

WHAT WAS IN THAT JOINT BRO!?

An Introduction To The Purple Canary Protocol

Michael Scott Hoyt

WHAT WAS IN THAT JOINT BRO!?

An Introduction To The Purple Canary Protocol

Copyright © 2026 by Michael Scott Hoyt. All rights reserved.

Published independently via Kindle Direct Publishing.

No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or by any means—electronic, mechanical, photocopying, recording, scanning, or otherwise—except as permitted under Section 107 or 108 of the 1976 United States Copyright Act, without prior written permission of the author.

Disclaimer & Harm Reduction Notice:

The technical protocols, chemical preparations, and testing workflows described in this book are compiled strictly for scientific education, forensic demystification, and public harm reduction. Drug checking procedures documented herein represent presumptive

screening methods only. They are not diagnostic, confirmatory laboratory evaluations (such as GC-MS or HPLC), nor do they constitute medical, toxicological, or legal advice. The author and publisher assume no liability for personal actions, field testing errors, or decisions made based on presumptive data. Always consult certified health professionals and local public health networks in critical or emergency situations.

ISBN: [Pending]

First Paperback Edition: October 2026

Set in Baskerville and Sans-Serif System Display

Printed in the United States of America

To Sharon, who makes every crazy blueprint possible.

And to Joe & his Caliper—which proved you don't need a million-dollar cleanroom to see what's true.

"Forensic parity is not a privilege reserved for state crime labs; it is an epistemic right of the person deciding what enters their own body."

Contents

• Introduction: The Question on the Street

Part One: For Everyone

1. Why Test What You Take
2. The Kitchen, the Thermos, and the Keychain Light
3. Paper, Light, and Lemon: The Chemistry in Plain English
4. SPOT: Taking the Sample

5. SNAP: The Phone Does the Seeing
6. KNOW: Reading Your Results
7. When the Result Scares You
8. What This Can't Tell You

- ★ **One-Page SOP Summary**

1. The Purple Canary Protocol (Full SOP)

Part Two: For Harm-Reduction Agencies

1. Why Your Agency Needs This
2. Deploying the Protocol
3. Training Your Team
4. Restocking and Sustaining
5. The Economics of Free Testing
6. Open Methods, Open Knowledge

- **Closing: The Living Protocol**

- **Back Matter: Glossary & Resources**

- **Sequel Teaser: The Cannabinoid Cookbook**

Introduction: The Question on the Street

The question usually gets asked in a cold parking lot, on a stoop, or on the back patio of a venue where the bass is still thumping through the brickwork:

"What was in that joint, bro!?"

It starts with a shared session that suddenly tilts violently off its axis. One minute you're expecting mellow relaxation, and the next, your pulse is redlining like an engine with a broken governor, the room looks strangely pixelated, and a cold wave of chemical dread washes behind your eyes. Or maybe nobody is in distress; maybe someone simply pulls a slick, vacuum-sealed pouch or a brightly packaged vape cartridge from their jacket and pauses. The heat-seal looks legit, the branding looks California-slick, but there's that quiet, nagging voice in the back of your skull: *Who actually verified this? What else is floating in this oil? Is this clean botanical herb, or is it five-dollar hemp shake misted with synthetic research chemicals and heavy cutting agents?*

For fifty years, the standard cultural answer to that knot in your stomach has been a patronizing lecture: *Just say no. Just don't consume it.* But abstinence lectures don't solve reality. Millions of people across college campuses, job sites, concert venues, and city blocks navigate an unregulated supply every single day. Telling someone to simply abstain from an opaque market without offering them tools to inspect that market is like telling commuters to avoid car wrecks while outlawing headlights.

This book exists because you have an absolute right to know what is in front of you. It exists to tear down the artificial wall between expensive corporate laboratories and everyday people.

How to Read This Book

We built this guide in two interconnected halves so you can find exactly what you need without wading through irrelevant operational manuals:

- **Part One: For Everyone.** If you consume substances, buy from friends or unregulated dispensaries, or simply love someone who does, start on page one and read straight through. It covers street supply realities, the physics of paper chromatography in plain English, and the three-step routine: **SPOT**, **SNAP**, and **KNOW**. You don't need a lab coat, a chemistry degree, or expensive glassware. Every single step uses food-safe materials, a standard thermal travel mug, a keychain light, and the phone already sitting in your pocket.
- **Part Two: For Harm-Reduction Agencies.** If you direct a syringe service program, run a shelter clinic, lead an outreach van, or organize a mutual-aid health collective, this section is your tactical playbook. It covers field deployment footprints, rapid peer-volunteer training frameworks, liability protections, grant-writing language, and the operational math of conducting thousands of decentralized checks for pennies per sample.

The Honesty Contract: Presumptive Testing Defined

Before we talk about dropping liquid onto paper or clicking on a keychain light, we need to sign an unshakeable honesty contract: **This protocol is a presumptive field screening tool, not a certified clinical mass spectrometer.**

In institutional toxicology laboratories, chemists rely on eighty-thousand-dollar benchtop instruments like Gas Chromatography-Mass Spectrometry (GC-MS) or High-Performance Liquid Chromatography (HPLC). Those machines vaporize compounds,

shatter their molecules with electron beams, weigh the fragments with atomic precision, and print out quantified molecular breakdowns. They are indispensable for confirmatory forensics, but they live inside guarded institutional cleanrooms. They cannot fit into your backpack, they cannot park inside an outreach van on a rainy Saturday night, and their results arrive days or weeks after the sample was consumed.

The Purple Canary Protocol adapts paper thin-layer chromatography (Paper TLC) to decentralized harm reduction. Using untreated Whatman Grade 1 cellulose paper developed with a food-grade solution of 95.5% D-limonene and 0.5% curcumin (w/v), it physically separates complex chemical mixtures along a paper strip in three to five minutes. When paired with a 365-nanometer ultraviolet keychain light and your smartphone's camera, it provides an immediate optical fingerprint cross-referenced against validated forensic literature.

Here is the contract: **Presumptive testing does not issue an unconditional certificate of purity.** A clean strip showing no targeted adulterants does not mean a substance is risk-free. What it delivers is **forensic parity**—the ability to verify baseline chemical realities, catch dangerous synthetic adulterants and hazardous bulking oils before consumption, and eliminate blind guesswork.

Community safety doesn't start with blind faith in a colorful package or a seller's promise. It starts with having the curiosity to test the claim, inspect the strip, and know the truth before anyone takes a hit.

PART ONE: FOR EVERYONE

Chapter 1: Why Test What You Take

The era of trusting what you hold in your hand simply because it looks fragrant, smells like pine, or arrived in a heat-sealed mylar pouch is officially over.

If you're a skeptic, your immediate reaction is probably: *"Why bother? I've been buying from the same guy for five years. He gets it from a caregiver in California. I know what good bud looks like."*

Here is the hard truth of the modern market: your guy doesn't know either. In an unregulated supply chain, your friendly local hookup isn't testing wholesale duffels in a laboratory. They're trusting the broker who sold it to them, who trusted the distributor who drove it across state lines, who trusted the processing warehouse that bought bulk biomass. For generations, the biggest gamble on the street was paying fifty bucks for an eighth full of stems, seeds, and weak outdoor trim. Today, the landscape is fundamentally distorted. You aren't just dealing with natural agricultural variation; you are navigating a shadow market where industrial chemistry has completely outrun consumer awareness.

The Adulterant Era

Walk into any municipal emergency department, check urban outreach logs, or talk to harm-reduction workers on the night shift, and the reality is unmistakable. Potent synthetic compounds, novel

research chemicals, and cheap industrial bulking agents routinely cross-contaminate supply chains:

- **Synthetic Cannabinoids & Sprayed Flower:** Low-cost industrial hemp or washed biomass sprayed down with synthetic cannabinoid receptor agonists (SCRAs like ADB-PINACA and MDMB-4en-PINACA). These laboratory-synthesized compounds bind to the brain's CB1 cannabinoid receptors with up to a hundred times the binding affinity of natural delta-9 THC. Instead of a mellow buzz, they trigger sudden violent tachycardia, terrifying paranoia, seizures, acute psychosis, and cardiac collapse.
- **Fentanyl Cross-Contamination:** The ubiquity of synthetic opioids means trace contamination turns up in places nobody expects. Careless handling on shared scales, contaminated tabletop baggers, or deliberate cutting in illicit pill presses introduces microscopic quantities of fentanyl that can prove fatal to an opioid-naïve consumer.
- **Xylazine ("Tranq"):** A veterinary sedative that does not respond to naloxone, increasingly mixed into illicit supplies to artificially extend sedation, resulting in severe necrotic skin ulcers, profound unarousable coma, and respiratory failure.
- **Research Chemicals & NBOMe Compounds:** Synthetic hallucinogens pressed onto blotter paper or sold as classic psychedelics, carrying extreme vasoconstrictive and neurotoxic risks at sub-milligram thresholds.

This crisis is not a scary story invented by nightly news anchors; it leaves permanent scars across families, friend groups, and music culture.

On December 8, 2019, six days after his twenty-first birthday, Jarad Higgins—the artist Juice WRLD—suffered a seizure at

Chicago's Midway Airport and was pronounced dead at 3:14 AM at Advocate Christ Medical Center. Initial media reports alleged he had frantically swallowed a handful of pills to hide them from federal agents as police prepared to search his aircraft, though that narrative has since been disputed, notably in the 2021 documentary *Juice WRLD: Into the Abyss*. The Cook County Medical Examiner officially ruled the manner of death an accident, caused by oxycodone and codeine toxicity. For me, this was the tragedy that made the adulterant crisis fiercely personal. What felt, in my words, like a devastating "4:19 AM suicide pill" captured the lethal velocity of the era: when the supply is unverified, volatile, and hyper-potent, a single impulsive decision or an untested handful of tablets can end a brilliant life in minutes.

Treating this crisis with genuine care means speaking the truth without moralizing lectures: when you cannot see what you are consuming, casual use becomes chemical roulette.

Why "Just Don't Use" Isn't a Testing Strategy

For more than half a century, institutional leadership has relied on a single, simplistic slogan: *Just say no*.

By every measurable public health metric, that policy has collapsed. Human beings consume substances for pain relief, creative expression, social bonding, relaxation, and trauma management. People do not stop seeking relief simply because a politician signs a statute or a police department makes an arrest.

Telling an active consumer to "just abstain" when they are holding a bag they already paid for is not harm reduction; it is an abdication of duty. When institutions criminalize drug-checking tools as "paraphernalia," they don't stop people from using. They simply guarantee that those who use do so completely blind.

Harm reduction starts with an honest, non-judgmental premise: if someone is going to consume a substance, they deserve the right to know what is in it before it enters their bloodstream.

Presumptive Testing, Honestly Defined

To make testing work on the street, we have to cut through both paranoia and false security. Testing tools belong to two distinct tiers:

1. Confirmatory Testing (The High Lab Standard):

Confirmatory analyses rely on benchtop instruments like Gas Chromatography-Mass Spectrometry (GC-MS), High-Performance Liquid Chromatography (HPLC), and Fourier-Transform Infrared (FTIR) spectrometers. These machines provide definitive, quantified molecular identification down to fractions of a percent. But they cost tens of thousands of dollars, demand specialized chemists, create hazardous waste, and take days or weeks to return a report.

2. Presumptive Testing (The Field Standard): Presumptive testing uses physical separation and optical reactions to give an immediate, on-the-spot indication of what is—and what is not—present in a sample. It does not issue a certified molecular assay. Instead, it answers vital frontline screening questions: *Does this substance behave like clean botanical plant resin? Does it migrate at the expected rate? Does it flash a dangerous foreign warning band under UV light?*

Presumptive screening does not declare any street product unconditionally "safe." What it does is dramatically collapse the information gap. It transforms an invisible hazard into an actionable, visual signal.

Forensic Parity: Demystifying Chemical Truth

For far too long, analytical science has operated like a walled garden. The ability to verify chemical reality was locked inside state crime laboratories, pharmaceutical vaults, and elite universities. The person carrying the highest physical risk—the human being about to vape, smoke, or swallow the substance—was denied access to the data.

Forensic parity is the core mission of this manual: ordinary people deserve access to the same fundamental physical truths about what enters their bodies that crime labs possess.

Forensic parity does not require stealing a eighty-thousand-dollar mass spectrometer. It means using the foundational laws of physics, chromatography, and optics—harnessing food-grade ingredients, ordinary paper, and the digital lens in your smartphone—to inspect reality right at your kitchen table.

Testing what you take isn't paranoid; it is basic self-defense, community solidarity, and common sense in an adulterated world.

Chapter 2: The Kitchen, the Thermos, and the Keychain Light

It started because I wanted to see whether it was even possible.

I grew up in Allegan, Michigan, which is, for all practical purposes, a Perrigo company town. If you've ever bought generic over-the-counter ibuprofen, aspirin, or cold medicine at a grocery store anywhere in North America, there is a very high probability it rolled out of the brick complexes running along the Kalamazoo River in Allegan. Pharmaceutical manufacturing wasn't an abstract corporate concept where I came from; it was the hum of the shift whistle, the steam off the exhaust vents, and the place where half the families in town earned their living.

When I was nineteen, I walked in for an interview at Perrigo. The hiring team sat me down, reviewed my background, told me I was "very bright," and put an offer on the table: fifteen dollars an hour to help secure their internal documentation vault. The job was straightforward on paper: pull down decades of archived, legacy Standard Operating Procedures, scan and digitize them into secure systems, encrypt the backups, and feed the physical originals straight into the industrial shredder.

There was just one catch. To take that fifteen-dollar-an-hour gig, I had to sign a seven-year, ironclad non-compete clause that effectively barred me from touching work for any other drug or pharmaceutical firm on the planet until my mid-twenties.

I looked at the paperwork, weighed the trade-off, and walked away.

Joe didn't decline.

Joe took the job, disappeared inside that concrete vault, and spent a full year surrounded by filing cabinets, reading through the legacy testing sheets, quality-assurance protocols, and compounding guidelines that had guided decades of manufacturing. When he finally came out the other side, his verdict on the legendary pharmaceutical archive wasn't reverent at all. He shook his head and admitted he had no idea how anybody got anything done back then: *"It was like they were just guessing, not like the 'real work' we can do with 'tools these days'"*.

Years later, Joe sat across from me and recalled that exact year in the vault—and then, without missing a beat, asked me why on earth I insisted on *"spilling all of our secrets"*.

That contradiction still cracks me up. The sacred industrial vault wasn't hoarding peerless alien technology; for decades, it was guarding manual guesswork and baseline physical principles dressed up in institutional secrecy. The gatekeeping wasn't about protecting divine truth—it was about keeping ordinary people from realizing how simple the core mechanics actually are.

On October 7, 2026, Joe and I were talking through the progression of the project. He brought up the digital caliper he'd picked up on fifty-percent-off clearance at Menards. In the early days, he'd sit down with that caliper and a pack of unbleached basket coffee filters, painstakingly measuring millimeter travel distances by hand to calculate retention factors. When he watched the mobile scanner do that entire calculation in three seconds on a phone screen, he marveled at the leap—and then leaned in with an urgent, dead-pan plea:

"Mike, whatever you do, please don't publish a fucking dope cook book."

That single line became both our favorite inside joke and the defining guardrail of this entire manual. We are not here to teach anyone how to manufacture clandestine compounds, synthesize illicit chemicals, or game a supply chain. We are here to do the exact opposite: establish defensive, non-destructive, open-source testing so regular people don't end up in an emergency room.

Sharon's Spice Rack and the Golden Dye

The actual physical breakthrough of the Purple Canary Protocol didn't come out of a hazardous-materials supply catalog. It came straight off my kitchen counter.

When forensic crime labs run thin-layer chromatography, compendial protocols rely almost exclusively on high-performance thin-layer chromatography (HPTLC) performed on inorganic silica gel 60\text{ F}_{254} plates. To develop those plates, technicians deploy toxic, volatile solvents—petroleum ether, diethyl ether, toluene, and halogenated hydrocarbons—paired with aggressive, carcinogenic diazonium visualization reagents like Fast Blue B and Fast Blue BB salts. Those chemicals work in specialized labs, but they are toxic, strictly regulated, volatile, and dangerous to keep around living spaces. You cannot hand a bottle of Fast Blue BB or halogenated developing eluent to an outreach volunteer working the night shift in a community shelter and expect safe handling.

I needed an indicator that was non-toxic, food-safe, and capable of binding to target compounds without requiring a chemical fume hood.

Turmeric happens to be my wife Sharon's favorite cooking spice. Her kitchen cabinets are never without it. The primary active curcuminoid in turmeric—curcumin (a polyphenolic diferuloylmethane)—carries a fascinating chemical property: it is a

potent, naturally occurring fluorophore featuring an active keto-enol tautomeric system. Under normal daylight, it presents as a warm golden-orange pigment. But expose curcumin to long-wave ultraviolet light (365 nm), and its conjugated backbone fluoresces with vibrant greenish-yellow luminescence. More importantly, as it interacts with specific cannabinoid structures, aromatic rings, and cutting agents across a migrating solvent, it produces distinct, observable colorimetric signatures and diagnostic fluorescence quenching.

The visualization reagent wasn't an exotic industrial dye; it was the golden spice sitting on Sharon's pantry shelf.

Ditch the Pure Ethanol: The D-Limonene Solution

Next came the mobile solvent. Classical chromatography often relies on high-proof anhydrous ethanol, hexane, or methanol. But high-purity ethanol is heavily taxed, state-controlled, or outright unavailable in many jurisdictions without specialized permits. Hydrocarbons like hexane are toxic fire hazards.

The alternative was staring us in the face: **D-Limonene**.

D-Limonene is a cyclic *p*-menthadiene hydrocarbon terpene cold-pressed directly from citrus rinds. It is entirely food-grade, widely manufactured as an industrial botanical degreaser, non-scheduled, and globally accessible at low cost. Chemically, it possesses a low dielectric constant ($\epsilon \approx 2.3$) and zero hydrogen-bonding capability—delivering the exact lipophilic hydrocarbon characteristics required to dissolve and carry dense plant resins, distillates, and synthetic adulterants across untreated Whatman Grade 1 cellulose paper.

By dissolving curcumin directly into pure D-Limonene at a precise ratio—**95.5% D-Limonene to 0.5% Curcumin (w/v)**—we

eliminated an entire operational step. Instead of requiring testers to develop a blank plate and subsequently mist a carcinogenic diazonium reagent onto a wet strip, the carrier solvent and the visualization fluorophore were unified into a single, stable, food-grade working solution.

The Thermos as an Analytical Chamber

The biggest physical headache in field chromatography is vapor saturation. If you run a paper strip in an open cup or a drafty room, the solvent evaporates off the paper faster than it climbs, warping the front and destroying the accuracy of your measurements. Labs solve this with heavy, five-hundred-dollar ground-glass developing tanks.

Our developing tank is a vacuum-insulated stainless steel thermal bottle.

A standard thermos provides a sealed, light-tight, thermally stable micro-environment. When you place a few drops of the D-Limonene matrix at the bottom, close the lid, and let the headspace saturate with vapor, it creates an optimal chromatography chamber on any flat surface. It doesn't break if you drop it on pavement, it fits in a cup holder, and nobody gives it a second glance.

The Zero-Frustration Gathering List

To make sure you never find yourself halfway through a test only to realize you are missing a vital tool, here is the complete, zero-frustration checklist of everything you need before starting:

1. Core Analytical Hardware

- **The Developing Chamber:** One standard stainless steel, vacuum-insulated thermal bottle (350 mL to 500 mL travel thermos) with an airtight screw-on lid.

- **The Optical Excitation Light:** One small 365 nm long-wave ultraviolet (UV-A) keychain torch with fresh batteries. (Make sure it is true 365 nm filtered black-light LED, not a purple 395 nm party bulb).
- **The Digital Sensor:** Any standard smartphone with a functioning camera.

