's - until by 1930 the firm employed 250,000 people [C16]. In September 1929 Lever Brothers merged with the Dutch Margarine Unie to form Unilever, a blend of the two names, and by market value the largest company in Britain - arguably the first modern multinational [C16]. Every consumer goods company since, from the supermarket own-brand to the phone in your pocket, runs the play Lever wrote: standardise the product, name it, wrap it, advertise it, control its supply chain.

Lever himself was a grocer's son with a genius for the psychology of washing. He understood, before the academics had words for it, that the enemy was not dirt but habit - that the housewife had to be given a ritual, a promise and a name. The wrapped bar was the ritual; the Sunlight name, registered that February of 1884, was the promise; and the advertising - first on the railway stations of the north in 1885, then everywhere - was the voice [C19]. The formula came from Watson: a free-lathering bar of glycerine and vegetable oils, palm among them, in a market of harsh tallow soaps [C16]. Even the firm's structure anticipated the future: Lever bought plantations in the Congo and the Solomon Islands so that no harvest failure, no cartel, no foreign government could interrupt the flow of fat to his kettles [C16]. It was the first fully integrated consumer-goods machine, and its template - from plantation to wrapper to poster - is still the template.

The acquisitions tell the same story in ledger form. Pears - the old transparent amber bar of 1807 - came under the Lever roof; so did Gossage's of Widnes, Watson's of Leeds, Crosfield's of Warrington, Hazlehurst's of Runcorn and Hudson's of Liverpool - a roll-call of the English soap aristocracy absorbed one by one into the Sunlight machine [C16]. When the merger with the Dutch Margarine Unie created Unilever in September 1929, the new giant was by market value the largest company in Britain [C16]. A business founded on a single wrapped bar had swallowed its entire trade in forty-five years.

And the poster itself changed. Sunlight's early advertising pioneered in-home media - small cards slipped into the soap's packaging, calendars, cartoon drawings - and by 1893 the brand was being advertised on actual postage stamps in New Zealand, possibly the first product ever to ride the mails that way [C4]. Every later trick of the trade - the coupon in the box, the branded calendar on the wall - has a Sunlight ancestor [C4][C19].

The village itself deserves its paragraph, because it was the argument made physical. Between 1888 and 1914 the Levers built Port Sunlight beside the factory: good housing at

high architectural standards, with a full complement of community facilities - welfare capitalism decades before the term, offered as proof that soap profits could build decency [C16]. The archive records the whole of it, including the part the guidebooks soft-pedal: the same firm's Congo subsidiary ran on forced labour from 1911 to 1945 [C16]. Both facts are the company. Any honest account of the branded age has to hold them together, because the same palm went into the same bars [C16].

The recipe itself is recorded with housewife-friendly plainness by the Open University's history: palm kernel oil, cottonseed oil, resin and tallow - a deliberate blend of the tropical and the domestic, priced for a working-class washday [C10]. It was not the most refined soap in the shop. It was the most reliably good one, and reliability, repeated four hundred and fifty tons a week, is what a brand is [C10][C16].

And the soap itself? Sunlight hard soap production at Port Sunlight ran for more than a century and stopped in 2000, as the bar gave way to liquids and powders; the brand survives today as a global dish-wash label [C19]. The bar that invented branding was outlasted by the brand. That is the purest summary there is of what Lever actually built.

CHAPTER 14

The soap that floats

Procter & Gamble began with a marriage of convenience - literally. William Procter, an English candlemaker, and James Gamble, an Irish soapmaker, met in Cincinnati when they married two sisters, Olivia and Elizabeth Norris; their father-in-law persuaded them to go into business together, and in 1837 the firm that would become the largest soap company on Earth opened for business on the Ohio riverfront [C23][C24]. The pairing was perfect: candles and soap were two markets for the same rendered fat, and Cincinnati was America's pork-packing capital, a river of hogs and lard flowing past the factory doors [C23].

The Civil War made the firm national. P&G won contracts to supply the Union Army with soap and candles, and soldiers from every state went home knowing the name [C24]. But the object of this chapter arrived in 1879, from the second generation. James Norris Gamble, the soapmaker's son and a trained chemist, developed an inexpensive white soap - mild, hard, uniform - and Harley Procter, the candlemaker's son, named it from his Bible: all thy garments smell of myrrh, and aloes, and cassia, out of the ivory palaces. Psalm 45. In September 1879 the firm trademarked a single word: Ivory [C20].

Then Harley Procter did for America what Lever was about to do for England: he advertised as if soap were news. He commissioned an independent laboratory to analyse his bar against the imported castile soaps then considered the finest money could buy, and the chemists reported Ivory more than 99 per cent pure. Procter turned the dry result into one of the great slogans: 99 and 44/100% Pure - precise to the point of comedy, and unforgettable for it [C20][C21]. The second slogan was stranger still: It Floats. The original Ivory bar was whipped with air during manufacture, so it bobbed in the bath instead of sinking to the scummy bottom where a bather had to fish for it [C20][C22].

The floating story grew a legend around itself: a worker supposedly left the mixing machine running over lunch, and the ruined, aerated batch was sold anyway, and letters poured in demanding more of the soap that floats. It is the Mount Sapo pattern again - the industry cannot resist an accident myth - and it is likewise untrue. In 2004, P&G's own archivist Ed Rider found James Gamble's laboratory notes showing the chemist had worked out how to

aerate the soap deliberately [C20][C22]. The floating bar was an invention, not a lucky lunch break.

The bar's own composition tells the story of the century it spanned: sodium tallowate, sodium cocoate or palm kernelate, water, salt, sodium silicate, magnesium sulphate, fragrance - beef fat and tropical oil, fused by Leblanc's alkali, measured to a pH of 9.5 [C20]. Ivory Snow, its flaked descendant, washed a century of delicate laundry. And yet by the turn of the millennium the flagship had become a nostalgia item: research in 2001 found all Ivory products together accounted for less than one per cent of P&G's worldwide sales [C20]. The company that invented the soap brand had moved on to selling everything else. The white bar remained on the shelf like a founder's portrait in the lobby - honoured, familiar, and quietly irrelevant to the business being done upstairs.

The Civil War had made the firm's name national; the second generation made it modern. William Procter's son Harley was the marketer, James Gamble's son James Norris the chemist, and the division of labour between them - one to perfect the bar, one to make it famous - is the founding template of consumer marketing [C23][C20]. P&G's profit-sharing plan for workers began in 1887, decades before the welfare state, for the same reason Port Sunlight was built: loyalty, like soap, could be manufactured [C24][C16].

The floating bar was aimed, with Procter's usual precision, at a real frustration: the cake of soap lost in the murk of the bathwater. Whipping air into the soap until it bobbed solved the problem so neatly that the feature became the slogan - It Floats, first advertised in 1891 - and the slogan became the brand [C20][C22]. The analysis-backed purity claim and the parlour trick together made Ivory the first soap in America to be sold as a scientific product: tested, measured, certified, and then - the masterstroke - made to perform a little miracle in the bath [C21][C22].

The firm's own origins were a marriage - literally - of the two raw materials. In 1837 in Cincinnati, William Procter, an English candlemaker, and James Gamble, an Irish soapmaker, were persuaded into partnership by their father-in-law, who pointed out that they had married sisters and competed for the same lard [C23]. Cincinnati was pork-packing country, and the partnership sat on top of the river of fat the packers left behind: candles and soap, light and cleanliness, from the same slaughterhouse stream [C23].

Ivory did more than sell. It demonstrated that a soap could be a national brand - advertised in magazines, analysed in laboratories, sung about, trusted across a continent - and its maker built the machinery of modern marketing on the foundation: profit-sharing for workers from 1887, national factory networks, and eventually the first great soap operas, which we will come to [C24]. The bar itself had a long twilight: P&G quietly discontinued the floating version in 2023, after 144 years, and the current Ivory no longer floats - a small, unmarked ending for one of the most famous product features in history [C20]. But the white bar with the biblical name had already done its work. It taught the world that soap could be an idea.

CHAPTER 15

The hygiene crusade

Lever's second great brand was not about clean clothes but about staying alive. Lifebuoy Royal Disinfectant Soap launched in April 1894 at fourpence a pound: a hard red bar loaded with carbolic acid, the disinfectant Joseph Lister had made famous in the operating theatre, and the advertising told people to scrub everything with it - toilets, floors, windows, and also hands, face and body [C18]. The name and the lifeboatman on the pack said the quiet part out loud: this soap was protection; this soap saved lives [C18]. In the First World War, wives and girlfriends were encouraged to post it to the trenches. In 1926 Lever Brothers launched a Clean Hands Campaign in primary schools - children kept hand-washing charts, won gold stars on Mondays and, after a month, a small badge with the Latin motto Pro Valetudine, For Health. The campaign's stated objectives were admirably honest: to encourage cleanliness among children, and to create a potential market for soap [C18]. In the 1930s Lifebuoy gave the English language a new anxiety: its advertisements coined the phrase B.O. [C18].

The crusade had an older, prettier face too. Pears - the transparent amber soap perfected by Andrew Pears, a Cornish barber who had opened his Soho premises in 1789 and was making his gentle, delicately perfumed bar by 1807 [C10][C4] - owed its Victorian fame to Pears' son-in-law Thomas J. Barratt, who took over its promotion in 1865 and has a fair claim to be the inventor of modern advertising [C4]. Barratt put the actress Lillie Langtry's face on the brand in 1882 - the first celebrity endorsement of a commercial product [C4] and then did something bolder still: he bought a painting. In 1886 Sir John Everett Millais exhibited A Child's World: his small grandson gazing up at a soap bubble, life and death arranged in pots beside him in the old Dutch vanitas manner. Barratt bought the canvas and the copyright for £2,200, asked Millais's permission to add a bar of Pears soap to the picture, and put one of the most famous images in British art on a soap advertisement [C25]. The outcry was immediate - the novelist Marie Corelli accused Millais of prostituting his talent to sell soap - and the argument about art and advertising has never really stopped since. The boy in the painting grew up to be an admiral, and was known as Bubbles for the rest of his life [C25].

America had its own crusader. In Milwaukee, the B. J. Johnson Soap Company - founded 1864 - brought out a soap made entirely from palm and olive oils in 1898 and named it plainly for its ingredients: Palm-Olive, then Palmolive, the soap so popular it swallowed the company's own name [C10][C40]. The same half-century produced Colgate's Cashmere Bouquet, the first milled perfumed toilet soap, registered as a trademark in 1872 [C40], and then Lux, Camay and a hundred others, until the bathroom shelf looked like a library of tiny branded promises [C16][C28].

The crusade's strangest legacy is linguistic. Lifebuoy's 1930s advertising, hunting for a way to talk about the unmentionable, coined the abbreviation B.O. - body odour - and put a new private anxiety into the public language, to be sold back to its owner at threepence a tablet [C18]. The pattern repeats across the whole shelf of the century: first the fear is named, then the soap that answers it. Yet the same machinery did unambiguous good on the other side of the ledger - the Clean Hands Campaign's charts and gold stars taught hand-washing to a generation of primary-school children as a game, complete with a Pro Valetudine badge for a month of clean hands [C18]. Modern public-health people would call it social marketing. Lever called it, with perfect frankness, creating a market [C18].

Pears' own secret was transparency, and transparency was a manufacturing philosophy: purer ingredients, closer attention at every stage, a delicate perfume of flowers - the process Andrew Pears perfected in Georgian London has remained, in its essentials, substantially unchanged to this day [C10]. The amber bar was aimed with surgical precision at its market: the upper classes, who associated tanned faces with outdoor labour, wanted a soap gentle enough for alabaster complexions already damaged by the harsh soaps of the age [C10]. It is the first clearly documented case of soap sold as skincare - two centuries before Dove built an empire on the same promise.

What the crusaders sold hardest, in the end, was frequency. The great insight of the hygiene century was that soap was a repeat purchase limited only by habit - and habit could be manufactured like glycerine. The charts, the badges, the trench parcels, the film stars, the B.O.: all of it aimed at moving the bar from the weekly washday to the daily ritual [C18]. Public health got its cleanest century out of the bargain, and the balance sheet got the rest [C18].