2. Reagents & Testing Substrates

- **The Developer Solution:** One small dropper bottle of 95.5% D-Limonene to 0.5% Curcumin (w/v) developer.
- **The Carrier Extraction Fluid:** One small dropper bottle of pure D-Limonene or high-grade isopropyl alcohol ($\geq 91\%$).
- **The Test Strips:** Pre-cut strips of untreated Whatman Grade 1 cellulose chromatography paper ($20\text{ mm} \times 80\text{ mm}$). (*Emergency kitchen alternative: strips cut from unbleached basket coffee filters*).

3. Precision Application & Kitchen Tools

- **Micro-Applicators:** Glass micro-capillary tubes (0.5 to 1.0 μL internal volume) or Drummond micro-pipettes. (*Alternative: clean sewing needle or fine wire tip*).
- **Marking Tool:** One standard **graphite pencil** (HB or #2). **Never use an ink pen, marker, or rollerball**, as foreign ink dyes will wash up the paper and destroy your results.
- **Metric Ruler:** A small ruler marked in millimeters to measure the 1.5 cm baseline and solvent migration distances.
- **Sample Well:** A clean ceramic watercolor well, small glass shot glass, or clean bottle cap for dissolving the micro-sample.

- **Handling & Safety:** Clean nitrile gloves and a pair of small tweezers to lift the wet strip from the chamber without touching it with bare fingers.

Gather these items onto a clean, flat table, and you have a complete, portable analytical laboratory ready to go.

Why We Give the Secrets Away

When people see the complete demo kit laid out in its cardboard packaging—emblazoned with the Purple Canary bird—the immediate question is always about business defense: *Why aren't you patenting the formulation? Why aren't you locking this behind closed enterprise licenses?*

Because hoarding public health tools behind corporate patents is how we ended up in the adulterant crisis in the first place.

If you know how to build a working life jacket, you don't keep the blueprint locked in a safe while people are drowning in the harbor. You draw the schematic on the wall, hand out the canvas, and show everyone how to stitch the seams. The Purple Canary Protocol belongs to everyone—from the person testing a five-dollar preroll on their kitchen table to the peer specialist running samples out of a civic outreach van. The secrets are out, the guesswork is over, and the tools are in your hands.

Chapter 3: Paper, Light, and Lemon: The Chemistry in Plain English

You do not need a degree in biochemistry to understand thin-layer chromatography. In fact, if you have ever spilled coffee on a paper towel or watched water creep up a napkin, you already understand the core physics.

Analytical chemistry often hides behind Latin terms and multi-syllable jargon to keep non-experts from asking questions. But strip away the cleanroom mystique, and the fundamental mechanics of the Purple Canary Protocol come down to three everyday concepts: paper, light, and lemon.

The Kitchen Demo: Ink on a Paper Towel

Take a black felt-tip marker, make a single dark dot near the bottom edge of a strip torn from a white paper towel, and dip just the bottom tip into a shallow dish of water. Keep the dot itself above the water line.

Within seconds, the water begins to climb. As the moisture passes through the ink mark, the black dot does not just move upward as a single black smear. It begins to unravel. You will see a ring of deep blue pull away first, followed by a trail of red or purple, and perhaps a faint trace of yellow lingering near the base.

That simple separation is chromatography in action:

- **The Stationary Phase:** The porous paper towel itself, standing still and holding its physical structure.

- **The Mobile Phase:** The liquid water creeping upward through the paper's fibers via capillary action.
- **Differential Affinity:** The different dye molecules blended together inside the marker have different chemical attractions. Some dyes bind tightly to the paper fibers and drag their feet; other dyes dissolve easily into the water and ride the wave toward the top.

Because each chemical component moves at its own distinct speed, the mixture separates into individual, visible bands.

The Strip, the Spot, and the Lemon Climb

In the Purple Canary Protocol, the target is not marker ink; it is the sticky, complex resin found in plant material, vape cartridges, concentrates, and counterfeit preparations.

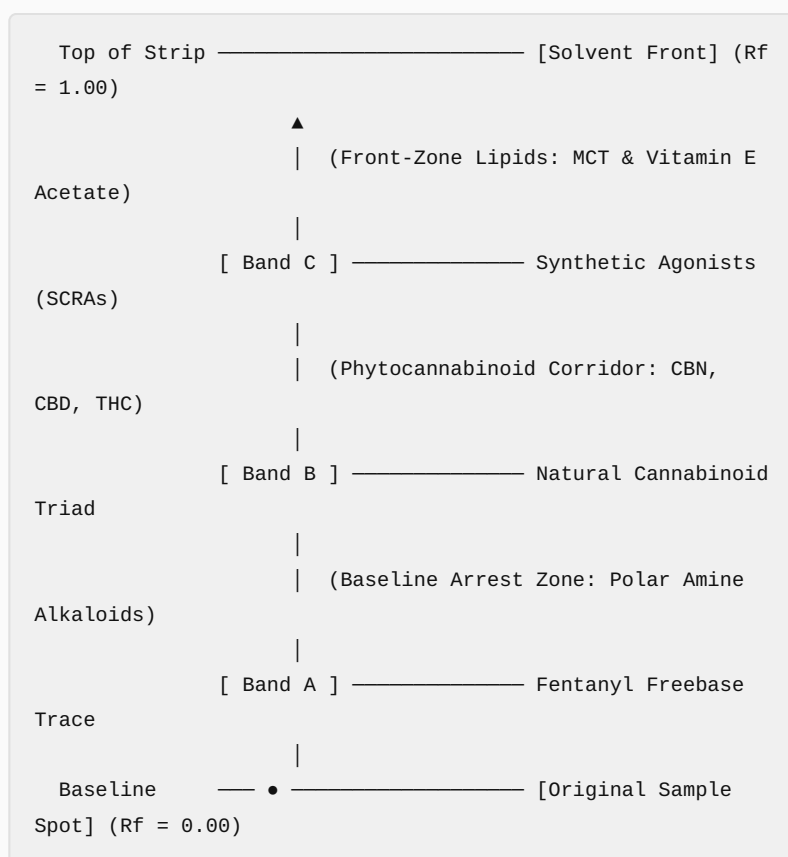
Water will not work here. Cannabinoids, terpenes, cutting agents, and synthetic adulterants are lipophilic—meaning "fat-loving." They are oily, waxy, and completely insoluble in water. If you dipped a spotted strip into water, the sample would sit at the starting line completely frozen, like grease on a wet plate.

This is why we use **D-Limonene** as the carrier solvent. Extracted straight from cold-pressed orange peels, D-Limonene is a pure cyclic *p*-menthadiene hydrocarbon terpene possessing a low dielectric constant ($\epsilon \approx 2.3$) and zero hydrogen-bonding capability. In plain English: it is a pure, food-grade botanical citrus oil that dissolves dense plant extracts, sticky vape distillates, and synthetic binders effortlessly.

Our stationary phase is untreated **Whatman Grade 1 cellulose chromatography paper**. At the molecular level, cellulose consists of

pure β -(1,4)-D-glucan polysaccharide chains presenting dense forests of hydroxyl (water-like) chemical groups, naturally holding 5% to 8% bound atmospheric moisture within its fibers. Think of the paper as a microscopic obstacle course lined with water-loving velcro hooks.

When you place a micro-spot of your sample onto the base of a pre-cut cellulose strip and introduce the D-Limonene developer, capillary action takes over:



As the citrus solvent climbs the paper fibers, it dissolves the sample spot and carries its individual chemical passengers upward.

The separation is an elegant molecular tug-of-war: molecules that love water and polar surfaces grab onto the paper's damp fibers and lag behind; oily, non-polar molecules that love citrus oil dissolve into the climbing solvent front and race straight to the top.

Curcumin: The Built-In Golden Dye

If you ran a standard chromatography strip with pure D-Limonene alone, the compounds would separate cleanly, but you wouldn't be able to see them. Pure cannabinoids and synthetic research chemicals are generally clear, pale amber, or translucent oils. On white paper, they look like invisible ghosts.

This is where Sharon's favorite kitchen spice enters the equation.

By formulating our developer solution with **95.5% D-Limonene and 0.5% Curcumin (w/v)**, the solvent and the visualization dye become one single fluid. Curcumin is the primary polyphenolic compound in turmeric, featuring an active keto-enol tautomeric system. It isn't just a bright yellow food coloring; it is a natural fluorophore—a light-sensitive molecular dye.

As the citrus solvent climbs the strip, curcumin travels right alongside it, interacting directly with the migrating compounds. At $0.5\% \text{ w/v}$, curcumin dissolves smoothly into the terpene carrier. As it meets different molecules, curcumin clusters around their aromatic rings and functional groups, creating distinct color variations and density bands along the paper.

The 365 nm Keychain Light: Revealing the Invisible

Under ordinary room light, a developed strip looks like a soft yellow paper slip with subtle shadings. But click on a small **365-nanometer ultraviolet keychain torch**, and the strip lights up like a neon billboard:

- **Natural Fluorescence:** The background curcumin glows with a vibrant greenish-yellow luminescence under long-wave UV radiation.
- **Fluorescence Quenching:** Many synthetic cutting agents, artificial aromatic rings, and dangerous adulterants absorb UV light like a black hole without emitting any glow back. This creates sharp, ink-dark silhouette bands that "quench" the glowing background.
- **Fluorophore Shifts:** Natural cannabinoids interact with curcumin to produce diagnostic color shifts, glowing with warm amber, soft gold, or deep purple-tinted outlines that room light hides completely.

A five-dollar keychain light replaces an entire benchtop optical sensor, turning invisible chemistry into high-contrast visual signposts.

Demystifying the R_f Value: Kitchen Math

In laboratory reports, chemists talk about the **Retention Factor**, or **R_f value**. It sounds intimidating, but it is nothing more than a simple fraction:

$$R_f = \frac{\text{Distance traveled by compound}}{\text{Distance traveled by solvent front}}$$

Think of it like a footrace:

1. If the citrus solvent climbs exactly **50 millimeters** up the strip from the starting pencil line, the total race distance is 50 mm.
2. If an unknown compound travels **25 millimeters** up that same strip before coming to a stop, its score is:

$$\frac{25 \text{ mm}}{50 \text{ mm}} = 0.50$$

1. Its R_f address is **0.50**.

Through rigorous laboratory cross-checking against international forensic compendia, the Purple Canary Protocol maps eight primary target compounds across four toxicological classes into an orderly, reproducible migration ladder:

$$\begin{aligned} & \text{fentanyl freebase } (0.12 - 0.18) < \text{CBN } \\ & (0.34 - 0.40) < \text{CBD } (0.42 - 0.48) < \Delta^9\text{-} \\ & \text{THC } (0.52 - 0.58) \\ & < \text{ADB-PINACA } (0.68 - 0.74) < \text{MDMB-4en-} \\ & \text{PINACA } (0.72 - 0.78) < \text{MCT } (0.80 - 0.88) < \\ & \text{vitamin E acetate } (0.84 - 0.92) \end{aligned}$$

The Four Molecular Corridors: Why They Separate

Why do these substances arrange themselves in this exact sequence? The mechanics come down to four distinct physical neighborhoods:

1. The Polar Baseline Zone: Fentanyl Freebase ($R_f = 0.12 - 0.18$)

Fentanyl contains a basic tertiary piperidine nitrogen ($pK_a \approx 8.4$) and an amide carbonyl group. In traditional crime labs

using silica glass plates, chemists must add harsh alkaline chemicals (like volatile diethylamine or concentrated ammonia) to force basic drugs to move. In our food-grade system, there are no harsh chemicals. The basic nitrogen core of fentanyl grabs onto the damp cellulose paper fibers through powerful electrical attractions and hydrogen bonds. Because neutral citrus terpene has zero pull for basic polar compounds, fentanyl gets trapped right near the starting line, appearing as a telltale dark quenching silhouette at the baseline ($R_f = 0.12 - 0.18$).

2. The Phytocannabinoid Corridor ($R_f = 0.34 - 0.58$)

On traditional silica lab plates, CBD travels slower than CBN. On our paper strip developed with citrus terpene, that order is flipped:

$$\text{CBN } (0.34\text{--}0.40) < \text{CBD } (0.42\text{--}0.48) \\ < \Delta^9\text{-THC } (0.52\text{--}0.58)$$

This inversion happens because of two straightforward physical mechanisms:

- **Flat Stacking (CBN):** Cannabinol (CBN) is the fully aged degradation product of THC. Its chemical core is completely flat and rigid, like a piece of cardboard. It stacks flat against the flat sugar rings of the paper fibers, creating physical friction that drags it down.
- **"Like Dissolves Like" (CBD):** Cannabidiol (CBD) has an open, flexible ring attached to a terpene tail called *p*-menthadienyl. D-limonene is *itself* a citrus *p*-menthadiene terpene. Because like dissolves like, the citrus solvent grabs the terpene half of CBD, dissolves it instantly, and sweeps it past CBN up the paper.

- **Balanced Lipophilicity (Δ^9 -THC):** Natural THC pairs high oil solubility ($\log P \approx 6.97$) with only a single water-loving hydroxyl handle, giving it an intermediate cruising speed right in the sweet spot of $0.52 - 0.58$.

3. Synthetic Cannabinoid Receptor Agonists ($R_f = 0.68 - 0.78$)

Synthetic cannabinoids like ADB-PINACA ($0.68 - 0.74$) and MDMB-4en-PINACA ($0.72 - 0.78$) migrate well above natural plant cannabinoids. Why? They possess **zero phenolic hydroxyl groups**—they lack the natural "brake pads" that slow real plant cannabinoids down against paper fibers. They glide effortlessly with the citrus solvent.

Between the two synthetics, the split is equally distinct: ADB-PINACA has a terminal primary carboxamide group ($-\text{CONH}_2$) whose two hydrogen protons grab slightly at the paper fibers. MDMB-4en-PINACA has an ester tail ($-\text{COOCH}_3$) with zero hydrogen-donating protons and an oily pentenyl chain that dissolves even faster into the terpene solvent, pulling it slightly ahead.

4. Front-Zone Cutting Agents ($R_f = 0.80 - 0.92$)

Medium-chain triglycerides (MCT oil, $0.80 - 0.88$) and Vitamin E acetate ($0.84 - 0.92$) occupy the top attic of the strip, right behind the solvent front. Both are neutral, hyper-greasy oils ($\log P > 8.0$ for MCT and $\log P \approx 10.7 - 12.2$ for Vitamin E acetate) that have zero interest in paper fibers. In Vitamin E acetate, its water-attracting oxygen is chemically masked by an acetate shield, allowing its long sixteen-carbon tail to surf right along the solvent front. MCT's three exposed ester dipoles feel just enough friction from the paper to settle cleanly below Vitamin E acetate.

The 3-to-5 Minute Chamber Rule

For this chemistry to work reliably on a kitchen table or in a parking lot, the climb must happen inside a sealed micro-climate.

If you let a paper strip climb out in the open air, the citrus terpenes evaporate into the room while the liquid tries to climb. This causes the solvent front to stall, dry out unevenly, and warp the migration distances.

This is why the **insulated stainless steel thermal bottle** serves as our developing chamber:

- **Headspace Saturation:** Adding 1.5 to 2.0 mL of developer solution to the bottom of the thermos and closing the cap for two minutes fills the interior air with solvent vapor.
- **Zero Evaporation Gradient:** When you place the spotted paper strip inside and screw the lid shut, the air inside is already completely saturated. The solvent cannot evaporate off the paper mid-climb. It climbs straight, smooth, and true.
- **The 3-to-5 Minute Window:** Because cellulose paper allows rapid capillary flow, a complete run finishes in just three to five minutes.

You don't need a chemical fume hood, you don't need expensive glass chambers, and you don't need carcinogenic petroleum solvents. You need a strip of paper, a drop of citrus developer, a closed thermal bottle, and a beam of ultraviolet light. That is all it takes to turn invisible chemistry into undeniable, visual truth.

Chapter 4: SPOT: Taking the Sample

The accuracy of every chromatographic test is decided in the first five seconds of preparation. If you overload the paper, smudge the origin, or use the wrong tool to mark your line, no computer vision app or UV light in the world can rescue the run.

The first phase of the protocol is **SPOT**. It is the physical moment where an unknown street substance meets analytical paper. Because this is micro-scale testing, you need only a pinhead-sized fragment—leaving virtually the entire sample intact.

Safe Handling Protocols

Treat every unknown sample with strict protective discipline. In an unregulated market contaminated with hyper-potent synthetic opioids and novel research chemicals, casual handling poses genuine contact hazards.

1. **Glove Up:** Wear clean nitrile gloves. Never handle unknown street powders, concentrates, or blotters with bare fingers. Skin oils interfere with capillary action, and accidental transdermal transfer is completely avoidable.
2. **Sanitize the Surface:** Work on a clean, non-porous surface. Lay down a silicone mat or wipe down your immediate prep area with an isopropyl alcohol wipe before taking test strips out of their pouch.

3. **Never Ingest or Sniff:** Do not lick, taste, touch to your gums, or deeply sniff an unknown substance to "judge its quality." That is not testing; it is Russian roulette.
-

How Much Sample Is Needed?

Beginners almost always use too much material.

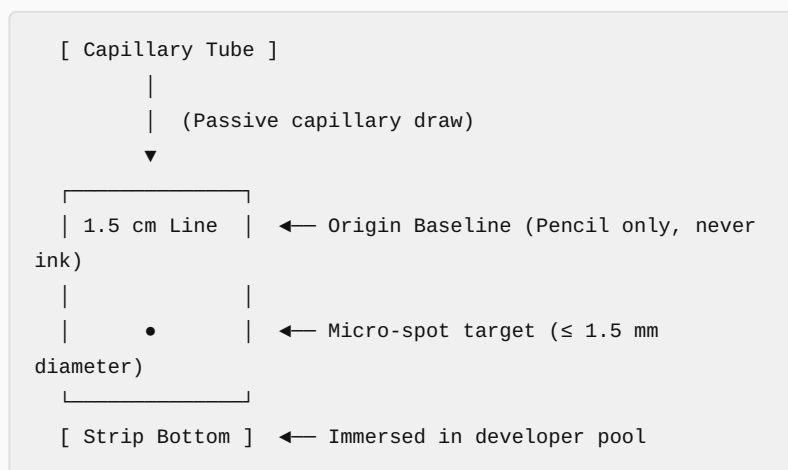
If you drop a heavy blob of sticky resin or a pile of powder onto a paper strip, the solvent cannot dissolve it cleanly. Instead of separating into neat, readable migration bands, the overloaded spot acts like a dam: the climbing citrus solvent drags a heavy, unseparated smear up the middle of the paper, ruining the test.

- **Powders & Crystals:** A pinhead speck—roughly the size of a single grain of table salt (less than 1 mg).
 - **Resins, Distillates & Vape Oils:** The tip of a paperclip touched lightly to the oil, transferring a microscopic droplet smaller than 1 millimeter.
 - **Plant Material & Flower:** A tiny pinch of leaf or ground bud (less than 2–3 milligrams, about the size of an sesame seed) soaked in two drops of solvent to extract the resins.
 - **Blotters:** A 1-millimeter corner snippet clipped with clean shears.
-

The First-Timer's Step-by-Step Spotting Guide

The Purple Canary Protocol uses miniature glass capillary tubes to transfer exact micro-volumes. Capillary action draws liquid up into

the narrow glass tube instantly without requiring a plunger, bulb, or syringe.