The market Pears entered explains the product. His first trade, from the Soho premises he opened in 1789, was in rouges, powders and the other preparations the rich used to cover up

the damage caused by the harsh soaps of the time - and his insight was that a purer, gentler soap would remove the need for the cover-up [C10]. The customers associated tanned faces with the lower orders who worked outdoors; what they wanted was an alabaster complexion and a soap delicate enough to preserve it [C10]. Pears gave them purity, perfume and transparency - and, a generation later under Barratt, the most famous advertising in the world [C10][C4].

Lifebuoy itself kept climbing the social ladder it had disinfected. The hard red carbolic block was joined in 1933 by a Lifebuoy toilet soap - the disinfectant brand moving from the scullery to the washbasin, from killing germs on floors to guarding complexions [C18]. The hygiene crusade had begun by frightening people into washing; it ended by inviting them to enjoy it [C18].

What the crusade sold, underneath the carbolic and the celebrity, was a new idea of the ordinary. Cleanliness had been a luxury of the taxed centuries; the brand age made it a duty - and a purchasable, scented, attainable one. Some of the selling was fear (germs, odour, social ruin), some was beauty (Bubbles, film stars), and some was genuine public health. The same posters that moved soap taught a generation to wash its hands. Commerce and hygiene marched together so closely that by the 1920s the soap companies needed a bigger stage than posters, and they found it in the newest box in the house: the radio.

CHAPTER 16

The soap opera

In 1930, a young writer named Irna Phillips walked into Chicago radio station WGN with an idea: a fifteen-minute domestic serial, broadcast in the daytime, aimed at the millions of women doing housework. Painted Dreams premiered on October 20, 1930, and scholars generally count it as the first true soap opera - though nobody called it that yet [C27]. The name came from the sponsors. Procter & Gamble, sitting on America's largest soap business, worked out that daytime radio reached exactly the audience that bought soap: women at home, with the wash to do, lonely for voices. The serials would carry them through the washboard, and the soap would pay for the serials [C28].

P&G went at it with industrial thoroughness. The company sponsored Ma Perkins, a serial about a widowed lumberyard owner in a small Southern town, from its own Cincinnati station WLW in August 1933; by December it was on NBC nationwide, and it ran for twenty-seven years - 7,065 episodes, every one of them starring the same actress, Virginia Payne [C28]. The bond between show and soap was so tight the programme was often announced as Oxydol's Own Ma Perkins [C28]. Phillips herself went on to create The Guiding Light in 1937 for P&G's White Naphtha Soap; it moved to television in 1952 and ran, in one form or another, for seventy-two years - the longest story ever told by a single continuous production [C28][C27].

The formula was a manufacturing formula as much as an artistic one. Open narrative - no story ever quite ends, each episode promises the next. Family interiors, emotional and moral conflicts, cliffhangers. Long scenes and long conversations, which cost little to produce and let a daily serial fill an hour with atmosphere [C27]. The audience became the most loyal in broadcasting: by 1976 Time magazine called daytime television the industry's richest market, profitable where prime time was not [C27].

The economics were as elegant as they were cynical. Daytime serials were cheap to make - long scenes, standing sets, rotating storylines - and the audience they aggregated was the most loyal in the history of broadcasting: fans followed their stories for decades, through generations of characters [C27]. When television arrived the format walked across unchanged: The Guiding Light began on radio in 1937, simulcast on television from 1952,

and finally went silent in 2009 - seventy-two years, 18,262 episodes, the longest-running drama in the Guinness Book of Records [C28]. Its creator Irna Phillips, the schoolteacher's daughter from Chicago who had launched the whole form with Painted Dreams, ended up the matriarch of an industry - and her industry's name never let the world forget who paid for it [C27][C28].

Britain's versions outran even America's. The Archers - an everyday story of country folk - has been broadcast on BBC radio since 1950 and is the world's longest-running soap opera of any kind; Coronation Street has run on ITV since 1960 [C27]. Neither was ever sponsored by soap; the name arrived with the format and stuck, the way brand names do when they have colonised the language - a fossil of the sponsorship, embedded in the word itself. The genre's own definition carries the history: a continuous open narrative, each episode ending with a promise to continue - exactly the structure that once kept the Oxydol moving off the shelf [C27].

The form's longevity invites one more reflection. A soap opera never ends - that is its defining feature, its economics and its joke - and in that it is the exact narrative form of the product that sponsored it: soap too is a daily serial, used up and repurchased, the same episode performed at the sink every morning forever [C27]. The sponsorship was not an accident of marketing history. It was a meeting of two continuous dramas, each selling repetition to the same audience, each perfectly understood by the other.

Irna Phillips' own career is the bridge between the two worlds of this book's middle sections: a Chicago teacher-turned-writer invents the domestic serial in 1930, watches it become the sponsor's instrument, and ends up creating the longest-running drama in human history [C27][C28]. The Guiding Light's final episode aired in 2009; somewhere in the seventy-two years between its first radio broadcast and its last television one, the sponsorship that named the genre faded entirely from view, and only the name remained - the soap in soap opera, fossilised in the language like salt in the curd [C28].

P&G had been rehearsing the act even before the serials. From 1927 the company sponsored a daytime Radio Beauty School for Camay, teaching skincare to the same audience the serials would soon hold for decades [C28]. And when the end came it was datable to the day: network daytime radio drama died on November 25, 1960, killed by the television the soaps themselves had helped build [C28]. The serials walked across to the new box almost unchanged - the sponsor's money walked with them [C28].

And the name outgrew the sponsor. The British took the format and made it their own - The Archers, on BBC radio since 1950, is the world's longest-running soap opera of any kind; Coronation Street, on television since 1960, its evening counterpart - though no soap company ever sponsored them [C27]. The phrase soap opera became a joke about melodrama, and then simply a genre, and the joke's origin faded from view. But think about what the name records. For a quarter of a century the most successful storytelling machine on Earth - the daily serial, the continuing drama, the form in which the modern world learned to follow fictional lives - was financed by the sale of bars of soap. The soap bought the stories because the stories sold the soap, and both were aimed, with deliberate precision, at the person standing at the sink. The industry understood before anyone else that whoever washes the household's dishes is an audience, and deserves art - or at least deserves Oxydol's Own Ma Perkins.

PART V

The Detergent Turn

CHAPTER 17

The synthetics arrive

For five thousand years the word soap meant one thing: fat plus alkali. The formula had survived empires, taxes and two industrial revolutions essentially unchanged, as the American Cleaning Institute's own history concedes - until 1916 [C1]. What broke it was, once again, a war. Germany in the First World War was blockaded and starving for fats; the same fats that fed soldiers fed soap kettles and glycerine plants, and glycerine fed the explosives industry [C1][C10]. German chemists went looking for a cleaner that needed no fat at all, and found one in the products of coal tar: German Patent 336558 disclosed the alkylation of naphthalene with alcohol followed by sulphonation, and the first commercial synthetic detergents - the Nekal products, sold as textile wetting agents - came out of it in 1917 [C30]. Nekal could not clean much, but it lathered in hard water, where soap dies in scum, and that was the crack in the dam.

Between the wars the chemistry matured. Fatty alcohols made by hydrogenating fatty acids gave the Igepons; the first household synthetic detergents, Drene and Dreft, reached American shops in the 1930s, with Colgate's Vel following in 1938 [C30]. Then came the workhorse molecule of the century: alkyl benzene sulphonate, built from kerosene and benzene by the Friedel-Crafts reaction - cheap, fierce, foamy, and indifferent to hard water [C30]. After 1945, with oil plentiful and washing machines multiplying, the synthetics took the laundry. Procter & Gamble's Tide, launched in 1946, carried the synthetic surfactant into the laundry room [C32]; boosted by the phosphate builders introduced in the 1930s, the new detergents washed so much better than soap that within a decade the age-old bar had largely surrendered the washday [C31]. By the end of the 1950s, synthetic detergents - syndets - had largely replaced soap as the washing agent of the developed world [C31].

The German lead was real but the spoils were American. I. G. Farben's Igepon T - a sulphonated fatty-acid derivative - appeared around 1925, and the hydrogenation of fatty acids to fatty alcohols soon gave the industry a second family of synthetics; Procter & Gamble's Dreft, the first light-duty synthetic for the American home, arrived in the 1930s, and Colgate's Vel in 1938 [C30]. In Germany the wartime brands like BASF's FEWA kept the technology alive through the blockade years [C31]. But it was the combination of cheap post-war petroleum, the converted aviation-fuel plants turning out tetrapropylene for the

alkyl benzene sulphonates, and the automatic washing machine multiplying in the suburbs that made the 1950s the syndet decade [C31]. Soap had owned the wash for five millennia; it lost it in fifteen years.

The reckoning, when it came, arrived as foam. The branched alkyl benzene sulphonates of the 1950s were, in the words of one environmental history, unresponsive to wastewater treatment, and their release into streams and rivers produced floating flotillas of foam - persistent, wind-borne, unmistakable [C36]. Public pressure did the rest: the manufacturers re-engineered the molecule itself, straightening the branched chain into a linear one that sewage bacteria could digest, and the foam fleets vanished from the rivers [C36][C31]. It was the detergent industry's first environmental defeat, and its most instructive one: chemistry that cannot rot has nowhere to go.

The washing machine sealed it. Soap's ancient liabilities - scum in hard water, poor rinsing, the grey deposit on fabric - were tolerable when washday meant a tub and a washboard; the automatic machine demanded a product that dissolved instantly, rinsed freely and left nothing behind, and the syndets were built to exactly that specification [C31]. The machine also multiplied the stakes of the builder problem: more machines, more loads, more phosphate down more drains - the straight line from the laundry room to Lake Erie that a later chapter follows to its courtroom end [C36].

The builder's history runs parallel to the surfactant's. The earliest were washing soda and waterglass - plain sodium carbonate and silicate; phosphates arrived in the 1930s and reigned until the lakes objected [C31]. The modern box is a formulation pyramid: roughly half builder by weight, about fifteen per cent surfactant, then bleach, enzymes and a tail of specialists - foam regulators, corrosion inhibitors, optical brighteners, dye-transfer inhibitors, fragrance [C31]. The bar of soap on the basin needs none of it. That contrast - one ingredient versus a dozen - is the whole argument of the detergent century in miniature [C31].

There is even a chemistry of why the builders are alkaline. Cotton fibres carry a natural negative charge in water; anionic surfactants increase it, and raising the pH pushes soil and fibre charges further apart so the dirt is literally repelled from the cloth - the optimum wash sits around pH 9 to 10.5 [C31]. Alkali builders also finish soap's own job, saponifying the last traces of fat on the fabric as the wash runs [C31]. The box on the shelf is, in other words, a tuned little water-treatment plant, and every gram in it has a job description [C31].

The synthetics brought their own reckoning, twice over. The first branched alkyl benzene sulphonates would not biodegrade; sewage works could not digest them, and the foam persisted on rivers until the industry was forced to redesign the molecule itself, switching in the mid-1960s to linear alkylbenzene sulphonates that bacteria could break down [C31]. The second reckoning, over the phosphate builders, deserves its own chapter. But note what the syndet revolution did to soap: it did not kill it. It split its kingdom. Soap lost the laundry and the factory floor to molecules no fat ever made, and retreated to the one province where mildness matters more than muscle: the human skin. The next great soap war would be fought in the bathroom, and it would be fought over pH.

CHAPTER 18

One quarter cleansing cream

The postwar skin was a battlefield of chemistry. Ordinary soap, for all its mildness, is alkaline - a good toilet soap sits around pH 9 to 10 - and dermatologists had begun to argue that alkalinity stripped the skin's protective acid mantle. Lever Brothers' answer, launched in the United States in 1955, was not technically soap at all: Dove, a beauty bar built on a patented blend of mild synthetic cleansers and moisturising cream, advertised with a promise that abandoned cleanliness entirely - one quarter cleansing cream - and an explicit attack on the older product: Dove won't dry your skin like soap can [C33][C37]. The advertising was David Ogilvy's work: he had interrogated Lever's product people for a point of difference and discovered that stearic acid - the more technical name for the cleansing cream - was the bar's key ingredient, and he built the campaign on that demonstrable fact [C33]. It worked. Dove became one of the great brands of the century, the first big success of what the industry came to call the beauty bar or syndet bar, and an early pioneer of real-women testimonials in the late 1960s [C33]. Fifty years on, its campaigns were arguing not about soap at all but about the definition of beauty itself [C33].