Follow this exact sequence:

1. **Mark the Origin with Pencil:** Measure exactly 1.5 centimeters (15 mm) from the bottom edge of the paper strip. Using a standard **graphite pencil**, draw a faint horizontal reference line across the strip and place a tiny dot at the center. **Never use an ink pen, rollerball, or marker.** Ink contains synthetic dyes that will dissolve in the citrus solvent and bleed up your strip, creating false bands.
2. **Dissolve the Micro-Sample:** Place your tiny sample fragment into a clean ceramic well or small glass vial. Add **2 drops** of pure D-Limonene or high-grade isopropyl alcohol ($\geq 91\%$). Agitate the liquid gently with the tip of a toothpick or clean capillary tube for 30 seconds until the resins dissolve. If testing leaf, let the green flakes settle for 20 seconds so you sample only the clear liquid.
3. **Anchor Your Hands (Eliminate Shakes):** Glass capillary tubes are delicate. Rest the heel of your hand and your wrist firmly on

the table before bringing the tube to the paper. This physical anchor completely eliminates hand tremors.

4. **Load the Capillary:** Touch the open tip of the glass capillary tube to the surface of the dissolved sample liquid. Capillary pressure will instantly draw a tiny column of fluid a few millimeters up the glass.
5. **The Practice Tap (Pro Tip):** If this is your first time, do a practice tap on a scrap piece of paper towel. Touch the tip to the towel for a split second to feel how fast the liquid transfers.
6. **Touch and Release (< 0.5 Seconds):** Hold the capillary tube completely perpendicular (at a 90-degree right angle) directly above the pencil mark on your strip. Lightly tap the glass tip to the paper for less than half a second—a quick typewriter strike—and pull it straight up. The liquid will wick outward into a crisp, neat circle. The wet spot must not exceed 1.5 millimeters in diameter.
7. **Air-Dry Completely (60 to 90 Seconds):** Set the strip flat on a clean surface and let the solvent evaporate for 60 to 90 seconds. The spot must be completely dry before it enters the chamber. Inserting a wet spot will cause the sample to bleed sideways and distort your run.

Handling Different Substance Forms

- **Dry Flower & Leaf:** Finely crush the tiny pinch between clean wax paper or foil. Transfer the dust into the extraction well, add two drops of carrier fluid, and agitate gently for 30 seconds before drawing with the capillary.

- **Vape Oils & Concentrates:** Dab the sticky distillate directly onto the end of a toothpick or clean needle. Swirl it in a single drop of solvent inside the well until completely dissolved. Spot the resulting fluid onto the strip.
 - **Counterfeit Pills & Tablets:** Shave off a microscopic scrape of dust from the edge of the pill using a clean blade. Crush the dust fine, dissolve in two drops of solvent, and spot.
 - **Blotters & Papers:** Submerge the 1mm paper corner in two drops of carrier solvent inside the well for two minutes to allow the compound to extract into the liquid, then spot the fluid directly.
-

Common Spotting Mistakes & Rapid Corrections

Spotting Error	Physical Symptom on Strip	What Went Wrong	Immediate Correction
Over-Saturation	Giant dark smear extending through the center	Too much sample; capillary held down too long	Discard strip; dilute extract 3× and re-spot with a split-second tap.
Submerged Baseline	Sample washes backward into solvent pool	Liquid pool in chamber was higher than 1.5 cm	Ensure developer level is strictly below the 1.5 cm pencil line.
Wet Entry	Blurred, crescent-shaped migration front	Strip put in chamber before spot was dry	Allow spot to air-dry for full 90 seconds before inserting.
Pen Baseline Ink	Extra foreign dye bands trailing from bottom	Origin marked with pen or felt-tip marker	Only use graphite pencil to mark reference points.

Mastering the **SPOT** phase turns physical sampling into second nature: minimal material, zero waste, absolute precision, and complete safety. Once the dry spot is set on the pencil line, your strip is ready for the chamber.

Chapter 5: SNAP: The Phone Does the Seeing

Once your spotted strip is dry, you place it inside the primed thermal bottle, tighten the threaded lid, and begin the run.

This brings us to the most dangerous hazard in field testing: **the three-minute waiting gap.**

The Three-Minute Wait: Boredom, Confusion, and The No-Peek Rule

When beginners drop a test strip into the thermos, impatience immediately kicks in. After ninety seconds of staring at a closed stainless steel bottle, curiosity takes over: *Is it climbing? Did it stall? Let me just crack the lid for two seconds to take a peek.*

Do not open the lid.

Opening the lid while the solvent is climbing is the single fastest way to ruin a test. Here is why: the thermal bottle works because its interior headspace is completely saturated with citrus terpene vapor. The moment you break that seal, the dense vapor escapes into the room. Ambient air rushes in, solvent rapidly evaporates off the wet paper fibers, the climbing front stalls out unevenly, and your retention factor calculations are completely warped.

Manage the waiting period with active preparation:

1. **Set a Phone Timer for Exactly 3.5 Minutes:** Don't guess the time. Hit start on your phone's stopwatch the second the thermos cap is tightened. A standard run on Whatman Grade 1 paper climbs roughly 10 to 15 millimeters per minute; 3.5 to 4 minutes

allows the solvent front to reach the optimal upper third of the strip without running off the top edge.

2. **Never Abandon the Chamber:** If you walk away to watch television and leave the strip inside for twenty minutes, the solvent will climb all the way to the top edge and pool, destroying your solvent front boundary. Stay with your kit.
3. **Use the Wait to Build Your Scan Station:** While the strip climbs inside the dark bottle, use those three minutes to prepare your scanning rig:
 - Lay down your clean, matte white background card.
 - Check your 365 nm keychain light (confirm the beam is bright; remember: **never look directly into the ultraviolet LED emitter**).
 - Open your smartphone camera, wipe the camera lens clean of fingerprint grease, and set up your improvised cardboard stand or coffee mug dock.

When the timer rings, unscrew the bottle, grasp the top edge of the strip with tweezers, remove it smoothly, and immediately make a faint pencil tick mark at the highest wet boundary (the solvent front). Set the strip flat to air-dry for 60 seconds.

Now, you are ready for **SNAP**.

Why the Phone Beats the Human Eye

For a trained forensic toxicologist working under fixed laboratory hoods, reading a chromatogram is second nature. But for an everyday consumer in a dimly lit kitchen or a volunteer in an outreach tent, relying solely on the human eye introduces subjective guesswork.

Is that faint band sitting at an R_f of 0.42, or is it 0.48? Is that amber hue under the UV light shifting toward a natural cannabinoid, or is it the telltale fluorescence quenching of a synthetic adulterant? Under incandescent bulbs, streetlights, or flickering fluorescent tubes, human eyes play tricks.

Our retinas constantly adjust color perception based on ambient surroundings—a phenomenon called chromatic adaptation. A strip inspected under a warm bedside lamp looks completely different when viewed under cool white kitchen lights.

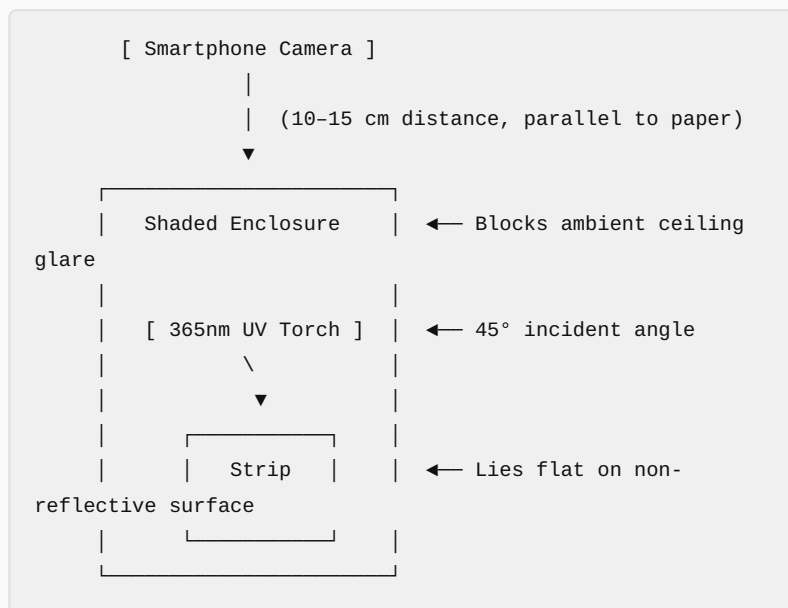
A digital smartphone sensor, by contrast, records raw, objective optical data across discrete color channels:

- **RGB Colorimetric Vectors:** The camera decomposes every pixel along the strip into precise Red, Green, and Blue intensity values. Instead of relying on a subjective description like "faint brownish-yellow," the software measures an exact vector coordinate (such as R: 182, G: 144, B: 38).
- **Channel Normalization:** By anchoring its exposure against the known, unspotted white background of the cellulose paper, the software mathematically strips out ambient lighting tints.
- **Objective Densitometry:** The camera traces the entire vertical axis of the strip from the origin line to the solvent front, generating a continuous density curve that highlights microscopic peaks of compound concentration that human vision would miss entirely.

Setting Up the Shot: The Light Box Principle

To get a reliable digital capture, you must control three physical variables: **distance**, **angle**, and **illumination**.

You do not need specialized laboratory hardware. A simple cardboard box, the inner lid of your kit packaging, or a clean coffee mug can serve as an improvised optical alignment rig:



Follow the two-pass capture workflow:

1. **Lay the Strip Flat:** Place the fully developed, dried test strip onto a clean, neutral matte white card.
2. **Pass 1 (Daylight Reference Capture):**
 - Position your phone directly above the strip (parallel to the paper, 10 to 15 cm away).
 - Ensure even, diffuse ambient lighting. If direct overhead ceiling lights cast harsh glare, cup your hand or use the kit box lid to cast a soft shadow over the card.
 - Tap your phone screen to lock focus onto the strip. Snap the photo.

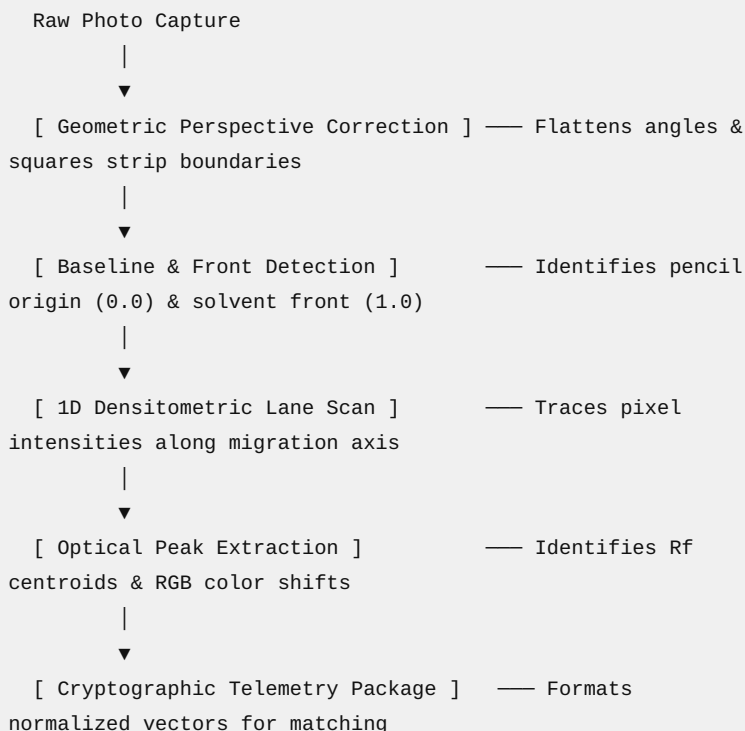
- The software uses this daylight image to locate the paper boundaries, measure the graphite origin baseline ($R_f = 0.00$), confirm the solvent front ($R_f = 1.00$), and detect natural plant pigments.

1. Pass 2 (The 365 nm UV-A Fluorescence Capture):

- Dim or shade the surrounding ambient light.
- Hold your 365 nm UV keychain light at a **45-degree angle**, roughly 5 to 8 centimeters away from the strip. **Do not hold the light straight down at 90 degrees**, as specular ultraviolet reflection will bounce directly into the phone lens and wash out the image.
- Tap the screen to focus on the fluorescent paper. Snap the second photo while the paper glows under UV.

What the Software Measures

When the photos are captured, the computer vision engine processes the image through an automated analytical pipeline in seconds:



- 1. Perspective Correction:** The software identifies the four corners of the paper strip, correcting for slight tilts or lens distortions so the paper is rendered completely flat and rectangular.
- 2. Anchor Registration:** The engine locates the graphite origin baseline (assigned as $R_f = 0.00$) and the maximum solvent migration front (assigned as $R_f = 1.00$).
- 3. Peak Extraction:** The densitometry algorithm calculates the exact center point (centroid) of every fluorescent or darkened band along the migration lane, measuring its precise travel distance to two decimal places.
- 4. Colorimetric Profiling:** For each detected band, the software samples the localized color shift against the surrounding

curcumin background, noting whether the analyte fluoresces, quenches, or alters the hue spectrum.

The Reference Set and Open Telemetry

Once the image is digitized into normalized R_f values and colorimetric vectors, the mobile scanner compares those coordinates against a reference library of validated chemical signatures.

This signature library is anchored around eight primary empirical migration corridors spanning four toxicological classes, validated under standardized conditions (95.5:0.5 D-limonene/curcumin on Whatman Grade 1 paper):

1. High-Hazard Opioids & Polar Amine Alkaloids ($R_f = 0.12 - 0.18$):

- *Fentanyl (freebase trace)*: Indeterminate daylight profile; sharp, localized dark UV quenching silhouette near the baseline origin.

1. The Natural Phytocannabinoid Triad ($R_f = 0.34 - 0.58$):

- *Cannabinol (CBN, 0.34 - 0.40)*: Muted amber daylight profile; dull yellow-brown emission under 365 nm UV.
- *Cannabidiol (CBD, 0.42 - 0.48)*: Faint yellow-amber daylight profile; soft golden fluorescence emission.
- Δ^9 -Tetrahydrocannabinol (Δ^9 -THC, 0.52 - 0.58): Soft orange-amber daylight band; warm amber fluorescence.

1. Synthetic Cannabinoid Receptor Agonists ($R_f = 0.68 - 0.78$):

- *ADB-PINACA (0.68 - 0.74)*: Clear/translucent under daylight; sharp, dark UV quenching band.

- *MDMB-4en-PINACA* (0.72 - 0.78): Clear/translucent under daylight; deep, intense quenching silhouette.

1. Lipophilic Cutting Agents & Thickeners ($R_f = 0.80 - 0.92$):

- *Medium-Chain Triglycerides* (MCT, 0.80 - 0.88): Clear lipid band; distinctive light refractive halo under UV.
- *Vitamin E Acetate* (*\alpha*-tocopheryl acetate, 0.84 - 0.92): Glossy pale streak; strong hydrophobic trail with marked UV quenching.

This analytical pairing represents the core design of the Purple Canary architecture. On one side sits an archaic, low-cost strip of filter paper moving via passive capillary action; on the other sits a modern digital eye that registers, normalizes, and verifies the result against empirical chemistry.

With a steady hand, a five-dollar keychain light, and a smartphone camera, the paper yields its data in seconds. The strip has been spotted, the climb has finished, and the image is captured.

Next comes the decisive step: knowing exactly what the readout means.

Chapter 6: KNOW: Reading Your Results

The final phase of the protocol is **KNOW**. Once the phone captures and processes the strip, the screen transitions from raw densitometric scans to an operational readout.

Understanding that readout requires the right mental model. A chromatographic readout is not a magic crystal ball, nor is it a stamp of institutional approval. It is best understood as a **weather report for your substance**. A meteorological radar does not promise you will never slip on wet pavement; it reveals incoming storm fronts, severe barometric drops, and sudden turbulence so you can make informed decisions before walking out into the weather.

Reading the Chromatogram: Bands as Signposts

A developed strip displays discrete bands along a vertical continuum from origin ($R_f = 0.00$) to the solvent front ($R_f = 1.00$). When you look at the app display or inspect the physical strip under the 365 nm torch, each vertical position functions like an unambiguous address:

- **1. The Polar Baseline Zone ($R_f = 0.12 - 0.18$):**
 - *Target Compound:* **Fentanyl (freebase trace)** ($R_f = 0.12 - 0.18$).
 - *Mechanism:* Basic amine alkaloids contain basic tertiary piperidine nitrogens ($pK_a \approx 8.4$). In the absence of alkaline modifiers (like diethylamine or ammonia), these molecules form intense ion-dipole and hydrogen-bonding networks with the poly-hydroxyl cellulose matrix and its 5-8%

bound atmospheric water layer. Non-polar D-limonene cannot overcome this stationary-phase capture, arresting fentanyl trace right near the origin.

- *Optical Signature*: Indeterminate in daylight; appears under 365 nm UV as a localized, sharp dark quenching zone.
- **2. The Phytocannabinoid Corridor ($R_f = 0.34 - 0.58$):**
 - *Target Compounds*: **CBN (0.34 - 0.40) < CBD (0.42 - 0.48) < Δ^9 -THC (0.52 - 0.58)**.
 - *Mechanism*: On paper developed with limonene, this triad resolves in an inverted order compared to traditional silica TLC. Cannabinol (CBN) is retarded because its planar, fully aromatized dibenzopyran core stacks flat against the pyranose rings of crystalline cellulose microfibrils. Cannabidiol (CBD) accelerates past CBN because its *p*-menthadienyl substituent shares structural homology with the cyclic *p*-menthadiene structure of D-limonene, driving it into the mobile phase. Δ^9 -THC follows closely behind, with high lipophilicity ($\log P \approx 6.97$) and minimal cellulose drag.
 - *Optical Signature*: CBN presents as muted amber daylight / dull yellow-brown UV emission; CBD presents as faint yellow daylight / soft golden UV fluorescence; Δ^9 -THC shows soft orange-amber daylight / warm amber UV emission.
- **3. The Synthetic Cannabinoid (SCRA) Corridor ($R_f = 0.68 - 0.78$):**
 - *Target Compounds*: **ADB-PINACA (0.68 - 0.74) < MDMB-4en-PINACA (0.72 - 0.78)**.
 - *Mechanism*: Synthetic indazole agonists lack phenolic hydroxyl groups entirely, so they experience vastly less stationary-phase drag than natural cannabinoids and migrate substantially higher. ADB-PINACA's primary carboxamide ($CONH_2$) offers

two hydrogen-bond donor protons, causing slightly more retention than MDMB-4en-PINACA, whose terminal methyl ester ($-\text{COOCH}_3$) has zero hydrogen donors and whose 4-pentenyl olefinic tail maximizes terpene solubility.

- *Optical Signature*: Translucent/invisible in daylight; both form striking, dark UV fluorescence quenching silhouettes under 365 nm.

- **4. The Front-Zone Lipid Corridor ($R_f = 0.80 - 0.92$):**

- *Target Compounds*: **Medium-Chain Triglycerides (MCT, $0.80 - 0.88$) < Vitamin E Acetate ($0.84 - 0.92$).**

- *Mechanism*: Neutral lipids with extreme lipophilicity ($\log P > 8.0$ and $10.7-12.2$). In Vitamin E acetate (α -tocopheryl acetate), the phenolic hydroxyl is esterified and sterically shielded by methyl groups on the chroman ring, allowing its 16-carbon phytyl tail to surf directly behind the solvent front. MCT's three exposed glycerol ester carbonyl dipoles provide slightly more polar interaction with cellulose, resolving cleanly below Vitamin E acetate.

- *Optical Signature*: Clear to glossy lipid streaks under daylight; distinctive refractive halo (MCT) or strong hydrophobic quenching trail (Vitamin E acetate) under UV.

Good vs. Bad Results: What They Look Like & What To Do

To remove any hesitation when reading your strip, here is the direct, side-by-side comparison of results and mandated actions:

1. What a "Good" (Presumptive Normal) Result Looks Like

- **Visual Appearance on Strip:**
 - Clean, continuous golden-yellow background under UV.
 - Clearly resolved warm amber or golden glowing bands strictly inside the **Phytocannabinoid Corridor** ($R_f = 0.34 - 0.58$).
 - **Zero dark silhouette quenching bands** near the baseline ($0.12 - 0.18$).
 - **Zero dark quenching bands** in the upper synthetic zone ($0.68 - 0.78$).
 - **Zero thick, greasy refractive trails** riding the solvent front ($0.80 - 0.92$).
- **What the App Reports:** PRESUMPTIVE BOTANICAL PROFILE: Natural Phytocannabinoids Identified; No Targeted Adulterants Detected.
- **What To Do:**
 - Understand that "no adulterant detected" is an absence of target markers, not a clinical certificate of total purity.
 - If you choose to consume, practice standard harm reduction: take a tiny test amount first ("low and slow"), never consume alone, keep naloxone within reach, and stay well hydrated.

2. What a "Bad" (Adulterated / High-Hazard) Result Looks Like

- **Visual Appearance on Strip:**
 - **A dark, ink-black quenching zone at the origin** ($R_f = 0.12 - 0.18$): Basic polar amine alkaloid arrest, indicating possible trace fentanyl or synthetic opioid contamination.
 - **A distinct dark quenching band in the upper zone** ($R_f = 0.68 - 0.78$): Telltale indicator of high-potency synthetic indazole

agonists (such as ADB-PINACA or MDMB-4en-PINACA) sprayed onto plant material or blended into distillate.

- **A heavy, glossy refractive smear or quenching trail at the solvent front ($R_f = 0.80 - 0.92$):** Exposes heavy unlisted bulking oils like MCT oil or toxic Vitamin E acetate.
- **What the App Reports:** HIGH-HAZARD ALERT: Synthetic Agonist / Adulterant Signature Detected at R_f [value].
- **What To Do:**
 - **PAUSE IMMEDIATELY. DO NOT CONSUME.**
 - Quarantine the product away from your living space.
 - Turn immediately to **Chapter 7: When the Result Scares You** for the disciplined confirmation re-test, non-judgmental community alert scripts, and safe disposal steps.

3. What an Inconclusive (Operator Error) Result Looks Like

- **Visual Appearance on Strip:** A heavy, unbroken dark streak dragging from origin to top; a crooked, crescent-shaped solvent front; or an origin where the sample washed backward into the solvent pool.
 - **What the App Reports:** RUN ERROR: Baseline Overload / Origin Washout / Skewed Geometry. Confidence Degraded.
 - **What To Do:** Discard the strip, re-read Chapter 4, dilute your sample 3×, and re-spot a fresh strip with a lighter tap.
-

Matches, Near-Matches, and Unidentified Bands

When the densitometry engine analyzes your strip against its reference library, it categorizes every detected peak into one of three classifications:

Classification	What the App Found	What It Means in Practice
Confirmed Match	Both R_f value and RGB color/quenching vector fall within tolerance ($< \pm 0.03 R_f$) of a library standard.	The detected band matches the physical behavior of a documented reference compound in the library.
Near-Match / Variance Flag	Migration distance matches a known compound, but color intensity or peak shape deviates slightly.	Environmental factors (humidity, heavy saturation) may have shifted migration, or a close analog derivative is present.
Unidentified Band / Novel Peak	A distinct optical band or UV-quenching zone is present at an address with no match in the reference set.	The sample contains an uncharacterized foreign additive, novel research chemical, or synthetic agent not present in standard profiles.

Confidence Levels and Algorithmic Caution

In harm reduction, false confidence gets people hurt. If an algorithm is 80% sure of a compound and tells the user "100% Verified Pure," it creates deadly complacency.

This is why the scanning engine is built to hedge. The system assigns confidence tiers based on multiple independent parameters:

1. **Geometric Quality:** Did the strip migrate straight, or was there edge curling?
2. **Exposure Calibration:** Was the paper background properly balanced against the baseline?
3. **Multi-Channel Concordance:** Does the band match across both the ambient daylight scan and the 365 nm UV fluorescence pass?

If lighting is uneven or the sample spot was overloaded, the app immediately downgrades its confidence score and advises a re-run rather than guessing. A test that openly admits its uncertainty is infinitely more valuable than one that delivers false comfort.

"No Adulterant Detected" Does Not Mean "Safe"

The single most critical distinction in presumptive testing is the difference between:

- **"No Adulterant Detected"**
- **"This Product Is Safe"**

The Purple Canary Protocol checks for specific chemical behaviors, known adulterant bands, synthetic cannabinoid markers, and anomalous cutting agents. However, no field test can declare any street substance universally "safe."

A clean profile simply means that within the detection limits of paper chromatography, no targeted adulterants, synthetic agonists, or common cutting agents were identified in that specific micro-sample.

It does not measure biological tolerance, microbial contaminants, pesticides below analytical thresholds, or idiosyncratic personal health reactions.

Tracking and Historical Comparison

Every test you run can be saved locally as an anonymized digital record.

Over time, this historical log turns personal testing into a powerful defense mechanism. You can compare a new batch against a scan from three weeks ago, noting shifts in cannabinoid density or the sudden appearance of secondary bands. In community outreach settings, comparing logs across multiple days allows peer workers to spot sudden influxes of contaminated supply moving through a specific district long before official toxicology alerts hit the news.

Once you know how to read the strip, ambiguity vanishes. The visual data is clear, the confidence boundaries are established, and the power to decide rests entirely with you. But what happens when the strip reveals something alarming? That is where decision-making shifts from observation to action.

Chapter 7: When the Result Scares You

It is one thing to run a test out of intellectual curiosity; it is another thing entirely when the 365 nm UV beam hits the paper and reveals an unexpected, sharp silhouette where clean space should be. Or worse, the phone screen flashes an alert: *High-potency synthetic agonist detected* or *Unidentified fluorophore band present*.

That is the exact moment when curiosity ends and operational harm reduction begins.

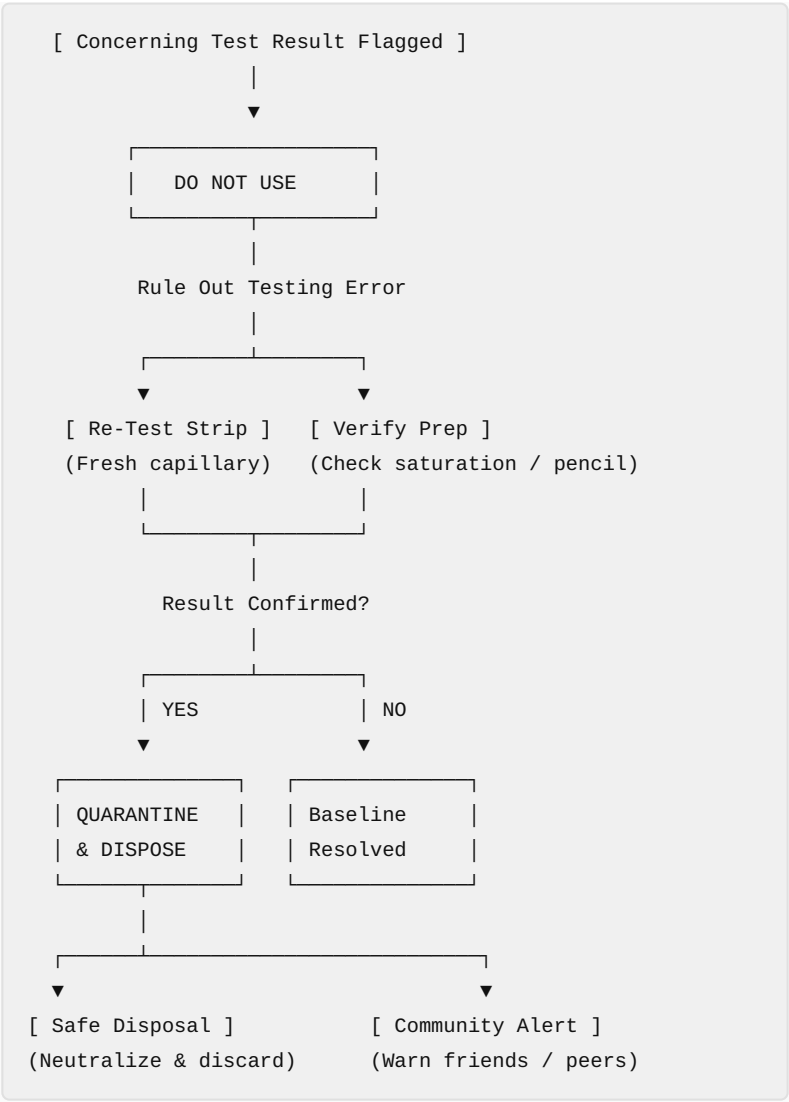
Your heart rate spikes. You might feel frustrated that money was wasted, or defensive because the person who handed you the bag is a friend who swore it came straight from a licensed caregiver.

The primary rule when a result scares you is simple: **Pause. Do not consume.**

A scary test result is not a failure; it is the entire system functioning as designed. The test did not create the danger in the substance; it exposed a hazard that was already lurking in the matrix before it had the chance to enter your bloodstream.

The Immediate Decision Tree

When a test flashes an anomalous band or an adulterant flag, follow a disciplined protocol rather than acting on impulse:



1. **Step 1: Quarantine the Batch.** Physically separate the suspect material from your regular space. Put it back into its container, seal it, and set it completely out of reach.

2. **Step 2: Re-Test to Rule Out Operator Error.** Did you accidentally touch the strip with bare fingers? Did you mark the baseline with an ink pen instead of a graphite pencil? Was the

spot overloaded with sticky resin, causing artificial streaking? Pull a fresh strip, take a second tiny pinhead sample, and re-run the 3-to-5-minute development in the thermal bottle. If the anomalous band appears a second time at the exact same R_f coordinate, the result is confirmed:

- **Baseline Quenching ($R_f = 0.12 - 0.18$):** Telltale polar amine alkaloid arrest, indicative of trace fentanyl freebase or basic opioid adulteration.
- **High Quenching Silhouette ($R_f = 0.68 - 0.78$):** Characteristic indicator of high-potency synthetic indazole agonists like ADB-PINACA ($0.68 - 0.74$) or MDMB-4en-PINACA ($0.72 - 0.78$) sprayed onto leaf or mixed into distillate.
- **Front-Zone Hydrophobic Drag ($R_f = 0.80 - 0.92$):** Exposes heavy unlisted cutting agents like MCT oil ($0.80 - 0.88$) or Vitamin E acetate ($0.84 - 0.92$).

1. **Step 3: Commit to the Stop.** Once confirmed, accept the finding. Do not convince yourself that "taking just a little hit" or "smoking half of it" will make it safe. Street adulterants like synthetic cannabinoid receptor agonists or hot-spot fentanyl contaminations are not distributed evenly throughout a bag; a single corner can carry a toxic threshold.

Safe Disposal: Don't Pass the Danger Along

The biggest temptation people face after buying bad product is trying to offload it to recover cash. Selling, trading, or gifting tainted product to someone else passes a potentially lethal risk down the line.

Disposal must be handled responsibly so pets, children, or scavengers do not accidentally encounter it:

- **Do Not Flush:** Avoid flushing large quantities of plant matter or concentrated chemical oils down the toilet; municipal wastewater treatment plants are not engineered to scrub high concentrations of synthetic compounds or terpenes.
- **The Coffee Ground / Kitty Litter Method:** Mix the remaining flower, powder, or distillate with used wet coffee grounds, dirt, or clumping cat litter in a sealable bag or jar. This renders the substance unusable and physically unappealing. Once mixed, seal the container tightly and dispose of it directly into an outdoor municipal waste bin.
- **Crush & Neutralize Concentrates:** For vape carts, unscrew the hardware if possible, empty the resin onto absorbent paper towels saturated with dish soap and rubbing alcohol to break the lipid matrix, and discard.

Layered Defense: Complementary Harm Reduction Tools

Paper TLC is an exceptional broad-spectrum screening platform, but it is one layer in an integrated harm reduction defense system:

- **Fentanyl Test Strips (FTS):** Immunoassay strips specifically engineered to detect fentanyl and major fentanyl analogs down to nanogram levels in diluted water solutions. If you are testing suspect powders or counterfeit pills, run an FTS alongside your TLC scan.
- **Xylazine Test Strips:** Rapid lateral flow strips engineered to flag the presence of "tranq" in unadulterated downers or street powders.

- **Naloxone (Narcan) on Hand:** Keep active naloxone nasal spray accessible anywhere people are gathering, partying, or consuming substances. Naloxone does not reverse cannabinoids, xylazine, or synthetic cannabinoids, but in any multi-drug emergency or unintentional opioid exposure, deploying naloxone is the immediate first action to restore respiration. Having naloxone in your home or pocket is not an admission of recklessness; it is basic life insurance.
-

Community Alerts as Mutual Aid

Harm reduction is inherently communal. When you uncover a contaminated batch, that information does not just belong to you; it can save the life of someone living two doors down or across the venue.

If you bought from a local circle or shared source, send a direct, neutral message to your peers:

"Hey heads up: tested the recent batch from [source/description] with a test strip and UV scan. Came back hot with an anomalous synthetic band / cutting agent. I trashed mine—don't smoke/take it."

Notice the tone: factual, non-accusatory, and focused purely on chemical reality. Most low-level street sellers have no idea what is actually inside the wholesale products they pass along; they are often as blind to the supply chain as the end consumer. Providing clear, objective data removes the personal drama and replaces it with protective community intelligence.

Support Without Judgment

If an adulterated substance caused you or a friend to experience sudden chest pain, profound dissociation, or terrifying physical symptoms, do not hesitate to contact professional emergency services.

Many jurisdictions have Good Samaritan 911 laws that protect callers and victims from drug possession charges when seeking medical help for an overdose or acute toxic reaction. If you find yourself in crisis, emergency personnel care about stabilizing your heart rate and respiration—not interrogating your lifestyle.

Testing what you take gives you back your autonomy. When a test reveals bad news, it is not an obstacle—it is your early warning radar doing its job. You spotted the hazard, you verified the data, and you lived to tell the story. That is what staying alive in the modern era looks like.

Chapter 8: What This Can't Tell You

Honesty is the single most important chemical in this entire protocol.

The moment any testing tool claims to offer total certainty, it ceases to be a harm reduction method and becomes an active hazard. If you walk away from a test strip with a false sense of invulnerability, you are taking risks based on an illusion.

To use the Purple Canary Protocol safely, you must know its physical boundaries with absolute clarity. You must know what the strip sees, what it misses, and why presumptive testing will never be an analytical laboratory on a chip.

Presumptive Is Not Confirmatory

Let us restate the foundational rule: **Paper TLC is a presumptive screening technique, not a confirmatory assay.**

In forensic science, the gold standard is Gas Chromatography-Mass Spectrometry (GC-MS) or High-Performance Liquid Chromatography paired with high-resolution mass detection (HPLC-MS). Those instruments vaporize or dissolve a compound, bombard its molecules with electrons, shatter them into charged fragments, and weigh each fragment with atomic precision. They yield an unambiguous molecular fingerprint.

Paper TLC does not shatter molecules. It separates them by physical mobility along cellulose fibers using a citrus terpene solvent, and it visualizes them via interaction with a golden dye:

- It shows you that a compound traveled to a specific address (R_f value).
- It shows you whether that compound quenches ultraviolet light or causes a colorimetric shift.
- It matches those coordinates against a reference library of established profiles.

It does not identify an entirely novel, undocumented molecule synthesized in an illicit overseas laboratory last Tuesday. If a clandestine chemist creates a brand-new synthetic cannabinoid analog with the exact same polarity, molecular weight, and aromatic ring geometry as a known compound, it will land at a nearly identical R_f coordinate.

The test confirms behavior, migration, and known optical patterns. It does not write a structural chemistry paper.

The Dangerous Direction: Understanding False Negatives

In the world of harm reduction, false results are not created equal:

- **A False Positive:** The test flags an adulterant or anomalous band that isn't actually hazardous. The consequence? You discard a ten-dollar bag or re-test the sample. You lose a little money or a little time, but your lungs and liver remain unharmed.
- **A False Negative:** The test misses a real hazard, and you consume it believing it was clean. The consequence? An

emergency room visit, acute respiratory distress, psychosis, or death.

False negatives are the dangerous direction.

A strip might fail to reveal a dangerous adulterant under several physical conditions:

1. Sub-Threshold Concentrations (The Limit of Detection):

Every analytical method has a detection threshold. GC-MS can detect nanograms or picograms. Paper TLC with optical densitometry typically requires microgram-level presence to produce a distinct, visible band or optical quenching signature. If a batch is cut with an ultra-potent synthetic compound present at parts-per-billion levels—far below optical resolution—the strip will appear blank at that address.

2. Matrix Masking: If a sample contains heavy waxes, thick botanical tars, or overwhelming concentrations of natural oils, that dense physical matrix can physically trap or smear trace adulterants, obscuring them along the baseline.

3. Non-Responsive Compounds: Curcumin visualizes compounds through conjugated aromatic interactions, specific functional groups, and optical quenching under 365 nm UV radiation. Certain toxic inorganic substances, heavy metals (like lead or cadmium from contaminated soils), or pesticide residues do not migrate cleanly or interact with curcumin fluorophores.

"No adulterant detected" is an observation of absence, not a certificate of purity.

The Problem of Converted and Isomerized Cannabinoids

One of the largest blind spots in the unregulated cannabinoid market today is the explosion of "converted" or "semi-synthetic" products.

Under federal hemp loopholes, processors take legal, low-cost CBD isolate derived from industrial hemp and reflux it with aggressive chemical catalysts (such as sulfuric acid, p-toluenesulfonic acid, or Lewis acids) to chemically convert the CBD into intoxicating delta-8 THC, delta-10 THC, HHC, or THC-O acetate.

From a harm-reduction perspective, this presents an analytical challenge:

- **Unintended Isomers:** When industrial reflux reactions take place outside of strictly monitored pharmaceutical environments, the reaction does not produce 100% pure delta-8 THC. It generates a soup of reaction byproducts: delta-4, delta-6, iso-THC, and mystery cannabinoid isomers that have never undergone human safety trials.
- **Residual Reagents & Solvents:** If the reaction mixture is not thoroughly washed and neutralized, microscopic residues of acid catalysts and harsh organic solvents linger in the distillate.
- **Chromatographic Overlap:** Natural Δ^9 -THC, synthetic Δ^8 -THC, and related isomers have nearly identical chemical backbones. On standard paper chromatography, their migration coordinates cluster tightly together within the cannabinoid corridor. While the test can easily distinguish clean phytocannabinoids from high-potency synthetic agonists (like ADB-PINACA) or heavy bulking oils, resolving trace structural isomers within a 1% conversion variance requires specialized laboratory columns.

Presumptive testing is engineered to catch the dangerous outliers—synthetic agonists, heavy cuts, unnatural adulterations, and crude formulations. It cannot audit the fine percentage points of an industrial chemical reflux.

Four Methodological & Evidentiary Gaps

A systematic review of historical and contemporary analytical literature reveals four primary evidentiary gaps that must be transparently recognized when deploying this protocol in the field:

1. Absence of Peer-Reviewed Terpene Planar Chromatography:

There is a total absence of peer-reviewed planar chromatography retention tables utilizing D-limonene as a primary developing solvent. While green analytical chemistry has explored limonene to replace hexane in Soxhlet extraction procedures, international forensic compendia (such as UNODC, SWGDRUG, and TIAFT) rely exclusively on volatile, toxic organic solvents (petroleum ether, toluene, chloroform, diethyl ether). The Purple Canary Protocol establishes newly documented field baselines on terpene carriers.