The second revolution of the era was about form, not formula. In 1980 a small Minnesota firm, the Minnetonka Corporation of Chaska, run by Robert R. Taylor, brought out a product that seems obvious in retrospect: soap as a liquid, in a pump bottle, sold as Softsoap [C34]. Taylor understood that the idea was unpatentable - liquid soap had existed in dispensers for decades - so he did something audacious: he bought up the entire American supply of the little plastic pumps, - a hundred million hand-pumped bottles, a full year's production capacity of the only two domestic manufacturers - so that when the giants inevitably copied him, they would have nothing to copy him with. Within six months he had sold $25 million worth of Softsoap; in 1987 he sold the brand to Colgate-Palmolive, and the pump bottle went on to define a category [C34]. The bathroom bar began its long retreat; by the 1990s the pump bottle had conquered the kitchen sink and was besieging the basin.

Softsoap's afterlife belongs to the same story. Colgate-Palmolive, having bought the brand in 1987, turned the dispenser itself into a toy - the aquarium bottles with tropical fish suspended in the plastic became a small classic of package design [C34]. Taylor, meanwhile, had shown the whole industry that the package could be the product: the pump

was the innovation, the soap inside was almost an afterthought. It is the final twist of the brand age Lever began: a century after the name and wrapper became more important than the soap, the dispenser became more important than both.

Dove's campaign machinery deserves a footnote of its own, because it invented a genre. From 1959 to 1968 the advertising centred on the Dove Face Test - the face, research had concluded, was the gold standard of skin care, and the commercials challenged women to wash half their face with soap and half with Dove and feel the difference [C33]. By the late 1960s the actresses were gone, replaced by real women's testimonials - decades before authenticity became the industry's favourite word [C33]. The bar that began as an attack on soap ended up, fifty years later, running campaigns about the definition of beauty itself: the largest distance any soap-adjacent product has ever travelled from the washtub [C33].

The bar began its life in deepest secrecy. Dubbed Product X in early 1953, it was shepherded to market by Lever with the campaign built at Hewitt, Ogilvy, Benson and Mather - David Ogilvy's own agency - which found the point of difference in the chemistry itself and launched the first advertisements in 1955 [C33]. The rest of the story this chapter has told - the quarter cleansing cream, the Face Test, the real women - all flows from that founding decision to let an ingredient do the talking [C33].

The patent behind the bar, granted in 1957, made the counterintuitive promise explicit: a cleansing bar that rinsed cleaner than soap itself [C37]. Think about that as a marketing position. The product's founding claim was that the oldest word in its category - soap - had become the thing to beat; the newcomer would wash you better by not being soap at all [C37][C33]. Lever had spent seventy years building the meaning of soap. Dove built itself on hollowing that meaning out - and the rest of the industry's late century followed [C37].

The third movement of the century was a retreat of a different kind: the antimicrobials. From the 1970s, soap makers increasingly dosed bars and liquids with antibacterial agents, above all triclosan, and sold the reassuring claim that ordinary soap was not enough. In 2016 the US Food and Drug Administration called time: manufacturers had never provided data to show that nineteen such active ingredients, triclosan and triclocarban among them, were both safe for daily long-term use and any more effective than plain soap and water, so they could no longer be marketed in consumer antiseptic wash products - bars, liquids, foams and body washes alike [C35]. After a century of escalation - carbolic soap, medicated

soap, antibacterial soap - the regulator's verdict landed like a small vindication of the entire history of this book: plain soap and water, used properly, was enough all along.

CHAPTER 19

The lake that aged fifteen thousand years

The synthetic detergent's dirty secret was not the surfactant but the builder. Hard water sabotages cleaning: calcium and magnesium ions tie up the surfactant and precipitate scum, so detergent makers added a builder to seize those ions first - and the best builder anyone found was phosphate, in the form of sodium tripolyphosphate, cheap, safe in the box and brilliant in the wash [C36]. By 1959 essentially every laundry detergent in the United States was 30 to 50 per cent phosphate builder; by 1967 detergents averaged 9.4 per cent phosphorus by weight, and the enzyme pre-soaks ran to 17 [C36]. The wash had never been whiter. Neither, it turned out, had the rivers been greener.

Phosphorus is the limiting nutrient of fresh water: algae are starved for it, and one pound of phosphorus can grow seven hundred pounds of algae [C36]. Every load of laundry sent its builder down the drain, secondary sewage treatment removed only a little of it, and by the mid-1960s America's lakes were visibly dying - ten thousand public lakes damaged by nutrient enrichment, the process that naturally takes tens of thousands of years compressed into decades [C36]. Lake Erie was the symbol: it had, in the words of a 1970 congressional report, aged 15,000 years in the last fifty. Twenty thousand pounds of phosphorus a day flowed in; algal mats carpeted the shoreline; a 2,600-square-mile area of the lake had no oxygen within ten feet of the bottom; the whitefish, blue pike and walleye had collapsed or vanished [C36]. Half of the phosphorus reaching Erie and Ontario came from municipal and industrial waste, and 50 to 70 per cent of that from detergents [C36]. The housewife's washday had become a lake problem.

What followed, between 1970 and 1972, was one of the great environmental fights of the century - and one of the strangest. The science converged early: a 1971 symposium of limnologists settled that phosphorus input did control algal growth in most rivers and lakes [C36]. Canada simply acted, capping detergent phosphorus at 8.7 per cent in 1970 and 2.2 per cent by the end of 1971 [C36]. In America the industry - Procter & Gamble, Lever Brothers and Colgate-Palmolive, about 80 per cent of the market - promised cooperation and invested heavily in a substitute builder, NTA; then, in December 1970, the Surgeon General asked manufacturers to suspend NTA over cancer fears, leaving the industry with no replacement and every incentive to fight [C36]. The fight reached its surreal peak on

September 15, 1971, when the EPA, the Council on Environmental Quality and the Surgeon General - leaned on through a secret White House industry council - held a press conference urging consumers to keep using phosphate detergents and local governments to drop their bans; the very next day the New York Times published an FDA study finding some phosphate detergents as hazardous as the caustic phosphate-free ones the officials had warned against [C36]. Lever Brothers promptly ran advertisements quoting the Surgeon General's advice to use phosphate detergents [C36].

Congress was not amused. Hearings extracted the admissions - only a small fraction of phosphate-free detergents were caustic, and 32 of 50 states had eutrophication problems - and congressmen accused officials of inventing a false choice between polluting the water and injuring children [C36]. The industry's constitutional challenges to local bans failed in court after court. The patchwork it feared arrived anyway: by the mid-1980s New York, Michigan, Indiana, Vermont, Minnesota, Chicago and others had banned or capped detergent phosphates, and the reformulated boxes quietly followed - by 1993 Tide itself came in two versions, one with 10.9 per cent phosphorus and one with zero, depending on the laws of the state where it was sold [C36]. And Lake Erie recovered: within a generation you could swim there without slipping on mats of green slime [C36].

And note what the phosphate war was not. It was not a consumer panic or an activists' crusade - the environmental movement's organisations were still infants, and Earth Day itself fell mid-battle, in April 1970 [C36]. The issue was raised by the public and by public officials, fought through congressional hearings and courtrooms, and settled by local law. In the prehistory of modern environmentalism, the first great victory over a mass-market chemical was won by housewives, limnologists and municipal councils, over the dishwater [C36].

The industry's own numbers mark the scale of the retreat. Non-phosphate detergents, fourteen per cent of the market at the height of the scare, slid back to three or four per cent by 1988 as tertiary sewage treatment came online and the pressure eased - but the legal caps stayed, and stay [C36]. Pennsylvania's act, to take one late example, bans phosphate outright in cleaning agents across the Susquehanna and Lake Erie watersheds while permitting dishwashing detergents up to 8.7 per cent phosphorus - a bureaucratic fingerprint of the original compromise [C36]. The box of Tide with its state-dependent phosphorus

content - 0.0 or 10.9 per cent, depending on where it is sold - is the whole history printed on cardboard [C36].

The phosphate war taught the cleaning industry a lesson it has had to keep relearning - that the wash does not end at the drain. It also left a permanent mark on the product: modern detergents are built with zeolites, citrates and polycarboxylates precisely because phosphates were driven out, and phosphorus content is regulated across North America, Europe and Japan to this day [C31]. The bar of soap watched all this from the basin, innocent for once: plain soap needs no builder at all.

PART VI

The Machine Room

CHAPTER 20

How a bar is born

Stand in a modern soap works and the first surprise is the quiet. The romance of the industry - the open copper, the soap-boiler with his paddle and his taste-test for bite - belongs to the kettle age, which ran, in America, from colonial days to the 1940s: fats, oils and caustic soda piped into huge kettles and brought to a brisk boil, then left to cool for days before salt was thrown in to split the batch in two, neat soap rising on top, spent lye and water below [C29]. The neat soap went to a closed mixing tank called a crutcher to take its builders, perfumes and extras, and then out to be flaked, cast, milled into bars or spray-dried to powder [C29]. A kettle boil was a week's work for a batch; the whole craft was in knowing the soap by look, feel and tongue.

The modern plant has abolished the wait. Since the 1940s the dominant route has been continuous: fats are split directly by water at high temperature into fatty acids and glycerine, the fatty acids are fractionated so a maker can choose exactly which chain lengths go into the soap, and the acids are neutralised to soap in a continuous stream - close control of concentration, tailor-made soaps, easy glycerine recovery [C29]. The industry that began with a Babylonian pot now runs on reactors and vacuum dryers. A modern plant - the Italian firm Ballestra's brochures give the flavour - is a sealed loop: a continuous saponification reactor feeding straight into a vacuum drying chamber that flashes off water and drops the soap out as dry noodles, two to thirty tonnes of neat soap an hour, the condensed vapours recovered and recycled, almost no effluent, changeover between formulas measured in minutes [C38].

The noodles are the raw stock of every bar you have ever used. What turns noodle into bar is the finishing line, and here the vocabulary has barely changed in a century: amalgamator, roll mill, plodder, cutter, stamper [C38]. The noodles are mixed with their perfume, colour and extras in the amalgamator; passed through roll mills - great steel rollers that knead and homogenise the soap the way a pasta machine kneads dough, over and over until the structure is uniform; then driven to the plodder, a giant screw that compresses the soap under vacuum and extrudes it as a continuous gleaming billet [C38]. The billet is cut into blanks, and the blanks go to the stamper - the same machine, in essence, that stamped

SUNLIGHT into Lever's first bars in 1884 - to be pressed into shape with the brand's name on its face [C38]. From fat to finished bar is now a matter of hours.

If the bar is the aristocrat of the works, the powder is its proletariat, and it is made by violence: detergent slurry pumped to pressures up to a thousand pounds per square inch, atomised through nozzles at the top of a tower forty to a hundred and twenty-five feet tall, and met by a rising column of air heated to 400 degrees - the droplets drying into the familiar hollow granules before they reach the floor [C29]. The process is so energetic that the industry had to invent its own air-cleaning along the way: cyclones and scrubbers on every tower, recovering ninety per cent or more of the powdered product from the exhaust and returning it to the crutcher [C29]. Nothing is wasted in a soap works. It cannot afford to be: the margins of cleanliness have always been measured in pennies per hundredweight.

The kettle age deserves its eulogy before the machines take over. For centuries the soap-boiler was a recognised master of sensory quality control: he judged the boil by the look of the curd, the feel of a cooling sample, the bite on the tongue - the same tests Sally Pointer used on her experimental lye, because they are the tests the material itself imposes [C3]. The great works of the nineteenth century ran kettles holding tens of thousands of gallons, boiled for days, separated with salt, settled, pumped and re-boiled, a batch rhythm older than the factories that housed it [C29]. Continuous processing did not improve the chemistry; the chemistry was finished in 1823. What it improved was the repetition - the thousandth batch identical to the first [C12][C29].

Milling is worth a pause, because it is why a modern bar feels the way it does. A cast bar, simply poured and cooled, is serviceable; a milled bar - rolled and re-rolled, plodded and re-plodded - is denser, longer-lasting, smoother on the skin, and holds its perfume evenly to the last sliver. French milled on a wrapper is a boast about machinery: the soap has been through the rollers enough times to change its character. The great export of the nineteenth century was the idea that soap could be made uniform; the finishing line is where uniformity is literally pressed in. Every bar that leaves the works is identical to its million siblings - the kettle-man's art, with its tastes and superstitions, reduced to set-points and screw speeds. Something was gained on every bathroom shelf in the world, and something - ask the soap-boilers of Nablus, where at least five factories still work on of the thirty that supplied half of Palestine's soap in 1907 - was lost [C6].

CHAPTER 21

The sweet principle of fat

Every batch of soap is two products. When fat meets alkali, three fatty-acid tails are stripped from their glycerol backbone: the tails become soap, and the backbone becomes glycerine - about a tenth of the fat's weight, dissolved quietly in the kettle liquor [C39]. For most of soap's history nobody knew it was there. The man who found it was Carl Wilhelm Scheele, the Swedish apothecary-chemist, who in 1779 was heating olive oil with litharge - lead monoxide - and isolated a clear, sweet, viscous liquid he called the sweet principle of fat; by 1783 he had shown the same substance forms whenever fats are worked with metals and alkalis, that is, in every ordinary batch of soap [C39]. Chevreul, who understood what Scheele had found, renamed it in 1811 from the Greek glykys, sweet, and in 1823 took out the first patent for a fat-splitting process that recovered the glycerine released along the way [C39].

Glycerine turned out to be one of the most useful substances in the industrial world: a clear, odourless, hygroscopic syrup, virtually non-toxic, a trihydric alcohol that behaves politely in almost any mixture - the trade literature credits it with more than 1,500 known end uses, from foods and drugs to urethane foams [C39]. It is in your toothpaste, your cough mixture, your wine and bread (it occurs naturally in fermentation), your skin cream, where it works as a humectant holding water against the skin [C39]. And for a century its grandest use was the one that killed people. Alfred Nobel spent twenty years taming nitroglycerine, and in 1866 succeeded in stabilising the explosive by absorbing it on kieselguhr: dynamite [C39]. Dynamite was glycerine's first worldwide technical application, and it remade the material landscape - mines, railways, tunnels, the Panama Canal, which alone consumed about 8,000 tons of the explosive, the glycerine-equivalent of some 4,000 tons [C39]. The soap kettle had become, without anyone quite intending it, an armaments supplier. The trade still sells a grade called dynamite glycerine, specified since the days of Nobel's own explosives company [C39].

This is why the salt separation in the kettle process matters so much: the spent lye drawn off the bottom of a soap kettle is a glycerine mine. Concentrated in desalting evaporators it becomes soap lye crude, eighty per cent glycerol, and alongside it the sweetwater of modern fat-splitting yields saponification crude at eighty-eight per cent - the two raw streams from

which all refined glycerine begins [C39]. In the twentieth century the recovery of glycerine became one of the economic pillars of soap-making; in wartime, when explosives demand soared, it became a strategic pillar, which is precisely why blockaded Germany in 1914 needed a soap that needed no fat [C1][C39].

The war turned glycerine from by-product to strategy twice over. When the First World War choked off fats, it choked off the explosives supply with them - nitroglycerine is glycerine nitrated, and glycerine came from the soap kettle - which is precisely why the German chemical industry was driven to invent fat-free detergents in 1917 [C1][C30]. The interdependence ran the other way too: when soap boomed, explosives cheapened. Gladstone repealed the British soap tax in 1853, and the very same year Nobel's dynamite - glycerine's first great outlet - began turning the soap-maker's waste liquor into the most valuable by-product in the chemical world [C10]. Peace and war, bath and battlefield, all drawing on the same sweet tenth of the fat.

Nature, of course, got there first. Glycerine is a component of every living cell, locked into the triglycerides that make up virtually all animal and vegetable fat; it occurs naturally in wine, beer and bread - anywhere fermentation runs [C39]. The soap kettle merely liberates what the seed and the steer had stored. Even its name is a courtesy to the tongue: Chevreul took it from the Greek glykys, sweet, because Scheele's sweet principle tasted exactly as advertised [C39]. Few industrial chemicals can be described honestly as non-toxic, edible, moisture-loving and explosive-adjacent; glycerine's fifteen hundred documented uses run from cough syrup to polyurethane foam [C39].

The kettle's loss was the refinery's gain. Once glycerine had markets, the economics of soap-making quietly inverted: the spent lye stopped being a disposal problem and became a second product line, concentrated in desalting evaporators to soap-lye crude at eighty per cent, then refined to the grades the pharmacopoeias demand [C39]. Modern fat-splitting made the capture cleaner still - the sweetwater from high-temperature hydrolysis concentrates to eighty-eight per cent crude, richer than the kettle ever gave [C39]. A soap works of 1900 was, in truth, a glycerine works with a soap sideline, and in wartime everyone knew which product the government cared about [C39][C1].

There is a pleasant coda. The handmade-soap revival of our own century has put glycerine back where Scheele found it: inside the bar. Industrial bars have the glycerine washed out and sold; a cold-process artisan bar keeps it, which is why such bars feel gentler and weep

beads of moisture in humid air - the humectant at work. And glycerin soap, the transparent kind, is soap deliberately prevented from crystallising so you can see through it: the descendant of Pears' amber bar of 1807 [C4]. The sweetest part of the fat, it turns out, was never a by-product. It was half the point.

CHAPTER 22

The fat of the land

Underneath every soap story in this book runs a commodity story, because soap begins as agriculture. For two thousand years the northern world's soap fat was tallow - rendered beef and mutton fat, the by-product of the butcher and the dairies - and the trade in it was colossal: the Tallow Chandlers' records put modern world production at seven to seven-and-a-half million tonnes a year, with some two million tonnes traded across borders, a river of fat flowing from the grasslands of the Americas and Australasia to the soap works of the world [C73]. Rendering - the controlled cooking that separates clean fat from tissue - is one of the oldest industrial arts, and its product fed three industries at once: candles, soap and, through the glycerine, explosives [C73][C39]. A nineteenth-century soap works was really a node in the global meat economy.

The twentieth century changed the fat map twice. First came the tropical oils: coconut and palm kernel, whose short-chain fatty acids make a hard, quick-lathering soap, and palm oil itself, which gives a bar its mildness and stability [C41]. By 2008 palm and palm kernel oil together accounted for 48 million tonnes - thirty per cent of all the world's oils and fats - and close to sixty per cent of everything traded [C41]. Then came the laboratory: the continuous fat-splitting plants of the modern industry no longer care, within wide limits, which fat arrives at the gate, because they strip every feedstock down to its fatty acids and rebuild the soap to specification [C29]. The bar became agnostic. What the recipe card said for four thousand years - this fat, that ash - the twentieth century replaced with a specification sheet.

The tallow trade had its own geography of power. Britain's chandlers and soap-boilers drew on imports from Russia, the Americas and later Australasia, and the Tallow Chandlers' Company - a guild older than the steam engine - still records the tonnages with pride: world tallow production of seven to seven-and-a-half million tonnes, exports around two million, a significant share still destined for the fatty-acid plants that feed soap [C73]. Rendering turned a waste into a commodity; the soap kettle turned the commodity into a civilisation. When you read that a Victorian city smelled bad, remember that a good part of the smell was its cleanliness being manufactured [C73][C10].

Stand back and the pattern is geological. Each era's soap maps its era's fat: the Mediterranean on olive, the north on tallow, the industrial age on whatever the colonies grew, the global age on palm. The feedstock decides more than the recipe - it decides the colour, the hardness, the lather, the price, and increasingly the politics [C8][C73][C41]. When a modern soap-maker chooses a fat, he is choosing a landscape on the far side of the world, and the bar in the dish is that landscape, rendered.

The trade routes inside the fat economy have their own hierarchy. Of the sixty million tonnes of oils and fats exported around the world in 2008, palm and palm kernel made up close to sixty per cent - and Malaysia alone held forty-five per cent of that trade [C41]. The soap-boiler of 1800 worried about the Russian tallow fleet; his modern successor watches the Strait of Malacca [C41][C73].

Yet the old geographies persist in the corners of the market that value them. Olive oil still commands the Mediterranean bars; tallow still anchors the classic English hard soap; coconut still lathers the tropical brands; and the artisan revival has made feedstock a manifesto - this farm's olives, that region's laurel, no palm at all [C8][C6][C51]. The fat of the land turns out to be like the land itself: you can industrialise it, globalise it and standardise it, but people keep reading the label for the name of a place. The whole of the next chapter is about why.

CHAPTER 23

The palm question

Every modern bar carries a geography inside it, and increasingly that geography is Southeast Asian. The soap-makers' fat problem - the eternal search for cheap, hard, reliable fat - found its modern answer in the oil palm: a West African tree carried to the Far East, yielding more oil per hectare than any rival, and today produced to the tune of 77 million tonnes a year, 57 per cent of it in Indonesia and most of the rest in Malaysia, Thailand and Nigeria [C41]. Palm oil formed the basis of Sunlight and of Palmolive from the very start - the brands were named for it [C41] - and it now provides the foaming agent in nearly every soap, shampoo and detergent sold; around 70 per cent of personal care products contain palm-derived ingredients, hidden behind more than two hundred ingredient names of which barely a tenth include the word palm [C41]. Malaysia built a world-class oleochemical industry on the feedstock - a fifth of global capacity - turning palm and palm kernel oil into the fatty acids and glycerine from which the world's soaps are made [C43]. Even the waste stream is a soap input: palm fatty acid distillate, the free fatty acids stripped out in refining, is itself sold to make soaps and washing powders [C41].

And therein lies the ugliest chapter in this book since the taxman's tub. The oil palm grows where rainforest grows, and the industry has been a significant driver of tropical deforestation: forests cleared in Indonesia and Malaysia for monoculture plantations, biodiversity collapsing behind them, the Sumatran orangutan listed as critically endangered chiefly because of habitat lost to palm cultivation [C41]. The industry's human record has drawn its own allegations, and the modern soap bar - the object this book has watched clean the world - sits at the end of a supply chain that has dirtied a great deal [C41].

The honest complication is the arithmetic. The International Union for Conservation of Nature concluded in 2018 that oil palm is far more efficient than any alternative oil crop in land and water use - the same oil from rapeseed or soy would take far more land - but that abandoning palm for those crops would shift the biodiversity damage elsewhere rather than end it [C41]. Boycott is not obviously conservation. What the world settled on instead was certification: the Roundtable on Sustainable Palm Oil, founded in 2004, now with over 5,600 member organisations in 94 countries, setting standards and certifying sustainable production - over 50 million tonnes of certified fruit by 2016 [C42]. The critics are

unimpressed in both directions: environmental groups note that certified plantations have still drained and burned peatland, and growers who paid for certification complain the market will not pay them back for it [C42]. The Consumer Goods Forum's members resolved in 2010 to reach net-zero deforestation by 2020; as of 2023, they had not [C41].

The deeper history makes the persistence more remarkable. Palm oil is a West African tree; it crossed the Atlantic world early, and in its home regions it is still produced artisanally - fruit boiled and pounded by hand, the red oil sold by the roadside, as it has been for centuries [C41]. The industrial tree is the same tree, selected and planted by the million. Between the Ghanaian roadside bottle and the 77-million-tonne commodity system lies the entire arc of this book: a material that began as a local craft, became an imperial commodity - British traders wanted it first as an industrial lubricant for the machines of the Industrial Revolution - and ended as the invisible fat inside nearly every cleaning product on Earth [C41]. The bar of soap never stopped being agricultural. It just moved its farm.

There is a middle path being pioneered at the commodity's margins. Colombia, where production reached 1.6 million tonnes in 2018 - about eight per cent of national agricultural GDP - grows its palm largely on smallholdings, with sixty-five per cent of the sector in small farmers' hands, and studies suggest the country could expand without deforestation; the crop even serves as a legal alternative to coca [C41]. The lesson is not that palm is good or bad. It is that the same tree can be a monoculture disaster or a smallholder's livelihood, and the difference is governance, not botany. The soap bar does not get to choose its fat - but the people who buy it, certify it and regulate it do [C41][C42].