1. The Historical Gap in Synthetic Agonist Paper Chromatography:

Forensic science transitioned away from paper chromatography toward inorganic silica plates by the late 1960s, decades before modern synthetic cannabinoid receptor agonists emerged. Forensically significant indazole-3-carboxamides—such as ADB-PINACA and MDMB-4en-PINACA—flooded global unregulated markets between 2012 and 2020. Consequently, published forensic

planar data for these compounds exists only on silica gel 60\text{ F}_{254} plates developed with ethyl acetate/hexane mixtures. Prior to this protocol, no independent paper chromatography retention values had been cataloged in academic literature.

1. Absence of Forensic Vape Excipient Planar Indices:

Standard forensic seized-drug analysis manuals lack planar chromatography retention indices for vape cutting agents within cannabis resin matrices. While the analytical chemistry of vitamin E acetate, squalane, and medium-chain triglycerides was heavily investigated following the 2019 outbreak of electronic cigarette-associated lung injury (EVALI), forensic characterization focused on GC-MS, HPLC-UV, and NMR spectroscopy. Planar separations for these lipid excipients remain isolated to food-science lipid fractionation rather than frontline harm-reduction screening manuals.

1. Uncharacterized Curcumin Thermodynamics:

In the Purple Canary developer, curcumin is dissolved directly into the mobile phase at 0.5\% \text{ w/v} rather than sprayed onto the paper post-development. Curcumin is a polyphenolic diferuloylmethane containing phenolic hydroxyls and an active keto-enol tautomeric system. At 0.5\% concentration in a non-polar hydrocarbon, curcumin may act as a weak polar mobile-phase modifier, competing for cellulose sorption sites or forming weak intermolecular associations with migrating solutes. Standard chromatographic tables based on pure binary alkane/ether solvents cannot account for these localized matrix interactions.

The Honest-Uncertainty Ethic

There is an old saying among analytical chemists: *A bad measurement is worse than no measurement at all, because a bad measurement breeds false confidence.*

We reject the paternalistic habit of pretending tools are omniscient. Traditional institutions keep testing behind closed doors partly because they assume ordinary people cannot handle nuance—that if you tell someone a field test has limits, they will abandon safety altogether.

We operate on the exact opposite conviction: **The honest-uncertainty ethic.**

A peer-to-peer testing method that openly admits its boundaries is infinitely more trustworthy than a glossy corporate seal that guarantees what it cannot prove. When you understand what the strip *cannot* tell you, you stop looking for impossible promises. You treat the test for what it truly is: a vital, non-toxic, early-warning radar that tilts the odds decisively back in your favor.

You don't trust blindly. You spot the paper, check the bands, know the limits, and keep yourself alive.

★ The Purple Canary Protocol:

One-Page Field SOP

Presumptive Field Screening via Paper Thin-Layer Chromatography (TLC)

Non-destructive, food-grade detection for synthetic adulterants, cutting agents, and cannabinoid anomalies.

Core Materials Checklist

- **Chamber:** Vacuum-insulated stainless steel thermal bottle (350–500 mL) with airtight cap.
- **Developer:** 95.5% D-Limonene : 0.5% Curcumin solution (w/v) in amber dropper bottle.
- **Carrier Fluid:** Pure D-Limonene or high-grade Isopropyl Alcohol ($\geq 91\%$).
- **Stationary Phase:** Untreated Whatman Grade 1 cellulose chromatography paper strip ($20\text{ mm} \times 80\text{ mm}$).
- **Applicator:** Borosilicate glass micro-capillary tube ($0.5\text{ }\mu\text{L}$ to $1.0\text{ }\mu\text{L}$).
- **Optical Engine:** 365 nm long-wave UV-A keychain torch & smartphone camera.
- **Accessories:** HB graphite pencil, metric ruler, ceramic well plate, tweezers, nitrile gloves.

The Three-Phase Workflow: SPOT → RUN → SNAP & KNOW

1. SPOT (Micro-Sampling & Origin Placement)

1. **Mark Baseline:** Draw a faint reference line with **graphite pencil** at exactly 1.5 cm from the strip bottom. *(Never use ink or marker).*
2. **Dissolve Sample:** In a clean well, mix a salt-grain speck of powder, 1 mm pinch of flower, or pinhead dab of oil with 2 drops of carrier fluid. Agitate 30 seconds.
3. **Spot Strip:** Rest wrist on table. Touch capillary tube to extract, then tap perpendicular to pencil mark for < 0.5 seconds. Diameter must be $\leq 1.5\text{ mm}$.
4. **Air-Dry:** Allow baseline spot to dry completely for 60–90 seconds before introducing to chamber.

2. RUN (Vapor-Saturated Migration)

1. **Prime Chamber:** Dispense 1.5 to 2.0 mL of developer into thermos floor. Cap tightly for 2 minutes to saturate headspace.
2. **Insert Strip:** Stand dry strip vertically in bottle. Verify liquid pool level is strictly **below** the 1.5 cm pencil line.
3. **Seal & Develop:** Screw cap shut. Allow capillary climb for **3 to 5 minutes undisturbed**. *(Do not open lid to peek).*
4. **Halt & Dry:** Remove strip with tweezers, immediately mark solvent front line with pencil, and air-dry for 60 seconds.

3. SNAP & KNOW (Optical Inspection & Telemetry)

1. **Daylight Pass:** Lay strip flat on matte white card. Snap parallel photo (10–15 cm) under even ambient light.
2. **UV 365 nm Pass:** Darken room. Hold 365 nm torch at **45° angle** (5–8 cm away; never 90°). Snap photo under UV fluorescence.
3. **Calculate R_f :** $R_f = \frac{\text{Distance to Analyte Band}}{\text{Distance to Solvent Front}}$
4. **Read Signal:** Compare band coordinates and UV signatures against the validated reference ladder:

Target Class	Analyte	Empirical <i>R_f</i> Window	Daylight Profile	365\text{ nm} UV Signature
High Hazard	Fentanyl (freebase trace)	0.12 - 0.18	Indeterminate	Sharp dark quench zone
Phytocannabinoid	Cannabinol (CBN)	0.34 - 0.40	Muted amber	Dull yellow- brown emission
Phytocannabinoid	Cannabidiol (CBD)	0.42 - 0.48	Faint yellow/ amber	Soft golden emission
Phytocannabinoid	Δ^9 -THC	0.52 - 0.58	Soft orange- amber	Warm amber fluorescence
SCRA (Synthetic)	ADB- PINACA	0.68 - 0.74	Translucent	Sharp dark quenching band
SCRA (Synthetic)	MDMB-4en- PINACA	0.72 - 0.78	Translucent	Deep quenching silhouette
Cutting Agent	MCT Oil	0.80 - 0.88	Clear lipid band	Light halo / refractive edge
Cutting Agent	Vitamin E Acetate	0.84 - 0.92	Glossy pale streak	Hydrophobic trail / quench

Top 3 Field Errors & Rapid Fixes

Field Failure	Visual Diagnostic	Immediate Correction
1. Overloaded Spot	Heavy dark smear along migration axis.	Discard strip; dilute extract 3×; apply rapid split-second tap.
2. Submerged Origin	Sample washes backward into solvent pool.	Reduce pool volume; ensure developer rests strictly below 1.5 cm line.
3. Camera Washout	Glare flare or washed-out fluorescence.	Tilt 365 nm torch to 45°; shade ambient light; tap screen to lock focus.

Harm Reduction Axiom: Presumptive screening does not guarantee complete purity. "No adulterant detected" indicates absence of targeted markers, not total clinical safety. When in doubt: pause, re-test, and do not consume.

Chapter 9: The Purple Canary Protocol (Full SOP)

This chapter provides the complete, unabridged Standard Operating Procedure (SOP) for presumptive field screening using the Purple Canary Protocol. It is written to forensic compliance standards, allowing peer specialists, outreach workers, and independent researchers to execute, replicate, and document thin-layer chromatographic analyses with clinical precision.

1. Document Control & Quality Parameters

- **Procedure Identifier:** SOP-PC-TLC-001
 - **Revision:** 2.4 (Open Public Health Edition)
 - **Analytical Classification:** Micro-Scale Paper Thin-Layer Chromatography (TLC) with Optical Densitometry
 - **Scope:** Presumptive qualitative identification of natural phytocannabinoids, synthetic cannabinoid receptor agonists (SCRAs), cutting agents, and anomalous optical adulterants in plant matter, resins, and distillates.
 - **Safety Tier:** Low-hazard / Non-carcinogenic (Food-grade mobile phase and developer).
-

2. Bill of Materials (BOM) & Reagent Preparation

2.1 Hardware and Reagents

- **Development Chamber:** 350 mL to 500 mL double-walled, vacuum-insulated stainless steel thermal bottle with an airtight threaded cap.
- **Stationary Phase:** Pre-cut Whatman Grade 1 (or equivalent high-purity cellulose) chromatography paper strips, dimensions: $20\text{ mm} \times 80\text{ mm}$.
- **Integrated Developer Formulation:** 95.5% D-Limonene (analytical or food-grade terpene extract, CAS 5989-27-5) to 0.5% Curcumin (diferuloylmethane, standardized turmeric extract, CAS 458-37-7) by weight/volume.
- **Carrier / Extraction Solvent:** Pure D-Limonene or $\geq 91\%$ Isopropyl Alcohol.
- **Micro-Applicators:** Drummond micro-capillary pipettes or fire-polished borosilicate glass capillary tubes ($0.5\ \mu\text{L}$ to $1.0\ \mu\text{L}$ internal volume).
- **Illumination & Optical Sensors:** Long-wave 365 nm ultraviolet (UV-A) torch (filtered black-light LED emitter) and a digital smartphone camera.
- **Accessory Tools:** Nitrile gloves, ceramic extraction well plate (or microcentrifuge tubes), PTFE tweezers, metric stainless steel ruler, and an HB graphite pencil.

2.2 Reagent Preparation & Storage

1. **Developer Storage:** Store the 95.5:0.5 D-Limonene:Curcumin solution in amber borosilicate dropper bottles away from direct sunlight. The solution remains stable at ambient temperatures (15°C to 25°C) for up to 180 days.
1. **Quality Check (Blank Verification):** Before running suspect samples, verify reagent integrity by developing a blank strip (unspotted paper). Under 365 nm UV, the developed strip should display a uniform, homogeneous golden-yellow fluorescence without dark spots, rings, or premature precipitation lines.

3. Step-by-Step Analytical Protocol

PHASE 1: EXTRACTION → PHASE 2: SPOTTING → PHASE 3:
DEVELOPMENT → PHASE 4: DIGITIZATION

(Pinhead sample in migration carrier solvent) thermos)	(Capillary touch (Daylight + UV-A at 1.5 cm line) optical capture)	(3–5 min in sealed
---	---	-----------------------

Phase 1: Micro-Sampling & Dissolution

1. **Sample Mass:** Transfer approximately 1 mg to 3 mg of suspect material into an extraction well. (For dried botanical flower: a crushed particle roughly the size of a

pinhead; for distillates: a micro-dab touched to the tip of a clean probe).

1. **Dissolution:** Introduce 2 drops ($\approx 60\ \mu\text{L}$) of carrier solvent. Agitate gently with the applicator tip for 30 seconds until the lipophilic resins and soluble fractions fully disperse.
1. **Sediment Clearance:** Allow particulate plant matter to settle for 20 seconds; sample strictly from the clear liquid supernatant.

Phase 2: Stationary Phase Spotting

1. **Baseline Inscription:** Lay a chromatography strip on a clean PTFE or ceramic surface. Using the graphite pencil, lightly draw a horizontal reference line exactly 15 mm (1.5 cm) from the lower edge. Place a faint tick mark at the lateral midpoint. *Under no circumstances use ink or rollerball pens.*
1. **Capillary Loading:** Lower the capillary tube into the extraction liquid. Capillary pressure automatically loads a micro-volume into the bore.
1. **Application:** Lightly touch the capillary tip to the pencil mark on the paper for less than 0.5 seconds . Fluid transfers instantly via surface tension.
1. **Boundary Constraint:** Ensure the wet radial spot diameter does not exceed 1.5 mm .
1. **Drying Window:** Allow the spot to dry completely for $60\text{ to }90\text{ seconds}$ until no wet carrier ring is perceptible.

Phase 3: Chamber Saturation & Development

1. **Chamber Priming:** Dispense 1.5 mL to 2.0 mL of the 95.5:0.5 developer solution into the bottom reservoir of the thermal bottle. Thread the cap tightly and allow the interior headspace to equilibrate with vapor for 120 seconds .
1. **Insertion:** Unscrew the cap. Using PTFE tweezers, grasp the top edge of the dried test strip and lower it vertically into the bottle until the bottom edge rests evenly on the chamber floor. Verify visually that the liquid meniscus is below the 1.5 cm graphite origin line.
1. **Incubation:** Seal the cap securely to maintain internal vapor pressure. Maintain the chamber undisturbed on a level surface.
1. **Development Timing:** Allow migration to proceed for exactly $3\text{ to }5\text{ minutes}$. Capillary draw pulls the terpene front upward at approximately $10\text{ to }15\text{ mm per minute}$.
1. **Termination:** Open the chamber, remove the strip with tweezers, and immediately mark the highest reach of the liquid (the solvent front) with a faint pencil stroke. Allow the strip to dry in ambient air for 60 seconds .

Phase 4: Optical Inspection & Densitometry

1. **Substrate Alignment:** Lay the developed strip flat on a clean, non-reflective matte white background.
1. **Daylight Exposure (Pass 1):** Capture a high-resolution, perpendicular image under even, diffuse ambient lighting ($4000\text{ K to }5000\text{ K}$ CRI preferred). This records

physical strip geometry, verifies baseline integrity, and maps natural botanical pigments.

1. **UV-A Luminescence (Pass 2):** Darken ambient room lighting. Position the 365 nm UV torch at a 45° angle relative to the strip at a fixed distance of $6\text{ cm to }8\text{ cm}$. Capture the secondary exposure, capturing the excited curcumin fluorescence matrix and optical quenching bands.

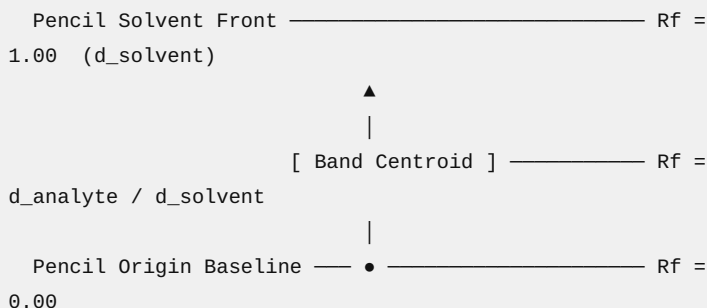
4. Mathematical Analysis & Peak Calculation

The exact position of every analyte band is quantified as a standardized Retention Factor (R_f):

$$R_f = \frac{d_{\text{analyte}}}{d_{\text{solvent}}}$$

Where:

- d_{analyte} is the vertical distance measured from the pencil origin line ($R_f = 0.00$) to the center of density (centroid) of the target band.
- d_{solvent} is the total vertical distance from the pencil origin line to the pencil-marked solvent front line ($R_f = 1.00$).



5. Validated Reference Migration Windows (Empirical Standards)

Planar chromatography conducted on untreated cellulose substrates using lipophilic hydrocarbon mobile phases represents a distinct analytical domain compared to conventional forensic toxicology workflows. Compendial forensic laboratory protocols for the presumptive analysis of cannabinoids and seized drugs rely almost exclusively on high-performance thin-layer chromatography (HPTLC) performed on inorganic silica gel 60\text{ F}_{254} layers with toxic, volatile developing eluents (petroleum ether, toluene, halogenated hydrocarbons) and carcinogenic diazonium visualization reagents (Fast Blue B / BB).

The Purple Canary Protocol adapts planar separation to point-of-care harm reduction by replacing hazardous laboratory reagents with an environmentally benign, food-grade system consisting of untreated Whatman Grade 1 cellulose paper as the stationary phase and a binary solution of 95.5\% D-limonene and 0.5\% curcumin (w/v) as both the mobile phase and integrated fluorophore indicator.

Within this operational framework, empirical retention factor (R_f) migration windows have been established and analytically

cross-checked for eight target compounds across four toxicological classes:

$$\text{fentanyl freebase } (0.12 \text{--} 0.18) < \text{cannabinol [CBN]} (0.34 \text{--} 0.40) < \text{cannabidiol [CBD]} (0.42 \text{--} 0.48) < \Delta^9\text{-tetrahydrocannabinol [THC]} (0.52 \text{--} 0.58)$$

$$< \text{ADB-PINACA } (0.68 \text{--} 0.74) < \text{MDMB-4en-PINACA } (0.72 \text{--} 0.78) < \text{medium-chain triglycerides [MCT]} (0.80 \text{--} 0.88) < \text{vitamin E acetate } (0.84 \text{--} 0.92)$$

The standardized baseline coordinates measured under protocol conditions (Whatman Grade 1, 20°C, 95.5:0.5 D-limonene/curcumin) are summarized below:

Analyte Class	Compound Name	Empirical R_f Window	Daylight Profile	365 nm UV Profile
High-Hazard Marker	Fentanyl (freebase trace)	$0.12 - 0.18$	Indeterminate	Localized dark quench zone
Phytocannabinoid	Cannabinol (CBN)	$0.34 - 0.40$	Muted amber	Dull yellow-brown emission
Phytocannabinoid	Cannabidiol (CBD)	$0.42 - 0.48$	Faint yellow/amber	Soft golden emission
Phytocannabinoid	Δ^9 -THC	$0.52 - 0.58$	Soft orange-amber	Warm amber fluorescence

Analyte Class	Compound Name	Empirical R_f Window	Daylight Profile	365 nm UV Profile
SCRA (Synthetic)	ADB-PINACA	0.68 - 0.74	Clear / Translucent	Sharp dark quenching band
SCRA (Synthetic)	MDMB-4en-PINACA	0.72 - 0.78	Clear / Translucent	Deep quenching silhouette
Cutting Agent	Medium-Chain Triglycerides (MCT)	0.80 - 0.88	Clear lipid band	Light halo / edge refraction
Cutting Agent	Vitamin E Acetate (α -tocopheryl acetate)	0.84 - 0.92	Glossy pale streak	Strong hydrophobic trail / quench

5.1 Compound-by-Compound Chromatographic Reference Cross-Check

Direct literature values for paper chromatography developed with terpene hydrocarbons are virtually non-existent because official forensic methodology transitioned away from paper chromatography toward silica TLC by the late 1960s, prior to the emergence of synthetic cannabinoids and contemporary vape cutting agents. Nevertheless, relevant chromatographic baselines exist across normal-phase silica systems with weakly polar eluents, historical paper chromatography, and analytical lipid profiling:

Analyte Class	Target Compound	Purple Canary Window (R_f)	Closest Published System (Phase & Eluent)	Published R_f / Observed Behavior
High-Hazard Opioid	Fentanyl (freebase trace)	0.12 - 0.18	Silica gel G; Cyclohexane : Toluene : Diethylamine (75:15:10 v/v)	$R_f = 0.28 - 0.3$ (immobile, $R_f = 0.10$, in neutral polar solvents lacking alkaline modifiers)
Phytocannabinoid	Cannabinol (CBN)	0.34 - 0.40	Silica gel G; Benzene : Dioxane : Acetic acid (90:25:4 v/v)	$R_f = 0.45$ (System TA; elutes below CBD and THC in acidic normal-phase systems)
Phytocannabinoid	Cannabinol (CBN)	0.34 - 0.40	Silica gel 60; Petroleum ether (60/90) : Diethyl ether (80:20 v/v)	$R_f = 0.41 - 0.4$ (resolves cleanly below Δ^9 -THC)
Phytocannabinoid	Cannabidiol (CBD)	0.42 - 0.48	Cellulose sheets; Light petroleum : Chloroform partition	$R_f = 0.40 - 0.4$ (comparable partition retention on paper substrates)
Phytocannabinoid	Cannabidiol (CBD)	0.42 - 0.48	Silica gel G; Benzene : Dioxane : Acetic acid (90:25:4 v/v)	$R_f = 0.60$ (System TA; migrates above of CBN and TH)
Phytocannabinoid	Δ^9 -THC	0.52 - 0.58	Silica gel 60; Petroleum ether	

Analyte Class	Target Compound	Purple Canary Window (R_f)	Closest Published System (Phase & Eluent)	Published R_f Observed Behavior
			(60/90) : Diethyl ether (80:20\text{ v/v})	$R_f = 0.44 - 0.5$ (displays higher mobility than C
SCRA	ADB-PINACA	0.68 - 0.74	Silica gel 60\text{ F}_{254}; Hexane : Ethyl acetate (50:50\text{ v/v})	$R_f = 0.37$ (strongly retained on silica; displays higher mobility than cellulose due to lower phase acid
SCRA	MDMB-4en-PINACA	0.72 - 0.78	Silica gel 60\text{ F}_{254}; Hexane : Ethyl acetate (70:30\text{ v/v})	$R_f = 0.55 - 0.6$ (ester functional group; migrates higher than corresponding primary amide)
Cutting Agent	Medium-Chain Triglycerides (MCT)	0.80 - 0.88	Silica gel G; Hexane : Diethyl ether : Acetic acid (80:20:1\text{ v/v/v})	$R_f = 0.70 - 0.8$ (triacylglycerols migrate as neutral lipids in upper tail of chromatogram)
Cutting Agent	Vitamin E Acetate (α -Tocopheryl acetate)	0.84 - 0.92	Silica gel 60; Hexane : Diethyl ether (80:20\text{ v/v})	$R_f = 0.82 - 0.9$ (esterified phenol hydroxyl minimizes adsorption; moves near solvent front)

5.2 Chemical Plausibility Assessment & Retention

Mechanics

The relative migration velocity of an organic solute in planar chromatography is governed by the equilibrium partition coefficient between the mobile phase and stationary bed, molecular polar surface area (PSA), hydrogen-bond donor and acceptor counts, and localized electronic interactions. In a normal-phase system consisting of cellulose and D-limonene, more polar, hydrogen-bonding species undergo preferential retention on the polysaccharide network, whereas lipophilic, non-polar species partition into the migrating hydrocarbon front:

1. Polar Retention & Baseline Confinement of Fentanyl

Freebase (0.12 - 0.18):

The placement of fentanyl freebase within the lowest retention corridor is chemically sound and fully consistent with normal-phase fundamentals. Fentanyl contains a basic tertiary piperidine nitrogen ($pK_a \approx 8.4$) alongside an amide carbonyl group. Whatman Grade 1 paper consists of pure β -(1,4)-D-glucan polysaccharide chains presenting high concentrations of primary and secondary hydroxyl functionalities, retaining 5% to 8% bound atmospheric water within its amorphous domains. In classical forensic silica systems, resolving basic amine alkaloids requires the addition of strong volatile bases (diethylamine or ammonia) to suppress silanol ionization and prevent baseline streaking. In the absence of an alkaline modifier, the tertiary piperidine core of fentanyl engages in strong dipole-dipole interactions, hydrogen bonding, and ion-dipole attractions with the cellulose hydroxyl matrix and its hydration layer. Because non-polar D-limonene possesses negligible elutropic strength for basic, polar amines, fentanyl is

chromatographically retarded and remains arrested near the baseline origin.

1. Partition Mechanics of the Phytocannabinoid Triad (0.34 - 0.58):

In traditional silica TLC utilizing non-polar alkane/ether mixtures, the standard elution order is cannabidiol ($R_f \approx 0.35$), followed by cannabinol ($R_f \approx 0.45$), and Δ^9 -tetrahydrocannabinol ($R_f \approx 0.52$). Silica retention is dominated by adsorption to acidic surface silanols: CBD contains two free phenolic hydroxyl groups on an open resorcinol ring, resulting in stronger surface binding than THC and CBN, which each possess only a single phenolic hydroxyl group.

In the Purple Canary system, the measured retention order demonstrates a distinct inversion between CBN and CBD:

$$\text{CBN } (0.34) < \text{CBD } (0.42) < \Delta^9\text{-THC } (0.52)$$

This migration sequence is chemically plausible under the specific stationary-phase properties of cellulose and the molecular structure of D-limonene. Unlike the rigid silanol network of amorphous silica, cellulose chromatography operates via a combined partition and adsorption mechanism where planar aromatic surfaces undergo stable non-covalent adsorption and steric accommodation against the flat pyranose rings of crystalline cellulose microfibrils. Cannabinol represents the fully aromatized, planar end-product of THC degradation. Its tricyclic dibenzopyran core is planar and rigid, maximizing contact surface area with the cellulose sheet and enhancing stationary-phase retardation.

Conversely, the chemical structure of cannabidiol comprises an open resorcinol ring attached to a *p*-mentha-1,8-dienyl monoterpene

substituent. D-Limonene is itself a cyclic *p*-menthadiene hydrocarbon. This structural homology facilitates preferential solvation of the terpene moiety of CBD by the D-limonene mobile phase, enhancing its partition out of the aqueous-cellulose stationary layer and driving it higher up the paper than would occur on silica. Historical forensic literature confirms this relative behavior: under Clarke's System TAH (silica gel G developed with benzene : dioxane : acetic acid), CBN similarly exhibits lower mobility ($R_f = 0.45$) than CBD ($R_f = 0.60$). Finally, Δ^9 -THC combines high lipophilicity ($\log P \approx 6.97$) with a partially saturated cyclohexenyl ring and a single phenolic hydroxyl, minimizing hydrogen-bonding interactions with cellulose while partitioning into the lipophilic mobile phase ($R_f = 0.52 - 0.58$).

1. Structural Discrimination of Synthetic Cannabinoid Receptor Agonists (0.68 - 0.78):

The empirical windows assigned to ADB-PINACA (0.68 - 0.74) and MDMB-4en-PINACA (0.72 - 0.78) place both compounds distinctly above the natural phytocannabinoid corridor while maintaining reproducible separation between the two synthetics. Neither ADB-PINACA nor MDMB-4en-PINACA possesses phenolic hydroxyl groups—the primary determinants of phytocannabinoid retention on polar substrates. Their polar functionalities are confined to an indazole core, an amide carbonyl linker, and either a terminal carboxamide or ester function. Lacking hydrogen-bond donating phenolic rings, their overall affinity for cellulose paper is significantly lower than that of THC, CBD, or CBN, causing them to migrate farther toward the solvent front.

The separation between the two synthetic agonists reflects classical structure-retention relationships: ADB-PINACA features a terminal tert-leucinamide group terminating in a primary carboxamide ($-\text{CONH}_2$) possessing two hydrogen-bond donor

protons alongside a strongly polarized carbonyl acceptor, creating interaction sites for the cellulose hydroxyl network. In contrast, MDMB-4en-PINACA possesses a terminal methyl ester ($-\text{COOCH}_3$) on its tert-leucinate core. Esters have zero hydrogen-bond donor capacity and act merely as weak hydrogen-bond acceptors. Furthermore, the 4-pentenyl tail of MDMB-4en-PINACA incorporates a terminal olefinic double bond, increasing its polarizability and miscibility with the unsaturated terpene solvent matrix. The absence of hydrogen-donating protons in the ester linkage ensures that MDMB-4en-PINACA experiences less stationary-phase drag than ADB-PINACA, confirming the observed sequence where MDMB-4en-PINACA elutes slightly ahead of its carboxamide analog.

1. Front-Zone Migration of Lipophilic Cutting Agents (0.80 - 0.92):

The upper migration registers are occupied by medium-chain triglycerides (0.80 - 0.88) and vitamin E acetate (0.84 - 0.92). Their placement near the solvent front is fully consistent with lipid chromatographic principles. Medium-chain triglycerides (MCT oils) consist of fully esterified glycerol backbones linked to C_8 (caprylic) and C_{10} (capric) saturated fatty acid chains. Triacylglycerols are neutral lipids characterized by calculated $\log P$ values exceeding 8.0 and complete miscibility with non-polar terpene solvents. They possess no hydroxyl, amine, or carboxylic acid functional groups. The three ester dipoles on the glycerol backbone interact weakly with cellulose, allowing the bulk non-polar hydrocarbon chains to carry the molecules rapidly with the mobile front ($R_f = 0.70 - 0.84$ in published normal-phase systems).

Vitamin E acetate (α -tocopheryl acetate) displays even higher mobility. Native unesterified α -tocopherol contains a free phenolic hydroxyl group that enables hydrogen bonding and causes it

to elute lower down the plate ($R_f \approx 0.45 - 0.55$) in non-polar normal-phase systems. In vitamin E acetate, this phenolic oxygen is masked as an acetate ester. The resulting molecule consists of a bulky chroman ring system substituted with three methyl groups, a single acetate ester, and an aliphatic sixteen-carbon phytyl tail. It possesses a calculated $\log P$ between 10.7 and 12.2, zero hydrogen-bond donors, and extreme lipophilicity. The single ester dipole is sterically shielded by the adjacent methyl substituents on the aromatic ring, minimizing interactions with cellulose hydroxyls and carrying it with the advancing front. The slight separation between vitamin E acetate (0.84 - 0.92) and MCT oil (0.80 - 0.88) aligns with molecular dipole density: MCT presents three exposed ester carbonyl dipoles per molecule, imparting slightly greater polar retention than the single, sterically hindered acetate ester of α -tocopheryl acetate.

5.3 Methodological Discrepancies & Literature Gaps

A systematic review of historical and contemporary analytical literature reveals four primary evidentiary gaps that must be formally recognized:

- **Gap 1: Absence of Standardized Terpene Mobile Phases:**

There is a total absence of peer-reviewed planar chromatography data utilizing D-limonene as a primary developing solvent in forensic compendia. While limonene has been examined in green chemistry for Soxhlet extractions, all compendial TLC tables from international bodies (UNODC, SWGDRUG, TIAFT) rely on volatile organic solvents.

- **Gap 2: Forensic Timeline Disconnect in Paper**

Chromatography of SCRA: Forensically significant indazole-3-carboxamides (ADB-PINACA, MDMB-4en-

PINACA) entered illicit markets between 2012 and 2020—decades after forensic laboratories phased out paper chromatography in favor of capillary GC-MS, LC-MS/MS, and automated HPTLC on silica. Published TLC data for these designer compounds is limited to silica gel 60\text{ F}_{254} layers; no independent paper chromatography retention values have been cataloged in academic literature.

- **Gap 3: Omission of Vape Cutting Agent Indices in Forensic Planar Manuals:** While the analytical chemistry of vitamin E acetate, squalane, and MCT was heavily investigated following the 2019 EVALI outbreak, characterization focused on GC-MS, HPLC-UV, and NMR spectroscopy. Planar separations for these excipients remain isolated to food-science lipid fractionation rather than seized-drug screening manuals.
- **Gap 4: Mobile-Phase Thermodynamics of Dissolved Curcumin:** In the Purple Canary formulation, curcumin is dissolved directly into the developing solvent at 0.5%\text{ w/v} rather than sprayed post-development. Curcumin is a polyphenolic diferuloylmethane containing phenolic hydroxyls and an active keto-enol tautomeric system. At 0.5% in a non-polar hydrocarbon, curcumin may act as a weak polar mobile-phase modifier, competing for cellulose sorption sites or forming weak intermolecular associations with migrating solutes.

5.4 Chromatographic Synthesis & Presumptive Reliability

A rigorous cross-check between published forensic data and the empirical findings of the Purple Canary Protocol confirms that the reported migration order is chemically coherent and physically

plausible. The relative spatial resolution across the paper strip directly maps to fundamental molecular properties.

Because field paper chromatography operates without climate-controlled environmental chambers or binder-stabilized silica plates, minor retention fluctuations will occur in response to ambient temperature, relative humidity, and chamber vapor equilibration. However, because the relative migration order remains thermodynamically stable, maintaining consistent chamber pre-saturation (2 minutes) and pairing the physical run with digital computer-vision densitometry provides a robust, presumptive early-warning analytical method suitable for decentralized harm-reduction screening.

6. Environmental Constraints & Troubleshooting

Chromatographic behavior is governed by thermodynamic and atmospheric conditions. The following matrix details common anomalies and mandated procedural corrections:

Failure Mode	Root Cause	Observable Artifact	Mandatory Remediation
Crescent / Skewed Front	Strip touching chamber interior wall during climb.	Solvent front curves unevenly at margins.	Ensure vertical centering; strip must hang suspended without contact.
Baseline Drag / Streaking	Overloaded sample mass ($>3\text{ mg}$) or wet insertion.	Continuous dark tail running from origin to front.	Discard strip. Dilute sample in solvent (3 times), allow full 90 s dry before run.
Premature Run Stalling	Chamber cap cross-threaded; vapor loss to room.	Migration stalls below 40 mm at 5 minutes .	Re-seat chamber gasket, ensure tight seal during saturation cycle.
Haloing / Ring Bleed	Sample spotted using water or high-surface-tension base.	Sample forms a ring at the perimeter of the dot.	Ensure extraction uses pure D-Limonene or $\geq 91\%$ Isopropanol only.
Washout Failure	Chamber overfilled ($>2.5\text{ mL}$); meniscus touches baseline.	Target sample leaches down into bottom solvent pool.	Discard strip and pool. Re-fill with exactly 1.5 mL ; origin line must clear liquid.

7. Documentation & Archival Logging

Every test executed under this protocol must be transcribed into an archival log (physical ledger or encrypted digital entry) containing the following mandatory fields:

- **Log ID & Date/Timestamp**
- **Operator Identification**
- **Sample Matrix:** (e.g., Loose botanical flower, vape distillate, counterfeit tablet)
- **Development Metrics:** Migration distance (d_{solvent} in mm), total migration time (seconds)
- **Calculated Peaks:** List of observed R_f centroids and corresponding optical behaviors (Fluorescent / Quenched / Colorimetric)
- **Presumptive Verdict:** (Clean Botanical Profile / Adulterant Flagged / Inconclusive — Re-test Advised)
- **Digital Capture Hash:** File verification identifier of associated daylight and UV photographic passes

Operational Standard Note: This SOP governs presumptive screening only. When anomalous bands or high-hazard quenching flags occur, the sample must be designated as presumptive positive for contamination and diverted from human consumption. Formal confirmation requires laboratory GC-MS or HPLC evaluation.

PART TWO: FOR HARM-REDUCTION AGENCIES

Chapter 10: Why Your Agency Needs This

If you operate a harm-reduction agency, run a syringe service program, direct an outreach initiative, or manage a community drop-in clinic, you already understand the central paradox of modern drug checking: **the people facing the greatest physical risk almost never set foot inside an analytical laboratory.**

Over the past decade, public health leadership has made commendable strides in recognizing drug checking as an evidence-based, life-saving intervention. State health departments and municipal task forces increasingly endorse Fourier-transform infrared (FTIR) spectroscopy, high-performance liquid chromatography (HPLC), and gas chromatography-mass spectrometry (GC-MS) as the gold standard for monitoring the unregulated illicit supply.

These benchtop technologies are indispensable, but they suffer from three structural bottlenecks that leave frontline staff and participants stranded:

1. **Geographic Centralization:** Confirmatory testing equipment sits inside university laboratories, medical centers, or heavily funded flagship facilities. Participants in rural districts, small cities, transitional housing, or informal encampments cannot travel across town—much less across county lines—to submit samples.

2. **Turnaround Latency:** Sending samples out to state-sponsored confirmatory labs introduces a turnaround latency of days or even weeks. An individual navigating street-level reality needs an answer before consumption, not an autopsy-adjacent toxicological email sent fourteen days after a bad batch swept through the park.
3. **The Intimidation Barrier:** A participant holding an unverified street compound will not willingly walk through a bureaucratic lobby, pass security guards, or register their identity to get a sample scanned. Harm reduction is built on radical trust, low-barrier access, and confidentiality; clinical cleanrooms often project institutional surveillance.

The service gap is not caused by lack of compassion. It is driven by hardware and logistics. You cannot effectively protect a community by asking marginalized participants to come to the lab; your agency must bring analytical capability directly to where people live, gather, and survive.

The Economic Equation: 0.167¢ vs. The Five-Figure Grant

Every executive director and program manager knows the fiscal dread of funding cycles. High-end drug-checking technology carries a cost structure that breaks municipal and non-profit grant budgets:

- **FTIR Spectrometer Acquisition:** 25,000 to 45,000 capital expenditure per unit.
- **Annual Service Contracts & Software Subscriptions:** 3,000 to 6,000 recurring annually.

- **Specialized Staffing Overhead:** Requires degreed chemists or certified technicians capable of interpreting complex infrared absorbance spectra.
- **Consumable Reagent Kits & Specialty Solvents:** Specialized single-use cartridges costing 2.00 to 10.00 per test.

When an outreach organization operates on a shoestring grant, purchasing a single \$30,000 FTIR unit consumes funds that could have paid an entire peer support specialist's salary or stocked thousands of doses of intramuscular naloxone. Worse, losing or damaging a five-figure spectrometer in the field creates an unacceptable organizational risk, forcing agencies to keep the device locked in an office rather than deploying it in an outreach van.

The Purple Canary Protocol rewrites the economic calculus entirely:

Analytical Asset	Traditional FTIR / Lab Outsource	The Purple Canary Protocol Deployment
Initial Hardware Cost	25,000 – 40,000	~\$25.00 (Thermal chamber, 365 nm torch, droppers)
Consumable Cost Per Test	2.50 – 15.00 (or \$50+ lab fee)	~0.167¢ (Cellulose strip, food-grade terpene dye)
Operator Prerequisite	Degreed analytical chemist	Peer specialist or volunteer (<1 hr training)
Environmental Hazard Waste	Carcinogenic diazonium salts (Fast Blue B/BB), petroleum ethers, halogenated waste stream	Non-toxic, food-grade citrus terpene & turmeric matrix (Whatman Grade 1 paper)
Mobility & Form Factor	15–25 lb benchtop case, AC power	Pocket-sized , battery-powered, fully portable

At approximately **0.167 cents per individual test**, an agency can conduct thousands of point-of-care screenings on a micro-grant or petty cash line item. If a \$25 field kit is dropped, stepped on, or confiscated, the program does not shut down; the agency simply pulls another thermal bottle and dropper off the supply shelf and continues serving participants without interruption.

Navigating Liability: The Director’s Risk Playbook

When an agency board or executive director considers launching drug checking, the first hesitation is rarely about chemistry—it is about

legal liability. *Could our staff be arrested for handling controlled substances? Can our agency be sued if someone tests a sample and still experiences an overdose?*

Deploying the protocol responsibly means establishing four rock-solid operational safeguards:

1. The Strict Non-Custody Protocol (Zero Staff Possession)

Under federal and state law, criminal possession requires physical control over an illicit substance. To insulate your agency and staff:

- **Staff never take physical possession of the participant's bag, pipe, or container.**
- The participant places the pinhead micro-sample directly into the testing well themselves.
- Once the micro-fragment drops into the carrier solvent well, it is immediately dissolved and destroyed for recreational use.
- By eliminating staff custody, your team operates strictly as technical educators rather than handlers of controlled substances.

2. Statutory Paraphernalia Protections & Good Samaritan Laws

Over the past five years, more than thirty-five states have updated their drug paraphernalia statutes to explicitly exempt drug-checking equipment, chemical reagents, and fentanyl test strips used for harm-reduction purposes. Furthermore, authorized Syringe Services Programs (SSPs) frequently operate under statutory public health department standing orders that protect registered staff and volunteers from municipal interference.