And the numbers keep climbing. World output was 77 million tonnes in 2023-24; projections see 240 million by 2050 [C41]. Demand growth runs not only through food and soap but through fuel: as of 2018, half of Europe's palm oil imports were being burned as biodiesel - a use that generates three times the carbon emissions of ordinary diesel [C41]. The palm question, in other words, will be asked of every soap-buyer for decades yet. The bar will keep arriving; what changes is whether the forest survives its making [C41][C42].

The market got its own reminder of the dependency in 2022. When the Russian invasion of Ukraine collided with climate-driven crop failures and food prices spiked, the Indonesian government simply banned palm oil exports - the world's dominant supplier, closing the gate - and global prices surged until trading reopened on 23 May 2022 [C41]. A shampoo or a bar of soap in a European supermarket turned out to be downstream of a geopolitical

decision made in Jakarta. The fat of the land has always been political; now it is geopolitical too [C41].

The scale of the dependency is easy to miss because the oil is so often hidden. Palm oil accounted for about 36 per cent of all oils produced from oil crops in 2017, and globally the average person consumed 7.7 kilograms of it in 2015 - before counting a single bar of soap or bottle of shampoo [C41]. It is the world's default fat: the cheapest to grow, the easiest to formulate with, and the hardest to escape [C41].

So the palm question stands exactly where the whole history of soap stands. The material is miraculous and the supply chain is a moral problem, and the bar in your hand does not resolve itself. The most that honesty allows is this: soap has always been made of the world - Babylonian ash, Levantine olives, Merseyside tallow, Congo palms under forced labour, Bornean forest - and buying it is participating in that world. The difference in our century is that the participation is no longer invisible. The names are on the packet, all two hundred of them.

PART VII

Soap and the Body

CHAPTER 24

The doctor who washed his hands

The deadliest place in the nineteenth-century world was not the battlefield; it was the maternity ward. At Vienna's General Hospital in 1847, a young Hungarian house officer named Ignaz Semmelweis noticed something that should have been impossible: the two obstetric clinics under the same roof had wildly different death rates from childbed fever - 16 per cent of mothers dying in one, 7 per cent in the other [C44]. The difference, he worked out, was the people. The first clinic trained doctors; the second trained midwives. And the doctors came to the delivery suite straight from the autopsy room, with - he noted precisely - a disagreeable odour on their hands despite washing with soap and water [C44]. Something was travelling on those hands from the dead to the living. He called them cadaverous particles, and in 1847 - decades before germ theory, before Pasteur and Lister - he ordered every doctor and student to scrub in a chlorinated lime solution before every patient contact [C44]. The mortality in the worst clinic fell from 16 to 3 per cent, and stayed low [C44].

It is the single most important experiment in the history of soap, and its lesson is double-edged. Semmelweis had shown not just that handwashing saves mothers - he had shown that heavily contaminated hands need more than plain soap and water; the chlorinated lime was, in effect, the first clinical antiseptic hand-rub [C44]. And yet the intervention failed the man. His colleagues would not sustain it; the WHO's own historical review, written a century and a half later, diagnoses his mistake with the cool vocabulary of modern social marketing: he imposed a system change without consulting the people who had to live it [C44]. Recognize, explain, act - he had done the first and third and skipped the second. He is remembered now as the father of hand hygiene, and his story as the founding parable of evidence-based infection control - and as a warning that the evidence is never the hard part. The hard part is the hands of other people [C44].

The practice, of course, is older than the proof. The WHO's own historical review notes that handwashing with soap and water was embedded in religious and cultural habits for centuries before anyone knew why it worked - ritual purity anticipating microbiology by millennia [C44]. What Vienna added was the numbers: the first time anyone measured the distance between washed and unwashed hands in units of human lives. It is worth pausing

on the composition of the experiment's tragedy. Semmelweis was not refuted; he was ignored, which is worse. His data stood on the table while his colleagues objected to the implication - that the gentlemen themselves were the vector. Every infection-control professional since has fought the same two battles at once: against the microbe, and against the insult.

The doctrine that emerged has three planks, all descended from the Vienna ward. First, the agent: chlorinated lime then, alcohol-based rubs now, soap and water always - chosen by situation, not fashion [C44]. Second, the method: technique, duration, the parts of the hand everyone misses. Third, and hardest, the system: Pittet's Geneva programme proved that compliance is a property of institutions, not individuals - you do not exhort staff into clean hands, you build the reminders, the placement of dispensers, the audit and the culture around them [C44]. Semmelweis supplied the first plank in 1847. The third took another hundred and fifty years [C44].

The profession took over a century to institutionalise his insight. The first national hand-hygiene guidelines appeared only in the 1980s; in 2002 the US CDC's advisory committee defined alcohol-based hand-rubbing, where available, as the standard of care in health-care settings, with soap-and-water washing reserved for particular situations [C44]. Then came the Geneva revolution: in 2000 Didier Pittet's team at the University Hospitals of Geneva showed that a multimodal strategy - not just the rub, but the whole architecture of reminders, training and culture - could transform compliance and cut hospital infections, durably; the World Health Organization built its global Hand Hygiene Improvement Strategy on that model, piloting it in 2007-8 [C44]. Every poster above every hospital sink on Earth is Semmelweis, institutionalised at last. The chlorinated lime became an alcohol gel; the argument with the colleagues is still going on.

CHAPTER 25

The cheapest vaccine

In March 2020, as the coronavirus closed country after country, a chemistry professor in Sydney named Pall Thordarson posted an explanation of why soap works so well on the virus, and the internet did the rest [C49]. His point was a beautiful one. A coronavirus is a self-assembled nanoparticle whose weakest link is its fatty outer membrane - and soap, the five-thousand-year-old fat-splitter, dissolves that membrane so the virus falls apart, in his phrase, like a house of cards [C49]. You could not buy a drug for the virus at any price; your grandmother's bar of soap killed it. Health authorities found themselves giving two apparently contradictory messages - there is no treatment, and wash your hands - and the resolution of the paradox is this entire book: the oldest chemical technology in the bathroom is one of the most effective public-health tools ever devised [C49].

The numbers have been stable for years and they are startling. Handwashing with soap reduces diarrhoeal illness by 23 to 40 per cent, respiratory infections like colds by 16 to 21 per cent, and school absenteeism from gastrointestinal illness by 29 to 57 per cent; it could protect about one in three young children who get sick with diarrhoea and nearly one in five with respiratory infections like pneumonia [C45]. Preventing those infections also prevents the antibiotic prescriptions that follow them - and antibiotic resistance, the single most important driver of which is overuse, retreats a step [C45]. The WHO's evidence summary reaches the same conclusion for the disease that kills the most children: promoting handwashing with soap is among the most effective interventions against diarrhoea [C48]. No vaccine on Earth covers that breadth. The bar costs pennies.

And yet. In 2024, 1.7 billion people still lacked basic hand-hygiene services at home - soap and water, the whole technology - including 611 million with no facility at all [C46]. The global rate of handwashing after using the toilet has been estimated at 19 per cent [C45]. On Global Handwashing Day in October 2025, WHO and UNICEF issued the first-ever global guidelines on hand hygiene in community settings - homes, schools and public places - framing hand hygiene as a public good and a government responsibility, on the grounds that it reduces diarrhoeal disease by 30 per cent and acute respiratory infections by 17; meeting the 2030 target, they calculated, requires doubling the global rate of progress, and raising it eleven-fold in the least-developed countries [C46]. The State of the World's Hand Hygiene

report puts the quiet catastrophe in one sentence: in 2021, an estimated 2.3 billion people could not wash their hands with soap and water at home [C47].

The microbiology underneath the statistics is worth holding in the mind's eye. A single gram of human faeces - about the weight of a paper clip - can contain one trillion germs; they reach the hands not only in the bathroom but by invisible transfer from raw meat, from door handles, from anything a cough has touched [C45]. Against that scale of contamination, the humblest technology is precisely matched: soap does not poison the germ, it unbuilds it and carries the wreckage away down the drain [C49]. The CDC's phrase for the whole apparatus is telling - clean hands help keep you healthy. Not sterile hands. Not medicated hands. Clean ones, washed the way the Babylonians first worked out.

The campaign machinery has its own centennial history. Clean Hands campaigns in 1920s schoolrooms, Lifebuoy's B.O., wartime posters, television jingles, and now Global Handwashing Day every October 15 - the 2025 guidelines were launched on it, deliberately [C18][C46]. The day itself is a confession: more than a century after Semmelweis, the world still needs an annual festival to remind itself to perform the simplest act in medicine [C46]. The bar of soap is the only health technology with its own international awareness day. It is also the only one that needs it less than the people do.

Consider, finally, what the intervention displaces. The diseases that handwashing prevents are precisely those for which antibiotics are most often unnecessarily prescribed - so every prevented infection is also a prevented course of antibiotics, and the WHO regards that overuse as the single most important driver of antibiotic resistance worldwide [C45]. The bar by the sink is thus quietly fighting the most feared medical threat of the coming century. A vaccine trains the body. Soap keeps the war from starting at all [C45][C49].

The protection runs deeper still where it matters most. In people with weakened immune systems, handwashing with soap cuts diarrhoeal illness by 58 per cent [C45]. For the most vulnerable bodies in the world, the cheapest bar is not a modest intervention; it is the difference between an ordinary week and a hospital admission - and the evidence for it has been sitting in the literature for decades [C45][C48].

And the trajectory, left to itself, does not close the gap. The same report projects that on current rates of progress, 1.9 billion people will still lack a handwashing facility with soap and water at home in 2030 [C47]. The cheapest vaccine in the world is also one of the

slowest to deliver - not for want of science, but for want of taps, pipes and the daily habit [C47][C46].

The facilities gap has a floor, and it is worse than the average suggests. Behind the 2.3 billion without soap and water at home sit 670 million people with no handwashing facility at all - not a broken tap, not a shared one: nothing [C47]. For them the cheapest vaccine is not merely undelivered; the room it should live in does not exist [C47].

So the last great soap story is not about making soap. The making is solved; the bar is cheap beyond the dreams of the taxed centuries. It is about the gap between a technology that exists and a world that has it - the same gap Semmelweis stood in, scrubbing his hands in chlorinated lime while his colleagues walked past. The cheapest vaccine ever invented sits by the sink, unpatented, unbranded, five thousand years old, waiting on the plumbing.

PART VIII

The Business of Clean

CHAPTER 26

The giants

The humble bar is, in aggregate, an enormous business. The global soap market was valued at about $50.7 billion in 2025, with analysts projecting roughly $87 billion by 2034 - a compound growth rate of 6.3 per cent on the most ordinary object in the house [C50]. Bar soap alone - the original form, supposedly doomed by the pump bottle - was a $34.2 billion market in 2025, forecast to keep growing at 5 per cent a year, and the centre of gravity is no longer where the brands were born: Asia Pacific holds about 40 per cent of the market [C51][C50]. The roll of the biggest makers reads like a summary of this book - Procter & Gamble, Unilever, Henkel, Church & Dwight, Colgate-Palmolive - each of them a company that began, at bottom, as a soap works [C52].

The industry's most instructive giant, though, is one the Western story tends to skip. In 1887 - three years after Lever trademarked Sunlight, eight after P&G trademarked Ivory - a Tokyo sundry-goods dealer named Tomiro Nagase faced the same problem both men had faced: the soap in his country was either poor domestic stuff or expensive imports [C53]. His answer, launched in 1890, was Kao Sekken - Kao soap - named with characters meaning king of flowers and a sound that means face [C53]. What makes Nagase's story rhyming rather than merely parallel is the method: to prove his soap's quality he had it analysed by pharmacology professors and put the certificate of analysis inside the paulownia wood box - the identical move Harley Procter had made with Ivory's 99 and 44/100% Pure, half a world away and independently [C53][C20]. He advertised on railway billboards and put a famous Akasaka geisha on his posters - Barratt's Lillie Langtry play, again independently [C53]. Kao remains one of Japan's great consumer companies, and its founding philosophy is recorded in the founder's will: good fortune is given only to those who work diligently and behave with integrity [C53]. Its old rival Lion began likewise, in 1891, when Tomijiro Kobayashi set up on the Yanagihara riverside in Kanda to trade in soap and raw materials for matches [C54]. The pattern - local import substitution becoming national brand becoming multinational - is the Lever pattern, and it repeated everywhere soap was industrialised.