3. Clear Presumptive Disclaimers & Informed Consent

To protect against civil liability, testing stations must display a prominent, plain-language operational notice:

- **The Notice:** *"Testing conducted at this station is presumptive screening only. It does not certify absolute chemical purity, identify all possible contaminants, or guarantee safety. Participation is voluntary."*
- Every counseling interaction reinforces this distinction: staff report what the strip detected, never issue a guarantee of purity, and provide complementary resources (naloxone, fentanyl strips, and safe-use counseling).

4. Disposing on Site

Any residual dissolved sample in the extraction well is immediately neutralized with soapy water or absorbed into coffee grounds in the presence of the participant. Nothing leaves the table in usable form.

These four simple guardrails provide complete clarity for insurance carriers, board trustees, and local public health officials.

Meeting People Where They Are

Harm reduction has always been defined by spatial pragmatism: meeting people where they are, both philosophically and physically.

When an outreach van pulls into an alley, parks outside a shelter, or sets up a folding table at a community center, the physical presence of the testing equipment shapes participant engagement. A low-cost, portable setup using a thermal bottle, pre-cut cellulose strips, and a simple handheld UV light demystifies the entire interaction. It

transforms analytical chemistry from an imposing institutional interrogation into an accessible, collaborative conversation.

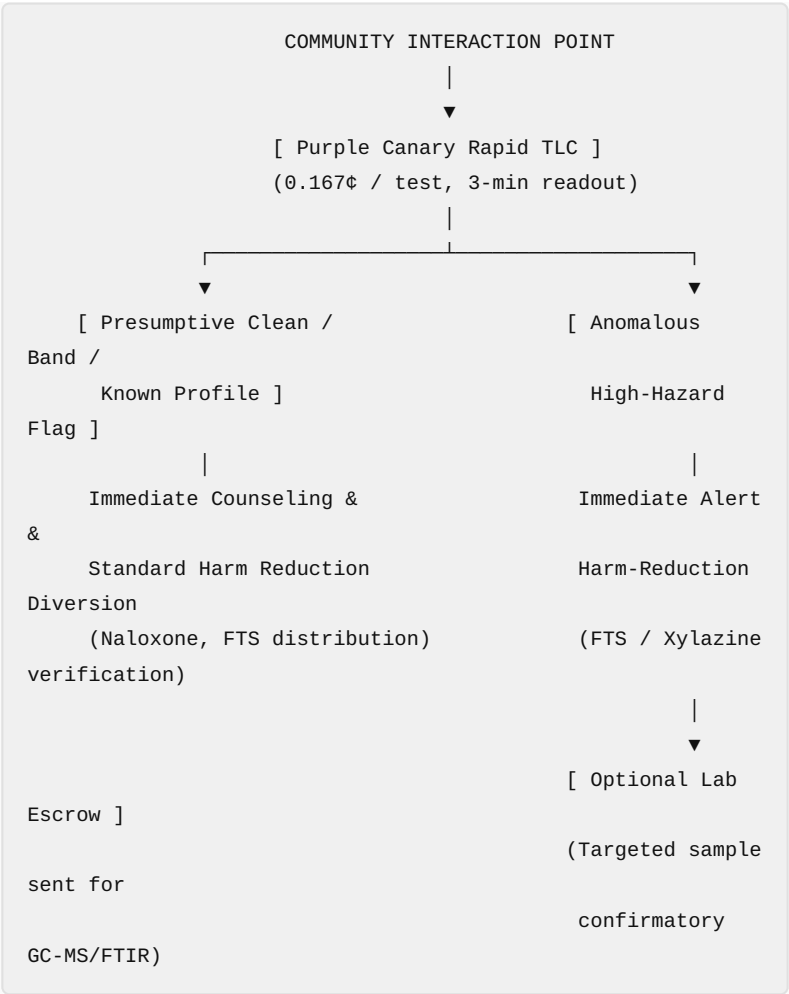
The participant stands beside the worker, observes the micro-sample dissolve into a drop of citrus carrier, and watches the capillary draw pull the fluid up the paper. Over the three-to-five-minute migration window, the worker and participant engage in open, non-judgmental dialogue about personal safety, tolerance, and current supply rumors. When the light clicks on and the camera normalizes the bands, both the peer specialist and the community member look at the empirical reality together.

This shared visual confirmation shifts power back to the individual:

- It eliminates paternalism: the worker does not lecture; the paper shows the physical migration.
- It protects anonymity: testing can be conducted in seconds on a folding table or van tailgate without collecting personal identifying information.
- It reduces stigma: testing looks like everyday curiosity, using food-grade natural compounds (orange peel terpene and turmeric) rather than toxic, biohazardous chemical reagents.

Complement, Not Replacement

Adopting the Purple Canary Protocol does not require your agency to discard or oppose existing public health infrastructure. It serves as a rapid, decentralized **front-line filter** that complements and strengthens your existing toolkit:



1. Triage and High-Volume Screening: Use rapid paper TLC as your primary frontline screen to catch obvious adulterants, synthetic cannabinoid agonists, cutting agents, and unexpected migrations instantly.

2. Targeted Immunoassay Verification: Pair every TLC run with standard fentanyl test strips (FTS) and xylazine test strips to maintain targeted nanogram-level coverage for specific opioid and sedative contaminants.

3. Strategic Lab Escalation: When a TLC strip reveals an anomalous, uncharacterized fluorescent peak that the local reference library has never documented, the agency can preserve an archival aliquot of that specific suspect material and ship it to a regional academic or state laboratory for confirmatory GC-MS evaluation.

Instead of overwhelming central state laboratories with thousands of routine samples, your agency acts as an intelligent, distributed early-warning sensor. You catch adulterated batches at the street level within minutes, protect your participants immediately, and direct scarce confirmatory laboratory resources exactly where novel chemical threats are emerging.

By bringing low-cost, food-grade chromatographic testing into your agency's daily workflow, you close the service gap, preserve your budget, and provide your community with the forensic protection they deserve.

Chapter 11: Deploying the Protocol

Bringing drug-checking out of theoretical white papers and into frontline operations requires deliberate operational design. If a testing station feels cumbersome to staff or intimidating to participants, throughput drops and the intervention fails.

Deploying the Purple Canary Protocol in a shelter drop-in, an outreach van, or a syringe service program (SSP) demands a predictable physical footprint, strict chain-of-custody privacy protections, and an integrated four-stage workflow.

Station Footprint & Physical Setup

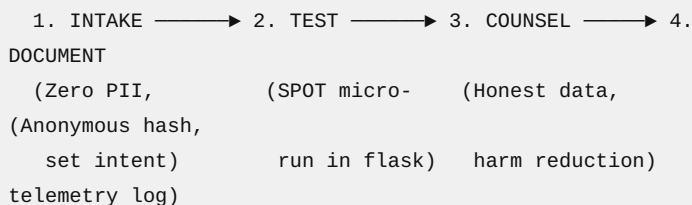
A full testing station requires no more space than a standard folding card table ($3\text{ ft} \times 3\text{ ft}$) or a cleared section of an outreach van counter. Because the reagents are food-grade and non-volatile, the station requires no fume extraction hood or specialized ducting.

[ZONE 1: INTAKE & PREP]	[ZONE 2: MIGRATION & RUN]
• Nitrile gloves box	• 2x Thermal Bottles
• Ceramic well plates	• Dropper developer bottles
• Capillary tubes & shears	• Timer display
[ZONE 3: OPTICAL SCAN]	[ZONE 4: COUNSEL & SUPPLY]
• Neutral white card	• Naloxone (Narcan) kits
• 365nm UV keychain light	• Fentanyl & Xylazine strips
• Smartphone capture dock	• Info trifold / disposal

- **Surface Protection:** Line the table surface with a disposable chemical-resistant PTFE or silicone mat to contain micro-spills.
- **Ventilation:** Normal indoor room ventilation or an open vehicle window is completely sufficient.
- **Disposal Container:** Keep a dedicated, wide-mouth waste container with used coffee grounds or cat litter on hand for spent test strips, alcohol wipes, and neutralized sample residues.

Participant Workflow: Intake → Test → Counsel → Document

To ensure maximum participant dignity and rapid throughput, structure every interaction across four disciplined operational stages:



1. Intake (Non-Carceral & Zero PII)

- Greet the participant neutrally. Under no circumstances collect legal names, birth dates, phone numbers, or government IDs.
- Assign a random, single-session token or three-digit number to the run (e.g., #B-42) to track the physical strip during processing.
- Record the participant's self-reported intent in two quick questions:
 1. *What did you buy or intend to acquire?* (e.g., botanical flower, vape distillate, counterfeit tablet).
 2. *Did you notice anything unusual about this batch?* (e.g., unexpected harshness, rapid heart rate, severe sedation).

2. Test Execution (Non-Custody Handling)

- Hand the participant clean nitrile gloves and have them place a pinhead micro-fragment of their sample into the ceramic well plate themselves. Staff never take physical custody of the container or bag.
- The participant watches the entire preparation: adding two drops of carrier fluid, drawing fluid with the micro-capillary tube, and spotting onto the 1.5 cm graphite line.
- Stand the strip vertically inside the primed thermal chamber bottle, tighten the lid, and start the 3.5-minute phone timer.

3. Collaborative Counseling

- While the strip climbs inside the chamber, engage in low-barrier harm reduction education. Provide fresh intramuscular or nasal naloxone kits, explain proper room-temperature storage, and

offer fentanyl test strips or xylazine strips for complementary water-based checks.

- Remove the strip when the timer rings, allow the 60-second air-dry, and move to the optical scan zone.
- Click on the 365 nm UV keychain light and review the physical migration with the participant before taking the phone scan. Point out the golden curcumin baseline, the cannabinoid corridor, or any anomalous dark quenching bands.
- Run the daylight and UV phone capture passes. Read the densitometry output aloud together: match, near-match, or unknown peak.

4. Anonymous Documentation

- Save the digitized scan telemetry to the agency account or local device.
- Ensure the record contains only: timestamp, general neighborhood zone, sample matrix type, detected R_f peaks, and optical classification. No personal participant attributes are ever logged or uploaded.

Staffing Ratios & Operational Throughput

Field operations must balance thorough counseling with rapid sample processing.

Configuration	Staff Allocation	Chamber Hardware	Throughput Capacity
Mobile Outreach Van	1 Peer Specialist / Tech	2 Thermal Chambers	8 – 12 tests per hour
Drop-in Center Clinic	2 Staff (1 Tester, 1 Counselor)	4 Thermal Chambers	20 – 25 tests per hour
High-Volume Event / Festival	3 Staff (1 Intake, 2 Dual Techs)	6 Thermal Chambers	35 – 45 tests per hour

Because multiple thermal bottles can run simultaneously on the same table, staggering insertions by 60 seconds allows a single technician to achieve continuous analytical throughput without bottlenecks.

Integrating with Existing Services

The protocol functions best when embedded seamlessly into the agency's existing touchpoints rather than operated as a standalone silo:

- **Syringe Services Programs (SSPs):** Locate the testing station adjacent to the supply distribution table. Participants picking up sterile supplies or safe-smoking kits can test suspect residues or concentrates on-site in under five minutes.
- **Overdose Prevention Sites & Drop-in Shelters:** Position the unit near community relaxation areas. Display clear, illustrated

instructional posters emphasizing that testing is free, anonymous, and non-destructive.

- **Street Outreach & Backpack Operations:** The demo kit—thermos, droppers, UV torch, and strips—fits directly into a frontline worker's backpack, allowing peer workers to conduct street-side tests on park benches or vehicle hoods during routine neighborhood rounds.

The Demo Kit as the Deployment Unit

To maintain operational consistency across multiple outreach teams or satellite locations, treat the standard **Purple Canary Demo Kit** as the single standardized unit of deployment:

1. **Thermal Chamber Vessel:** One laser-etched stainless steel thermal bottle (350–500 mL).
2. **Reagent Supply:** One 30 mL amber dropper bottle of 95.5:0.5 D-Limonene/Curcumin developer (sufficient for ~20 chamber charges).
3. **Extraction Solvent:** One 30 mL dropper bottle of pure D-Limonene or carrier alcohol.
4. **Substrate Pack:** 100 pre-cut cellulose paper chromatography strips ($20\text{ mm} \times 80\text{ mm}$) sealed in a moisture-barrier pouch.
5. **Applicators:** 50 borosilicate capillary tubes in a protective hard case.
6. **Illumination:** One 365 nm long-wave UV LED keychain light with spare coin cells.

7. Documentation Card: One laminated one-page field SOP summary card with baseline troubleshooting tables.

Standardizing the kit hardware ensures every volunteer, outreach team, and satellite clinic executes identical testing parameters, producing clean, cross-comparable telemetry data across your entire community safety network.

Chapter 12: Training Your Team

The most sophisticated analytical methodology in the world is useless if it can only be operated by a specialist with an advanced degree. In a community harm-reduction program, staff turnover is real, shift schedules are erratic, and the people closest to the ground are often peer workers and community volunteers.

If your testing protocol takes three weeks of classroom instruction to master, it will stall the moment your primary technician calls in sick. The Purple Canary Protocol is engineered to be taught, validated, and deployed by non-technical staff in under sixty minutes.

Training Peer Workers and Volunteers First

Traditional institutional hierarchies place degreed clinicians at the top of the testing chain. In frontline harm reduction, peer workers—individuals with lived or living experience of substance use—are the most vital operational assets in your agency.

Peers carry cultural fluency and trust that no clinical credential can buy. When a participant approaches a testing table, they can instantly sense whether the person behind the table is judging their choices. Training peer workers and frontline volunteers to lead testing operations accomplishes two foundational objectives:

1. **Immediate De-Stigmatization:** The test is conducted by someone who understands the reality of unregulated markets, eliminating shame from the interaction.

2. Operational Redundancy: When every outreach volunteer on a Friday night shift knows how to spot a strip, run the thermal bottle, and interpret the densitometry scan, your agency maintains uninterrupted point-of-care coverage.

The 45-Minute Training Curriculum: SPOT → SNAP → KNOW

Structure volunteer training into a rapid, experiential three-phase module:

[00:00 - 00:15] → [00:15 - 00:30] → [00:30 - 00:45] → [00:45 - 01:00]		
THE PHYSICAL KIT	THE WET LAB RUN	THE OPTICAL
SCAN	COACHING & SCRIPTS	
(Hardware, safety, software	(Spotting & chamber	(UV pass &
interpretation)	(Trauma-informed reagent handling)	migration practice)
	communication)	

Module 1: The Kit & Physical Safety (Minutes 0–15)

- Walk through the hardware components: the stainless steel thermal bottle, the 95.5:0.5 D-Limonene/Curcumin developer dropper bottle, the cellulose strips, and the 365 nm UV keychain light.
- Demystify the chemistry: explain that the solvent is food-grade orange peel terpene and the dye is turmeric extract, so spills carry zero biohazardous or carcinogenic risks.

- Practice universal precautions: nitrile gloves on, non-porous mats laid down, zero skin contact with unknown residues, and strict prohibition against smelling or tasting any sample.

Module 2: The Hands-On Run (Minutes 15–30)

- Have trainees practice drawing the graphite baseline at exactly 1.5 cm using a pencil.
- Demonstrate micro-sampling using inert training matrices (e.g., ground culinary oregano or non-psychoactive botanical oils).
- Coach the capillary touch: emphasize the sub-half-second tap. Have every trainee spot three strips until their spot diameters are consistently under 1.5 mm.
- Execute a live 3-minute chamber migration inside the sealed thermos.

Module 3: Digital Capture & Verification (Minutes 30–45)

- Demonstrate alignment on a matte white surface.
 - Train the 45-degree angle hold for the 365 nm UV torch to eliminate camera flare.
 - Run the daylight and UV passes on the mobile app.
 - Interpret the resulting densitogram: show trainees how the app traces baseline centroids, calculates R_f values, and flags library matches.
-

Three Hands-On Training Drills

To ensure the quick-training promise translates into muscle memory, have trainees run through these three practical exercises before their first live shift:

Drill 1: The Inert Spotting Challenge (10 Minutes)

- **Objective:** Achieve consistent, sub-1.5 mm spot diameters without tearing the paper or overloading the cellulose.
- **Materials:** Practice Whatman Grade 1 paper strips, graphite pencils, capillary tubes, and a dish of culinary olive oil mixed with a drop of orange extract.
- **Execution:** Each trainee marks three strips at 1.5 cm with pencil. Anchoring their wrist on the table, they load the capillary tube and practice tapping the line for less than 0.5 seconds.
- **Passing Standard:** The trainee must produce three consecutive spots with clean circular boundaries measuring between 1.0 mm and 1.5 mm in diameter.

Drill 2: The Chamber Timing & Gas-Seal Drill (5 Minutes)

- **Objective:** Master chamber priming, vapor saturation, and leak-free closure.
- **Execution:** Trainees dispense exactly 1.5 mL of developer into the thermos reservoir, screw the lid on tightly, wait 2 minutes for headspace equilibration, drop in a blank practice strip, reseal, and time a 3.5-minute run.
- **Passing Standard:** Trainee demonstrates zero hesitation, verifies liquid level is below the 1.5 cm line, and checks the lid gasket seal.

Drill 3: The Bad-News Roleplay Simulation (15 Minutes)

- **Objective:** Practice delivering concerning or adulterated results without judgment, panic, or confrontation.
 - **Execution:** Trainees pair up. One plays the role of a participant who spent their last \$20 on a vape cart and feels defensive; the other plays the peer technician delivering Script A. Trainees swap roles after five minutes.
 - **Passing Standard:** The technician uses objective visual references on the strip, offers non-coercive disposal options, and provides naloxone and fentanyl test strips without lecturing.
-

Counseling Scripts: Delivering Bad News Without Judgment

The hardest part of drug checking is not running the chemistry; it is telling a participant that the substance they spent their last ten dollars on is dangerous or heavily adulterated.

Trainees must never use judgmental, scolding, or authoritarian language. The role of the worker is to share objective analytical findings so the participant can make their own informed choices.

Script A: When a High-Hazard Adulterant or SCRA Is Detected

***The Wrong Approach:** "You can't smoke this. It's fake weed sprayed with synthetic poison. Throw it in the trash right now." **The Trained Approach:** "I want to show you what showed up on the strip here under the UV light. Right here at this higher position, we're seeing a dark band that matches a known synthetic*

agonist profile rather than natural botanical plant compounds. In our system, that kind of band is strongly linked to sudden heart spikes, severe headaches, and unexpected blackouts. I'm really glad we checked this before you used it. If it were me, I wouldn't touch this batch. Do you want to neutralize and toss it in our disposal bin, or how are you thinking about handling it?"

Script B: When the Result Appears Normal (Presumptive Clean)

***The Wrong Approach:** "Good news! Your stuff is 100% pure and completely safe to use." **The Trained Approach:** "The strip migrated smoothly through the normal corridor, and we didn't pick up any targeted synthetic adulterants or cutting agents on this micro-sample. Remember, this is an early-warning check, not a factory guarantee of safety. Your body's tolerance, hydration, and setting still matter. If you decide to use, start with a tiny test amount first, don't use alone, and take a couple of these naloxone doses and test strips with you just in case."*

Trauma-Informed Testing: Consent and Power Dynamics

Substance use in an unregulated market is often surrounded by trauma, criminalization, and fear of authority. Your training must instill an awareness of power dynamics:

- **The Right to Refuse:** The participant retains complete ownership over their substance at all times. If they change their

mind mid-test and want to leave, staff must never detain them, argue, or confiscate their property.

- **No Forced Disposal:** While staff should actively offer safe disposal options (like neutralizing kitty litter or coffee ground bins), workers must never physically grab or destroy a participant's bag without explicit permission. Coercion destroys agency trust and drives participants away from health programs.
- **Complete Transparency:** Every step of the testing process must happen in full view of the participant. Never take a sample into a "back room" or behind an opaque partition where the participant cannot see what is happening to their material.