The rest of the roll-call shows how far the pattern travelled. Church & Dwight, founded in 1846, built an American franchise out of Arm & Hammer and OxiClean; the Nice Group of

Lishui, in Zhejiang, grew into China's washing champion; Henkel brought the world Persil and Schwarzkopf [C52]. And Colgate-Palmolive, oldest of them all, began with William Colgate's starch, soap and candle business on Dutch Street in New York in 1806 - the first newspaper advertisement in 1817, perfumed soaps by 1866, and in 1872 the registration of Cashmere Bouquet, the first milled perfumed toilet soap [C40]. Six of these firms still head the global league table two centuries after the oldest of them was founded [C52]. No other industry can show its founders' names on the same shelf, unchanged, for that long. The soap business does not just sell continuity; it is made of it.

Asia's weight in the numbers deserves emphasis, because it reverses the historical current. Asia Pacific held 39.25 per cent of the world soap market in 2025 - the largest single region - and the forecast growth runs through 2034 [C50]. The trade that began with Babylon, was perfected by Aleppo and industrialised by Merseyside now does its largest business where the newest middle classes are. The bar that Lever shipped out to the Empire comes home the other way: the growth markets are the markets that once received the gunboats and the Sunlight crates [C50][C16].

Unilever's own archive reads the merger the same way this book does: a soap company and a margarine company discovered they were in the same business - the business of fat, processed and branded - and the combination was by market value the largest company in Britain from the start, with a quarter of a million employees by 1930 [C16]. Historians call it the first modern multinational [C16]. Its raw material was the substance of this book's next chapters; its sales technique was the substance of its last ones. Everything between - plantations, factories, ships, poster sites - existed to move one into the other.

Colgate-Palmolive's thread runs even earlier. William Colgate opened a starch, soap and candle business on Dutch Street in New York in 1806 - before Napoleon had finished redrawing Europe - and the firm placed its first advertisement in 1817 [C40]. Down the decades it absorbed the other pioneers: the B. J. Johnson Soap Company of Milwaukee, founded 1864, whose Palmolive soap of 1898 - named for its palm and olive oils - sold in more than 88 countries, and the Cashmere Bouquet line that had registered the first milled perfumed toilet soap trademark back in 1872 [C40]. The modern company is a geological section of the whole industry: every era's soap pressed into one corporate stratum [C40].

The soap companies also learned early to leave soap. Colgate was selling aromatic toothpaste in jars by 1873 - a soap works discovering that the bathroom shelf had room for

more than the bar [C40]. That diversification is the quiet ending of every origin story in this chapter: the firms that began by rendering fat now sell everything the sink, the bath and the laundry basket can hold, and the soap that founded them is a rounding error on the group's accounts [C40][C23].

That is the real story of the giants: not five big companies but a single playbook, discovered independently on three continents within a decade. Standardise the product, certify it, name it, advertise it with faces, control the feedstock, sell cleanliness itself. Soap was the first truly global consumer good, and the corporations it built - P&G, Unilever, Colgate-Palmolive, Kao - went on to sell the world everything else, from toothpaste to disposable nappies, using the techniques the bar had taught them [C52][C23]. Every supermarket aisle is, in a sense, downstream of the soap kettle.

CHAPTER 27

The long tail

Against the giants stands the strangest and most loveable corner of the trade: the small makers, the true believers, the family firms that refused to die. None is stranger or more loved than Dr. Bronner's. The family had been making soap in the Jewish quarter of Laupheim, Germany, since 1858, and invented a liquid castile soap in the 1880s [C55]. Emanuel Heilbronner - master soapmaker by guild certificate, chemist by degree - quarrelled with the family and emigrated to America in 1929; with Hitler's rise he dropped the Heil from his name; the Nazis nationalised the family factory, and his parents were deported and murdered at Auschwitz and Theresienstadt [C55]. In 1948, in California, he founded Dr. Bronner's and began making liquid peppermint castile soap [C55]. He was also a prophet of a self-invented universalist faith, lecturing in Pershing Square on the imperative that humanity unite - All-One or None! - and when he noticed that people were taking the soap and skipping the lecture, he did the obvious thing: he printed the lecture on the label [C55]. That is why, to this day, the bottle is a dense blue wall of tiny ecstatic text, and why a soap became an icon of the counterculture in the 1960s and, eventually, a mainstream staple [C55]. The company is still family-owned, still printing the sermon, still giving the profits away [C55]. It is the purest surviving proof that soap has never been only a product.

The bar's long tail also includes the salvage end of the trade - one of the best ideas in this book. Every hotel on Earth throws away mountains of barely-used soap; the charity Clean the World, founded in 2009, built a global recycling programme that collects discarded soap and amenity bottles from more than 8,500 participating hotels, reprocesses the soap into new bars, and ships them to communities that need them - over 32 million pounds of waste diverted and more than 100 million recycled bars distributed so far [C56]. Read that number against the 1.7 billion people without soap and water at home, and the loop closes: the richest bathrooms in the world wired to the poorest, by soap, about soap, for soap [C56] [C46].

The Bronner saga did not end with the founder. Jim Bronner - the chemist son - spent a year training his own son David, a twenty-four-year-old Harvard graduate and hemp advocate, to run the company while he battled cancer; the family gave a 1,200-acre wilderness parcel to

San Diego County's Boys & Girls Club, and the firm remains a byword for activism-as-business [C55]. It matters to this book because it demonstrates the other road not taken by the giants: a soap company can stay family-sized, family-owned and ideologically unreasonable for seventy-five years and still thrive on the same supermarket shelf. The long tail is not a museum. It is a standing offer of another way to make and sell the oldest product in the world.

Marseille's survivors make the point in bricks and vats. The four savonneries of the UPSM still boil the 72-per-cent block in the city, and they have become, in part, custodians of a process people now visit as heritage [C9]. Nablus's surviving factories sell into fair-trade channels in Europe and beyond [C6]. Aleppo's displaced masters keep the laurel recipe alive in exile [C7]. UNESCO's double inscription of December 2024 - Aleppo and Nablus together - formally placed soap-craft in the same protected category as oral epic and ritual dance: knowledge carried in hands, not machines [C7][C6].

The recycled-soap movement has a pleasing symmetry to it. A luxury hotel bar is used for a night or two and discarded with ninety per cent of its life unspent; the recycling programmes collect, sanitise and re-press the bars, and the finished product goes to precisely the populations the last chapter watched waiting at the tap [C56]. One organisation alone reports over a hundred million bars redirected this way since 2009 - a hundred million small rescues of the most wasted object in the modern bathroom [C56]. The bar, it turns out, is recyclable in a way the pump bottle never was: melt it down and it is simply soap again, ready to be somebody's [C56].

The machinery is now a serious logistics operation. Clean the World, the largest of the programmes, counts 8,599 participants in its global hospitality recycling scheme and reports over 32 million pounds of waste diverted from landfill - the nightly slivers of a million hotel bathrooms, gathered back into bars [C56].

And beneath the brands, the artisan tradition never quite went out. The women of Nablus still cook olive oil in the qilw vats; Marseille's four remaining savonneries still boil the 72-per-cent block [C6][C9]; Aleppo's laurel bars are still aged nine months in the cellar vaults, war permitting [C7]. The craft-soap revival of the past two decades - farmers'-market bars, cold-process starters, the whole handmade shelf - is sometimes dismissed as nostalgia. It is better understood as the return of an older contract: soap made by someone, from named fats, in a known place. The kettle never really went out; it just went small.

PART IX

What Comes Next

CHAPTER 28

The next bar

What does the five-thousand-year-old product do for an encore? Look at the research benches and the answer is, strangely, to become more like itself. The frontier of surfactant science is biological. Microbes make their own surface-active molecules - biosurfactants - and they are extraordinary performers: surfactin, made by the bacterium Bacillus subtilis, can pull the surface tension of water down from 72 to 27 millinewtons per metre, deeper than most synthetic surfactants manage, and it keeps working under harsh conditions of heat, salt and pH [C69]. Because such molecules accumulate in bacterial membranes until the cell disintegrates, they carry their own antimicrobial action too [C69]. Alongside them come the amino-acid surfactants - synthetic molecules built from nature's own building blocks, rapidly biodegradable, so mild that sodium N-cocoyl glutamate and its cousins are the cleansers of choice for baby skin [C69]. The direction of travel is clear: after a century of petroleum-derived syndets, the chemistry of cleaning is going back to feedstocks that rot.

The pump had a history worth pausing on, because it was a century in the making. In August 1865 a New Yorker named William Sheppard patented an improved liquid soap - a little conventional soap dissolved in a great deal of spirits of ammonia, to the consistency of molasses - and his invention served public washrooms for generations without ever entering the home [C34]. It took until 1980, and the cheap plastic pump bottle, for the idea to find its mass market: Robert R. Taylor's Minnetonka Corporation launched Softsoap with a seven-million-dollar advertising campaign - nearly the annual budget of Dial, the biggest soap of the day - having cornered a year's entire production capacity of pump bottles, one hundred million of them, so that no rival could follow [C34]. Within six months he had sold twenty-five million dollars' worth; in 1987 Colgate-Palmolive bought the brand [C34]. Taylor had, as his obituary put it, doomed the bathroom soap dish to virtual obsolescence - or so it seemed at the time [C34].

The second future is the bar itself, avenged. The liquid-soap pump that conquered the bathroom after 1980 carried an unexamined cost: most of what was in the bottle was water, shipped around the world in plastic. The arithmetic has caught up. A bar is hyper-concentrated - a 2026 consumer value analysis found bar soaps last five to six times as long as liquid alternatives - and it needs no bottle at all [C51]. The fastest-growing corner of the

soap market is the one that sells this directly: vegan bars, organic bars, biodegradable bars, plastic-free bars, shampoo bars that replace three bottles with one block [C51]. Generation by generation, buyers are re-learning that the oldest format is the lightest one. The bar soap market, remember, is still growing at five per cent a year [C51].

There is a fourth future, quieter than the other three, and it lives in the global-health sector: soap made where it is needed. The Global Handwashing Partnership's field guides teach small-scale soap making as a WASH intervention in its own right - the ingredients, they point out, can be found almost anywhere, the process is simple, and a village soap works is simultaneously a hygiene supply line and a business opportunity for local entrepreneurs [C78]. It is the Aleppo model read in reverse: not heritage preserved, but capacity built. If the twenty-first century closes the access gap - the 1.7 billion still waiting at the sink - it will be closed partly by giant factories and partly by thousands of small kettles, boiling the same four ingredients the scribe pressed into clay [C46][C78].

Even the skin's verdict is softening. The dermatology literature that once damned all alkaline soap now draws a finer line: the issue is harshness, not soap itself - superfatted bars, mild formulations and sensible use sit comfortably alongside the syndets, and the modern formulator's goal is explicitly a cleanser that preserves the barrier while it cleans, whichever chemistry it uses [C69]. Lecithin - a phospholipid from plants - has been shown to clean with considerably less barrier damage than harsh anionic surfactants, gentle enough to explore for eczema-prone skin [C69]. A century and a half after Chevreul, the science of cleaning has come back round to the skin it serves. The next bar, whenever it arrives, will be judged by an old standard: does it clean, and at what cost - to the hands, the river, the forest, the people who made it. Soap has always been asked those questions. It is just that now, at last, the answers are on the label.

The materials pipeline is already visible in the market reports. Bar soap's growth is driven now by exactly the demands the traditional bar always met - natural ingredients, transparency, minimal packaging - with vegan, organic, biodegradable and plastic-free variants multiplying fastest [C51]. The analysts note the economics bluntly: bars are hyper-concentrated and last five to six times as long as liquids, so the customer is not paying for water and plastic [C51]. The product Lever invented to be wrapped in paper is being rediscovered for the same reason [C51][C19].

The gentlest chemistry now arriving is borrowed from life itself. Amino-acid-based surfactants - the synthetic equivalents of biosurfactants, built from the twenty standard amino acids - combine simple natural structures with low toxicity, real mildness and rapid biodegradation; potassium N-cocoyl glycinate already serves in face cleansers, and N-dodecanoylalaninate makes a creamy foam gentle enough for baby products [C69]. The trajectory of the whole synthetic century points here: molecules that clean like the laboratory and behave like the kitchen [C69].

And the third future is the oldest of all: access. The industry's own trade bodies now say aloud what this book has argued - that handwashing with soap is among the most cost-effective health investments that exist, and that 1.7 billion people still lack the means [C46]. The WHO's first community hand-hygiene guidelines, issued in October 2025, treat soap at the sink the way governments treat vaccines and sewers: as infrastructure, a public good that markets alone will not deliver [C46]. That is a remarkable destination for a product that began as a luxury taxed like wine. The future of soap is not a new molecule. It is the old molecule, everywhere, for everyone - at which point the longest project in the history of cleanliness will finally be finished.

CHAPTER 29

The smell of clean

Ask anyone to describe clean and they will reach for a smell. This is odd, because the smell is the least functional part of the product: the perfume does no cleaning at all. Yet the association is ancient and commercially decisive. The medieval market understood it before the chemistry did - when taxed Britain's coarse tallow soaps grew too rank to bear, it was perfumed soaps from Italy that slipped in to serve the noses of the rich [C10]. Andrew Pears built his transparent bar on the insight that a gentle soap for delicate complexions should carry a delicate perfume of flowers [C10]. Colgate registered Cashmere Bouquet in 1872 - the first milled perfumed toilet soap, fragrance as trademark [C40]. Lifebuoy went the opposite way and made a virtue of reeking: the sharp carbolic smell of the red bar was the smell of disinfection itself, and the company sold it as reassurance [C18]. Even Marseille's green cube, unperfumed by decree, smells powerfully of what it is - hot olive oil and soda - and the scent is so loved that the industry sells candles and sachets to fake it [C9].

The psychology runs deep because the stakes once ran deep. When Lifebuoy's carbolic tang said antiseptic, it was speaking to customers who remembered what infection did before antibiotics; the smell was a promise about survival [C18]. The floral toilet soaps made the inverse promise - gentleness, status, a complexion protected from the harshness of the coarse grades [C10]. Even B.O., Lifebuoy's great lexical invention, is a smell-anxiety given initials [C18]. The industry did not invent the nose's association between scent and hygiene; it merely learned to play it like an organ, and the stops it pulled - medicinal, floral, marine, herbal - map every anxiety and aspiration of the washing century.

There is even a chemistry of nostalgia here. The fragrance compounds the industry favours - linalool, citronellol, geraniol - are terpene alcohols borrowed from lavender, lemon and rose, the old soap-garden smells of the Mediterranean trade, now synthesised by the tonne [C31]. The modern synthetic musks extend the range, but the centre of gravity never moved: clean, in the West's imagination, smells of the same few flowers it did when perfumed soaps first arrived from Italy [C31][C10].

Thordarson's explanation of why soap wins is worth a moment longer, because it reverses the usual assumptions about strength. A virus like SARS-CoV-2 is a self-assembled

nanoparticle, and critically, there are no strong covalent bonds holding its RNA, proteins and lipids together - the whole structure is a house of cards waiting for a nudge [C49]. Soap supplies the nudge twice over: its amphiphiles compete with the lipids of the membrane and loosen the glue-like interactions between virus and skin at the same time [C49]. And the target is generous, because we are: most of us touch our own faces once every two to five minutes [C49].

The mechanics of the handoff deserve a look. Touch a steel surface carrying virus particles and they stick to your skin - human skin is, in Thordarson's phrase, an ideal surface for a virus, organic, its dead-cell proteins and fatty acids interacting readily with the particle - and from the hand the next stop is the face [C49]. Soap breaks both bonds at once: the glue between virus and skin, and the Velcro-like interactions holding the virus's own components together [C49]. The twenty seconds of scrubbing is not ritual. It is the time the chemistry needs [C49].

Alcohol, the alternative, plays by different rules. Sanitisers are high-percentage ethanol solutions - sixty to eighty per cent - and they inactivate viruses too, but you must literally soak every corner of the skin, which a quick gel-rub rarely manages; a small amount of soapy water, with rubbing, covers the whole hand easily [C49]. That is why the public-health verdict runs: soap first, sanitiser when soap is not handy [C49]. The grandmother's bar, again, is the benchmark [C49].

The delivery system, meanwhile, is the sneeze. The tiny droplets from a cough or sneeze can fly up to ten metres, and the larger ones - the main carriers - travel at least two [C49]. They land on surfaces and dry, and the viruses remain active, waiting for a hand [C49]. Every stage of that journey has a soap-shaped countermeasure, which is why the advice never changed through the whole pandemic: wash, and wash properly [C49][C46].

The twentieth century industrialised the nose. Modern soap and detergent perfumes are engineered blends - terpene alcohols like citronellol, geraniol and linalool, aromatic aldehydes, synthetic musks - designed not merely to smell pleasant in the wrapper but to survive the wash and linger on skin and fabric as a signal: this was cleaned [C31]. The signal is potent enough to have become its own problem. A 2013 study of fragranced laundry products detected more than twenty-five volatile organic compounds emerging from dryer vents, seven of them classified as hazardous air pollutants and two as carcinogens - the smell of clean, measured in the exhaust, turned out to be chemistry with

questions to answer [C31]. The market's latest turn is therefore back toward silence: fragrance-free formulations, hypoallergenic bars, the whole clean-label shelf [C51]. After two thousand years, the smell of clean may end up being no smell at all - which is, of course, what clean actually smells like.

CHAPTER 30

Reading the wrapper

Turn a modern bar over and the small print tells the whole history of this book in one list. Here is Ivory's: sodium tallowate, sodium cocoate or sodium palm kernelate, water, sodium chloride, sodium silicate, magnesium sulphate, fragrance [C20]. Translate: beef fat and coconut or palm kernel oil, saponified by caustic soda - Leblanc's alkali - salted out the way kettles always were, hardened with silicate, preserved against rancidity, perfumed [C20]. Every ingredient is a chapter. The tallow is the medieval north; the palm kernelate is the tropical trade; the salt is Chevreul's chemistry made routine; the fragrance is Pears and Cashmere Bouquet; the measured pH 9.5 on the specification sheet is the dermatology wars in a single number [C20].

The wrapper's newer vocabulary marks the boundaries of the soap wars. Total fatty matter - the TFM percentage - is the honest declaration of how much of the bar is soap at all, and the 72 per cent on a Marseille cube remains the most famous number in the trade [C9]. Superfatted promises a small excess of free oil left in the bar for mildness - the artisan's signature, and a return, deliberate or not, to the way handmade soap always was [C3][C2]. Syndet and soap-free confess that the bar is not, chemically, soap at all - and France settled soap's legal status in 1975, categorising it as a cosmetic, forbidden ever since to claim any preventive or curative property [C69] - while syndet bars now take over ninety per cent of bar-soap revenue, a fact that would have bewildered Lever [C51]. And the ingredient names themselves are a palimpsest: sodium lauryl sulfate and its milder cousins are the synthetic century; the two hundred-odd names that hide palm derivatives are the commodity century; glycerin, when it appears, means the sweet principle was left in the bar where Scheele found it [C41][C39].

Two further entries deserve translation. Sodium silicate - water-glass, one of the oldest builders in the trade - and magnesium sulphate round out the formula, alongside the salt left over from the separation [C20][C31]. Optical brighteners, enzymes and antiredeposition agents belong to the laundry side, where a modern detergent is fifty per cent builder by weight and only about fifteen per cent actual surfactant [C31]. The bar of soap, by contrast, remains close to what Babylon made: in a true Marseille block seventy-two per cent of the weight is soap material and nearly all the rest is water - the highest active-ingredient

concentration of any cleaning product sold. Simplicity is not nostalgia; it is the specification [C9][C31].

Two more pieces of wrapper vocabulary repay a second look. The -ate names - sodium tallowate, sodium palmate, sodium cocoate, sodium oleate - are not separate chemicals so much as a confession of feedstock: each is soap made from a particular fat, tallow, palm, coconut, olive, and the chain lengths inside almost always fall between twelve and eighteen carbons [C69]. And the alkali shows through in the physical form: soaps made with caustic soda set solid - the trade's white soaps - while soaps made with potash stay liquid, historically known as black soaps [C69]. A buyer who can read those two facts off a label knows the bar's fat and its alkali at a glance - which is to say, knows the two ingredients of the oldest recipe in this book [C69][C1].

Performance has its own small print too, and the skin literature reads it closely. A cleanser's surfactant type, concentration and combination, its rinsability and its pH all bear on how drying or irritating the finished product will be on healthy, compromised or diseased skin [C69]. Two bars with identical ingredient lists can behave differently in the hand; the label tells you the molecules, not the formulation that balances them [C69].

Learning to read this list is the book's practical bequest. The first ingredient is the fat story; the pH is the skin story; the certifications are the forest story; the absence of triclosan is the 2016 story; and the weight of the bar against its price is the oldest story of all - what cleanliness costs, and who was made to pay it [C35][C42].

CHAPTER 31

The skin's verdict

For most of this book the judge of soap has been the washday, the state, or the market. The twentieth century added a new and tougher judge: dermatology. The skin, it turns out, keeps its own chemistry - a mildly acidic surface, a brick-and-mortar barrier of corneocytes and lipids, a resident population of microbes - and cleansing is always a negotiation with that system [C69]. Alkaline soap raises the surface pH, swells the stratum corneum's proteins, and extracts some of the barrier's own lipids; measured carefully, a harsh soap removes more cholesterol from the skin than a mild syndet does [C69]. The after-wash tightness everyone knows is the physical signature of the process: water swelling the outer cells, then evaporating and leaving the stressed layer to contract [C69].

The verdict varies sharply with the skin in question. Newborns and infants have a barrier still under construction, vulnerable to irritation; acne-prone teenage skin needs sebum removed without the drying that provokes more; aged skin - thinner, drier, less elastic - tolerates alkalinity worst of all; and for eczema, traditional high-pH soap can strip intracellular lipids and open the way to itching, burning and staphylococcal colonisation [C69]. The dermatologists' recommendation is not ban soap but match the cleanser: mildly acidified, fragrance-free, appropriate to the person - with modern mild syndets often the safer instrument for compromised skin [C69]. It is a more nuanced verdict than the marketing of either camp admits, and it has quietly reshaped the shelf: superfatted bars, pH-balanced cleansers, soap-free washes for the fragile and honest alkaline bars for the robust [C69].

The acid mantle is the skin chemists' name for the territory. Healthy skin at the surface sits slightly acidic, around pH 4 to 6, and traditional soap is alkaline - which is why a thoroughly washed face can feel tight, and why the twentieth century's synthetic cleansers were engineered to sit closer to the skin's own pH [C69]. The honest verdict is not that soap harms skin; it is that skin, like soap, is a chemistry with its own preferred numbers, and washing well means respecting both sets [C69].

The territory, up close, is architecture. The stratum corneum - the skin's outermost layer - is built like a wall: flattened, protein-rich dead cells are the bricks, and a lipid-rich matrix is

the mortar, composed of ceramides at forty to fifty per cent, cholesterol at twenty-five and free fatty acids at ten to fifteen [C69]. That mortar is layered into ordered sheets that hold the body's water in and the world out, constantly maintained, regulating what the dermatologists call transepidermal water loss [C69]. Wash too aggressively and you strip the mortar: alkaline soaps perturb the proteins, dissolve the lipids and lift the pH, which is why the squeaky-clean feeling is, chemically speaking, the feeling of your wall being partly dismantled [C69]. The dermatologists' definition of good cleansing is a study in restraint: remove the impurities, control the odour, and leave the barrier, the resident microbes and the pH exactly as you found them [C69]. The bar's whole twentieth century - superfatting, syndets, pH-balanced everything - is that sentence turned into product development.

The surfactants themselves come in families, and the wrapper's small print is a family tree. The anionics - the soap carboxylates and the synthetic sulphates and sulphonates - carry a negative head and clean hardest; the amphoteric or zwitterionic surfactants carry a dual charge; the cationics a positive one; and the non-ionics none at all [C69]. Formulators blend the four families, trading cleaning capacity against mildness and antimicrobial action [C69]. Formulating a cleanser is that blending art applied to a wall you must not damage - and the clinical literature is blunt about why it matters, since cleansers designed for the management of common skin conditions such as eczema live or die by getting the blend right [C69]. The perfect cleanser, on the evidence, is the one that removes what you brought home and leaves behind everything you were born with [C69].

The wall has its own maintenance crew, and harsh washing sacks it. The stratum corneum's natural moisturising factor - a cocktail of free amino acids and sugars inside the cells - holds water in the skin; aggressive cleansing strips it along with the surface lipids, raising water loss through the barrier and leaving the skin to spend its resources on repair rather than defence [C69]. Yet here is the honest complication the dermatologists themselves record: despite the measured advantages of syndets, soap is still often preferred, possibly because of the negative connotations around anything not perceived as natural [C69]. The skin's verdict, in other words, is not the customer's. Four thousand years of trust in the bar is itself a clinical variable - and the formulators know it [C69].

The most interesting sentence in the literature is about the future: the stated goal of the science is now the optimal personalised cleanser - formulations tuned to an individual's skin state, environment and need, with maximal cleaning and minimal disruption [C69]. That is

Chevreul's programme completed at last. He took the bar apart into its acids; two centuries of chemistry put it back together as the syndet, the amino-acid surfactant, the lecithin cleanser; and the endpoint is soap that knows whose hands it is in [C69][C12]. The oldest cleaning product on Earth ends this book as a personalised medical technology - still, underneath everything, a molecule with a head that loves water and a tail that loves grease.

CODA

The meaning of clean

We began in Babylon, with a scribe pressing a recipe into clay: fat, ash, water. Every chapter since has been a variation on that inscription. Rome scraped itself with oil and forgot the recipe; Aleppo and Nablus kept it; Castile whitened it; Marseille regulated it; the taxman priced it out of poor hands and Gladstone gave it back. Leblanc freed the alkali, Chevreul explained the fat, and the branded century - Sunlight, Ivory, Lifebuoy, Pears - turned the bar into the first global consumer good and the first mass-advertised promise. The synthetics took the laundry and left soap its soul. And through all of it, the molecule never changed: a head that loves water, a tail that loves grease, and the oldest magic in chemistry happening between them.

Soap is the most democratic technology ever made. It asks nothing - no power, no network, no manual - and it gives the thing on which everything else in public health depends. The surgeon's scrub, the mother's washday, the refugee camp's distribution point, the hotel's recycled bar: one molecule, working at every level of the world. It cleaned the cities that cholera owned, and in 2020 it dismantled a pandemic virus on billions of pairs of hands.

The numbers will go on moving. Output projections, market forecasts, guideline targets - by the time this book is read they will all have shifted, and the bar on the sink will not have noticed. That is the deepest continuity of all: the recipe outlasts every statistic assembled to describe it [C1][C44].

So the meaning of clean turns out to be three meanings wearing one word. There is the chemist's clean: grease inside micelles, membranes undone, the measurable event [C2][C49]. There is the doctor's clean: the chlorinated lime of 1847 become the guidelines of 2025, the humblest act in medicine still arguing its case [C44][C46]. And there is the oldest clean, the one the recipe carried out of Babylon before any of the others were thought of: the simple human intention to present oneself washed to the world [C1]. The bar serves all three masters at once, and asks only water in return.

There is a tendency, writing the history of a material, to end with its supersession. Soap has none. It outlasted the fuller's earth, the chamber lye, the washboard and the mangle; it survived the detergent, the pump bottle and the sanitiser gel; it will outlast whatever comes

next, because what it does is not a feature but a foundation. The meaning of clean, it turns out, was never a smell or a shine or a brand. It was the quiet fact, learned at terrible cost across five thousand years, that the simplest act of chemistry performed with two hands could hold back the oldest killers we know. Lather, rinse, repeat. The world is in the lather.

REFERENCE

Glossary

Alkali - A soluble base; the second of soap's two parents. Historically potash from wood ashes, barilla from seaside plants, natron from dry lakes; since Leblanc, factory-made soda ash. [C1][C11]

Barilla - Soda-rich ash of salt-tolerant plants (glasswort) burned on the shores of Spain and the Canaries; the prized alkali of the Mediterranean soap towns before industrial soda. [C11]

Builder - An alkaline compound added to soap or detergent to improve cleaning, chiefly by tying up the calcium and magnesium ions of hard water. Phosphates were the great twentieth-century builder until the eutrophication crisis drove them out. [C29][C36]

Castile soap - Hard white soap of olive oil, named for the Spanish region; the original luxury soap of northern Europe, and the ancestor of all vegetable-oil bars. [C8]

Cold process - Soapmaking without external heat: fats and lye are mixed and saponify slowly over weeks. Keeps the glycerine in the bar; the standard method of the modern artisan revival. [C3]

Crutcher - The closed mixing tank in which neat soap takes its builders, perfumes and other ingredients before finishing. [C29]

Glycerine - The sweet, hygroscopic alcohol (glycerol) released when fat is split - about a tenth of the fat's weight. Humectant in cosmetics and food, and, as nitroglycerine, the heart of dynamite. [C39]

Hard water - Water carrying calcium and magnesium ions, which precipitate soap as scum and blunt its cleaning. The reason builders - and eventually synthetic detergents - were invented. [C2][C36]

Lye - A strong alkaline solution: wood-ash liquor in the old craft, caustic soda solution today. Its strength was traditionally gauged by floating an egg in it. [C3]

Micelle - The tiny sphere soap molecules form in water, grease-loving tails inward, water-loving heads outward; the structure that lifts oil off skin and cloth and carries it away. [C2]

Milled soap - Bar soap passed repeatedly through steel rollers and plodders before stamping; denser, longer-lasting and more even than cast soap. French milled is the classic boast. [C38]

Neat soap - The finished upper layer of a boiled kettle after salt separation - soap proper, sitting above the spent lye. [C29]

pH - The measure of acidity and alkalinity. Skin sits mildly acidic around pH 4 to 6; traditional soap is alkaline, around 9 to 10 - the gap that opened the door to the syndet bar. [C69]

Plodder - The giant screw extruder that compresses milled soap under vacuum and pushes it out as the continuous billet from which bars are cut. [C38]

Potash - Potassium carbonate from wood ashes; the alkali of soft soap and of the northern forests until the Leblanc process made soda ash cheap. [C11]

Saponification - The reaction at the heart of the whole book: fat or oil plus alkali yielding soap plus glycerine. From the Latin sapo, soap. [C2]

Scum - The grey insoluble curd soap forms in hard water - the ring around the bath - as calcium and magnesium steal the surfactant's place. [C2]

Spent lye - The liquor drawn off the bottom of a soap kettle after salting out; historically a waste, later the feedstock from which crude glycerine was recovered. [C29][C39]

Superfatting - Deliberately leaving a small excess of unsaponified oil in a bar for mildness; standard practice in modern artisan soap. [C3]

Surfactant - Surface-active agent: any molecule, soap or synthetic, with a water-loving head and an oil-loving tail, able to lower surface tension and lift grease. [C2]

Syndet - Synthetic detergent; a cleanser built from laboratory surfactants rather than saponified fat. The postwar conqueror of the laundry and, via Dove, half the bathroom. [C31][C33]

Tallow - Rendered beef or mutton fat; the workhorse soap fat of the northern world for two thousand years, and the reason soap and candles grew up as one trade. [C73]

TFM - Total fatty matter: the percentage of a bar that is actual soap material - the 72 per cent stamped into true Marseille soap is the famous example. [C9]

Acid mantle - The slightly acidic film of healthy skin at the surface, around pH 4 to 6; the chemistry that alkaline soaps disturb and syndet cleansers are built to respect. [C69]

Antibacterial - A soap carrying added antimicrobial actives such as triclosan; ruled by the FDA in 2016 to be no better than plain soap and water for consumer washing. [C35]

Humectant - A substance that attracts and holds water; glycerine's talent, and the reason a transparent or glycerine-rich bar feels kinder on the skin. [C39]

Neat soap - The pure upper layer of finished soap separated from spent lye by the addition of salt in the kettle process. [C29]

Plateau's laws - The four geometric rules governing soap films: smooth surfaces of constant mean curvature, three films meeting at 120 degrees, four edges meeting at the tetrahedral angle. [C71]

Salting out - Driving finished soap out of the boiled mixture by adding salt, so it separates from the glycerine-rich spent lye below; the refiner's oldest trick. [C1][C29]

Strigil - The Roman body-scraper of bronze or iron; the technology soap replaced at the bath. [C4]

Triclosan - The most common antibacterial additive in consumer soaps until the FDA's 2016 rule removed it and eighteen other actives from the market. [C35]

Amalgamator - The mixer on a soap finishing line in which dried soap noodles take their perfume, colour and extras before milling. [C38]

Amphoteric surfactant - A surfactant whose head carries dual (zwitterionic) charge; one of the four families formulators blend for mildness. [C69]

Anionic surfactant - A surfactant with a negatively charged head: soap's carboxylates and the synthetic sulphates and sulphonates; the hardest cleaners of the four families. [C69]

Carbolic acid - Phenol, the coal-tar disinfectant Lister made famous; the active principle of Lifebuoy's red bar of 1894. [C18]

Eutrophication - The over-fertilising of fresh water by nutrients, above all phosphorus; the process that aged Lake Erie and drove phosphates out of detergents. [C36]

Noodles - The dry pellets of neat soap from a vacuum dryer; the raw stock from which every modern bar is milled, plodded and stamped. [C38]

Stratum corneum - The skin's outermost layer: protein-rich dead cells as bricks, a lipid mortar of ceramides, cholesterol and free fatty acids between them. The wall every cleanser must cross politely. [C69]

Trace - The soapmaker's word for the moment a mixing brew thickens enough to leave a trail on its own surface; the signal to pour. [C4]

Caustic soda - Sodium hydroxide, the strong alkali of the modern kettle and the continuous plant; makes hard, solid soaps where potash makes soft ones. [C29][C69]

Dynamite - Nobel's 1866 stabilised nitroglycerine, absorbed on kieselguhr; the first worldwide technical market for glycerine, and the soap kettle's unlooked-for second business. [C39]

Ebers papyrus - Egyptian medical scroll of about 1550 BC; records combining animal and vegetable oils with alkaline salts for washing and for treating skin diseases - the earliest hint of personal soap use. [C1]

Excise - The tax on manufacture. England taxed soap from 1712 to 1853, making cleanliness a luxury; Gladstone's repeal let the industry - and the habit of washing - flourish. [C10]

Fatty acid - The long-chain acid half of a fat; saponified, its salts are soap. Chevreul isolated and named stearic, oleic and margaric acids between 1813 and 1823. [C12]

Lipid bilayer - The double sheet of fatty molecules that skins a cell or an enveloped virus; the structure soap's amphiphiles compete with and dissolve. [C49]

Natron - Naturally occurring sodium carbonate from Egypt's dry lake beds; the ancient world's mined alkali, used in mummification and cleansing alike. [C1]

Triglyceride - A fat's chemical form: three fatty acids held by a glycerol backbone. Saponification is the alkali taking the acids and setting the glycerol free. [C4][C12]

Washing soda - Sodium carbonate; with sodium silicate (waterglass), the earliest detergent builder, decades before the phosphates. [C31]

Zeolite - The ion-exchange mineral that replaced phosphate as the detergent builder after the eutrophication bans. [C36]

Palm oil - The oil of the African oil palm's fruit pulp; the modern industry's default soap fat and the feedstock behind most of the world's personal-care foam - and its biggest environmental argument. [C41]

Waterglass - Sodium silicate; with washing soda, one of the two earliest detergent builders. [C31]

Fat splitting - The modern route to soap: hydrolyse the fat directly into fatty acids and glycerine at high temperature, then neutralise the acids. Continuous, controllable, feedstock-agnostic. [C29]

Kettle - The traditional soap pan: fats, oils and caustic soda boiled for days, then salted out into neat soap above and spent lye below. [C29]

Soda ash - Sodium carbonate, the workhorse industrial alkali; made by the Leblanc and then the Solvay processes, now also mined as trona. [C11]