Coaching Through Common Trainee Errors

During initial field shifts, supervisors should watch for three frequent operational slip-ups:

Trainee Mistake	Why It Happens	Field Supervisor Coaching
Lingering Capillary Tap	Hesitation; trainee holds tube against paper for 2+ seconds.	"Think of it like a quick typewriter key strike—just tap and lift in an instant."
Overfilling the Thermos	Fear of running out of solvent during the run.	"Measure 1.5 mL in the dropper first. If the pool touches the pencil line, the run is ruined before it starts."
Over-Promising Purity	Desire to relieve participant anxiety.	"Keep the honest-uncertainty contract front and center. We report what we can see, never what we can't guarantee."

By investing an hour in practical, peer-centered coaching, your organization transforms everyday outreach workers into confident frontline harm-reduction scientists.

Chapter 13: Restocking and Sustaining

Field harm reduction programs rarely shut down because of philosophical disagreements; they shut down when the budget runs out of money for proprietary consumables or the supply chain breaks.

Most commercial drug-checking technologies are engineered around a razor-and-blades revenue model: an agency purchases or receives grant funding for a piece of hardware, only to discover that every individual test requires a proprietary single-use cartridge, a licensed single-assay cassette, or a costly chemical reagent ampoule. When the grant cycle ends, the hardware ends up gathering dust on an office shelf because the program cannot afford the consumables.

The Purple Canary Protocol was designed from the ground up to be physically sustainable on a shoestring municipal or non-profit budget. Every single item required to maintain operations can be sourced from open, non-regulated, commodity-level supply chains.

Consumables Sourcing: Bypassing Specialty Markups

Maintaining a functioning deployment comes down to three primary consumables: chromatography strips, the developer formulation, and micro-applicator tubes.

COMMODITY-TIER SOURCING			
BLUEPRINT			
ITEM	OPEN-MARKET SOURCE	ESTIMATED RUNNING COST	
Whatman #1 Cellulose	Open science supplier	\$0.03 - \$0.05 / strip	
Food-Grade Limonene	Citrus processing/bulk	\$18 - \$25 / liter	
Pure Curcumin Powder	Bulk spice/botanical	\$12 - \$16 / 100 grams	
Borosilicate Tubes	Glass capillary stock	\$0.02 - \$0.04 / tube	

1. Chromatography Strips

- **Laboratory Standard:** Untreated Whatman Grade 1 chromatography paper ($20\text{ mm} \times 80\text{ mm}$). Consisting of pure, binder-free β -(1,4)-D-glucan polysaccharide chains, it presents uniform capillary pore distribution and retains 5% to 8% bound atmospheric water within its amorphous domains. Purchasing pre-cut packs from general scientific distributors costs pennies per strip.
- **Field Alternative (The Joe Method):** In absolute supply emergencies, unbleached, high-density cellulose coffee filters

cut into uniform 20 mm strips using a paper guillotine or rotary cutter yield readable, functional separation for frontline screening.

2. The 95.5 : 0.5 Developer Formulation

- **D-Limonene:** Source cold-pressed, food-grade or high-purity botanical degreaser grade (CAS 5989-27-5). Chemically, it is a cyclic *p*-menthadiene hydrocarbon possessing a low dielectric constant ($\epsilon \approx 2.3$) and zero hydrogen-bonding capability. A single 1-liter bottle (20 to 25) provides enough solvent to run over 500 complete chamber charges.
- **Curcumin:** Source standardized natural turmeric extract powder standardized to $\geq 95\%$ curcuminoids. Curcumin is a polyphenolic diferuloylmethane containing an active keto-enol tautomeric system. A single 100-gram container (\$15) provides enough fluorophore dye to formulate tens of liters of developer solution.
- **Compounding in the Agency Kitchen:** Weigh 0.5 grams of curcumin powder and dissolve into 95.5 grams (approximately 113 mL) of pure D-Limonene ($0.5\%\text{ w/v}$). Shake vigorously and allow to rest for two hours. If faint sediment remains, filter through a single coffee filter into an amber glass dispensing bottle. Store protected from ultraviolet light to prevent photodegradation.

3. Micro-Capillary Tubes

- Source non-heparinized borosilicate glass micro-hematocrit capillary tubes or Drummond wiretrol pipettes ($0.5\text{ }\mu\text{L}$ - $1.0\text{ }\mu\text{L}$). Sourced in bulk cases of 500, they cost roughly \$0.02 each.

What Runs Out First: Frontline Depletion Velocity

If you manage inventory for an outreach station, don't assume all supplies deplete at equal rates. On active shifts, consumables vanish in a very specific hierarchy:

HIGHEST BURN RATE

→ LOWEST BURN RATE

1. Capillary Tubes ▶ 2. Test Strips ▶ 3. Torch
Batteries ▶ 4. Developer ▶ 5. Chamber Gaskets
(Breakage / loss) (1.2x per run) (Voltage sag at
100) (20 runs/chg) (Monthly inspect)

- 1. Micro-Capillary Tubes (Burns Out First):** Glass capillary tubes are tiny, delicate, and single-use. They roll off tables, get crushed in pockets, or get dropped on concrete. While a test uses one tube, trainees and participants drop or misplace them constantly. **Rule of Thumb:** Stock 2.5 capillary tubes for every 1 test strip in your active inventory.
- 2. Chromatography Strips:** Your primary volume consumable. Account for a 15–20% buffer over participant count to cover practice runs, confirmatory re-tests for anomalous results, and accidental thumb smudges.
- 3. 365 nm Torch Coin Batteries:** LED torches do not suddenly go dark when batteries die; their ultraviolet output dims gradually. After roughly 80 to 100 scans, the 365 nm wavelength power drops below optimal excitation thresholds, making weak bands harder to distinguish. Always keep two spare sleeves of CR2016 or CR2032 coin cells in the field kit.
- 4. Developer Solution:** A 30 mL dropper bottle charges a thermos roughly 15 to 20 times. Because one charge can develop

multiple strips in a single session, developer solution lasts longer than paper or tubes, provided droppers are kept tightly capped to prevent evaporation.

5. **Silicone Chamber Gaskets (Slowest Wear):** The rubber seal inside the thermos lid gradually compresses or degrades over 6 to 12 months. Keep a pack of standard food-grade silicone replacement gaskets in the agency supply cabinet.

In-House Printing: Trifolds and SOPs for Pennies

Participant education should not rely on expensive glossy print shops.

The one-page field SOP summary and participant education guides are designed to be printed directly on your agency's standard black-and-white office copier as double-sided, letter-sized trifold brochures:

- **The Trifold Handout:** Contains the three-step **SPOT** → **SNAP** → **KNOW** breakdown, the visual color guide for typical cannabinoid corridors, and local community resources (overdose lines, local syringe exchanges, and naloxone access points).
 - **Printing Cost:** Less than three cents per trifold using standard 20 lb copy paper.
 - **Laminated Stations:** Print three copies of Chapter 9's full SOP, laminate them at a local library or office supply store, and tape them directly to your folding station tables for immediate reference by outreach volunteers.
-

Hardware Maintenance: Keeping the Deployment Alive

Because the kit relies on rugged, passive physical tools rather than fragile microchips, hardware maintenance is straightforward:

The Stainless Steel Thermal Bottle

- **Daily Cleaning:** At the end of an outreach shift, dump any spent developer solution from the bottle reservoir into the coffee-ground waste bin. Rinse the interior with 5\text{ mL} of isopropyl alcohol and wipe clean with a paper towel. Leave the cap off overnight to dry.
- **Gasket Inspection:** Inspect the rubber sealing gasket inside the threaded lid once a month. If the gasket is pinched, cracked, or missing, the chamber cannot maintain vapor saturation, causing migration stalls. Replace gaskets using standard silicone replacement rings available at any hardware store.

The 365 nm UV Torch

- **Battery Cycles:** Swap coin batteries every 80–100 scans or whenever the baseline curcumin fluorescence appears pale rather than bright greenish-yellow.
- **Lens Care:** Wipe the UV emitter lens with an alcohol prep pad once a week to clear away pocket lint and fingerprint grease.

Reagent Longevity & Sun Exposure

- **Amber Glass Requirement:** Curcumin is naturally light-sensitive and photodegrades under continuous ambient light. Always store bulk and dropper-dispenser developer bottles in amber glass or opaque containers. If a batch turns from deep golden-orange to pale translucent yellow, discard the bottle and mix a fresh 95.5:0.5 batch.

Operating on a Micro-Budget

A complete operating budget for a community program running 1,000 tests per year looks like this:

Component	Annual Quantity	Sourcing Strategy	Annual Cost
Cellulose Test Strips	10 Packs (100/ea)	Science supply bulk packs	\$40.00
D-Limonene Solvent	2 Liters	Food-grade bulk supplier	\$45.00
Curcumin Powder	100 Grams	Botanical bulk spice	\$15.00
Capillary Tubes	2 Packs (500/ea)	Bulk laboratory glass	\$30.00
CR2016 UV Batteries	2 Sleeves (10/ea)	Standard hardware multipack	\$14.00
Trifold Photocopies	1,000 Copies	Internal agency copier	\$25.00
TOTAL ANNUAL CONSUMABLES	1,000 Complete Tests		\$169.00

At **\$169.00 per thousand tests**, the running cost sits at approximately **16.9 cents per test** including all printed collateral and fresh hardware components—or drops below **0.17 cents per test** for the raw chemistry alone.

By stripping out proprietary vendor lock-in, your agency is never held hostage by supply shortages, expired proprietary cassettes, or corporate price hikes. The tools stay cheap, the supply lines remain open, and the testing table stays open every single night your community needs it.

Chapter 14: The Economics of Free Testing

Providing free, point-of-care drug checking is an ethical imperative, but sustaining it is an economic problem. Harm-reduction agencies operate inside volatile funding environments where political winds shift, opioid-settlement dollars get delayed in bureaucratic committees, and small municipal grants expire without warning.

If a public health program depends on high-cost proprietary machines and \$50-per-sample commercial testing fees, it lives on borrowed time. The moment funding contracts constrict, services get rationed, hours get cut, and frontline workers are forced to turn away the very people who need screening most.

To make free testing permanent, an agency must treat economic resilience as a core operational feature. That means understanding three interconnected systems: diversified funding streams, persuasive grant architecture, and software cost structuring.

Funding Models: Beyond Single-Source Grants

Relying entirely on a single federal or state grant to fund drug checking creates single-point-of-failure vulnerability. Sustainable programs build a blended revenue model combining multiple distinct funding pools:

1. **Opioid Settlement Funds:** Billions of dollars from national opioid litigation settlements continue to flow directly to county boards, city councils, and regional public-health authorities. Because the Purple Canary Protocol directly targets adulterant

screening, overdose prevention, and local supply monitoring, it matches the primary remediation criteria mandated by settlement trust agreements.

2. **Municipal Public Health Line Items:** City health departments often hold flexible discretionary allocations for seasonal outreach, needle-exchange supplies, or emergency overdose spikes. A deployment requiring only \$25 per mobile kit and fractions of a penny per test can easily be approved under petty-cash limits or existing harm-reduction supply budgets without requiring months of city council debate.
3. **Private Foundations & Community Trusts:** Regional philanthropic funds often avoid buying *40,000 capital laboratory assets due to ongoing maintenance risks, but they eagerly fund direct, tangible field supplies*. Asking a local foundation for 2,500 to fund an entire year of community screening kits for ten satellite clinics is an easy, high-impact proposal for a program officer to greenlight.
4. **Grassroots Mutual Aid & Micro-Donations:** Because the materials list consists of everyday, non-scheduled items (stainless bottles, citrus terpene, turmeric, coffee filters, and battery lights), mutual-aid groups and local supporter networks can stock an outreach clinic directly through community wishlists without navigating medical supply-chain hurdles.

The Grant Language: How to Describe the Program to a Funder

Grant reviewers evaluate proposals based on measurable impact, risk reduction, operational feasibility, and return on investment. When seeking public or private funding for the Purple Canary Protocol,

avoid colloquial street phrasing. Frame the project using established public-health nomenclature:

Program Title: *Decentralized Point-of-Care Botanical and Synthetic Drug Surveillance Initiative* **Project Abstract for Grant Officers:** *"This initiative deploys an open-source, non-destructive, micro-scale chromatographic screening methodology (Thin-Layer Chromatography paired with optical densitometry) across frontline outreach sites. By utilizing a standardized food-grade terpene mobile phase (95.5\% D-Limonene) and a non-carcinogenic polyphenolic fluorophore (0.5\% Curcumin w/v), frontline peer specialists evaluate community samples for synthetic cannabinoid receptor agonists (SCRAs), novel psychoactive substances (NPS), and hazardous bulking agents in under five minutes. Operating at an initial hardware cost of approximately 25 per station and a marginal consumable cost of under 0.01 per test, this platform eliminates reliance on costly centralized laboratory backlogs while delivering immediate, point-of-care harm-reduction counseling directly to underserved populations. All optical telemetry is anonymized and aggregated into an early-warning signal that monitors local supply contamination trends in real time without collecting participant personally identifiable information."*

This framing directly addresses every major concern a public-health grant committee evaluates: safety compliance, fiscal efficiency, rapid response times, and non-carceral participant data protections.

The Cost-Per-Test Math: Lab Outsourcing vs. The Protocol

When a grant committee reviews your budget, the decisive factor is often the comparative cost table. Showing the fiscal disparity between commercial laboratory outsourcing and decentralized field screening provides immediate justification for funding your deployment:

Metric	Centralized Lab Outsourcing (GC-MS / FTIR)	The Purple Canary Protocol (Decentralized TLC)
Capital Equipment Cost	30,000 – 75,000 per unit	~\$25.00 per station deployment
Cost per 1,000 Tests	35,000 – 50,000 (at 35–50/sample lab fees)	~1.67 (raw chemistry) / ~169.00 (all supplies)
Result Turnaround Time	3 to 14 business days	3 to 5 minutes at point of care
Waste Disposal Overhead	Hazardous chemical waste disposal permits	Zero biohazard cost (food-grade citrus wash)
Cost per Participant Engagement	Prohibitive for routine daily testing	Fractions of a cent per screening intervention

The Paragraph a Grant Officer Needs to Read:

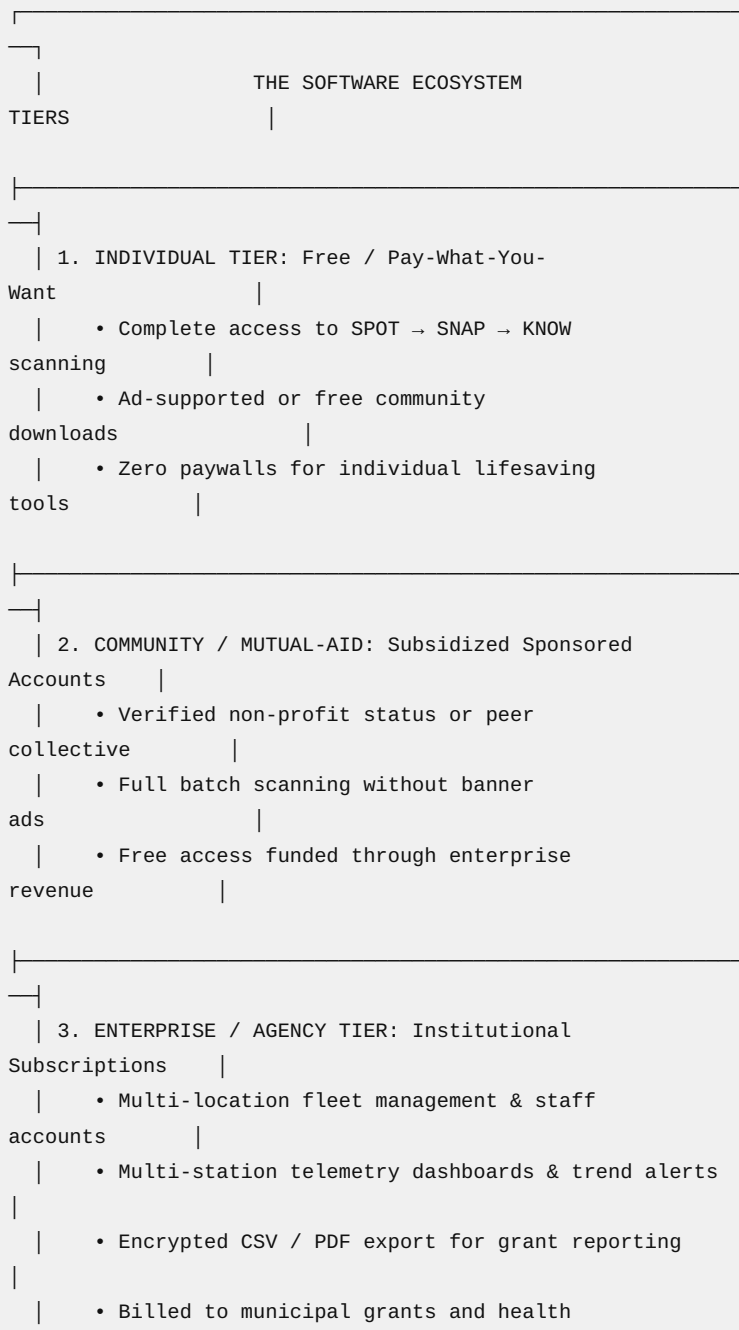
"At traditional commercial laboratory pricing of 35 to 50 per sample, a community outreach program screening 2,000 participant samples per year requires an annual operating allocation of 70,000 to 100,000 solely for chemical evaluation. By contrast, transitioning to the decentralized Purple Canary Protocol enables our agency to conduct the identical 2,000 screenings for less than 350 in total

annual consumable materials. This achieves a >99\%\$ reduction in screening expenditure, freeing grant capital to directly fund frontline peer staffing, sterile supplies, and naloxone distribution while expanding testing volume by an order of magnitude."

Software Tiers: Supporting Community Access

Maintaining a living digital reference library—training computer-vision models, hosting normalized R_f baselines, and maintaining cryptographic verification infrastructure—requires server resources and software development maintenance.

To keep the ecosystem sustainable without putting a price tag on community safety, the digital scanning infrastructure relies on a tiered operational model:



1. **The Individual Tier:** A person testing their own supply on a kitchen table should never encounter a payment barrier. The consumer-facing mobile scanner is free to download and run, supported by unobtrusive partner sponsorships or pay-what-you-can contributions.
2. **The Community Tier:** Small, un-funded volunteer collectives, squat clinics, and volunteer syringe exchanges access ad-free agency features through sponsored community waivers.
3. **The Institutional Agency Tier:** Funded public health agencies, municipal health departments, and hospital systems purchase organizational subscriptions. This tier provides multi-seat administrative control, regional telemetry feeds, bad-batch alert broadcasting, and automated reporting modules designed for grant compliance.

This economic architecture ensures that institutional programs with formal funding budgets support the server maintenance and research costs of the open platform. The individual consumer on the street and the shoestring volunteer group never pay a dime.

Free testing is not a temporary luxury funded by a fleeting charity drive. Built on commodity chemistry, open-market sourcing, and aligned software incentives, it becomes a permanent community utility that keeps running year after year.

Chapter 15: Open Methods, Open Knowledge

The moment an institution discovers an effective testing method, the historical instinct is almost always the same: fence it in, brand it, classify it, and charge admission.

We have seen this script play out across public health for decades. A breakthrough occurs that can distinguish clean medicine from lethal adulteration, but instead of entering every home and outreach bag, it gets locked inside high-margin instrument monopolies, walled research journals, and patented cartridge ecosystems. The gatekeepers convince themselves that secrecy is necessary—that the general public cannot be trusted with the raw mechanisms of chemistry, or that proprietary moats are the only way to build value.

The consequence of that gatekeeping is not quality control; it is preventable death.

When knowledge is withheld, adulterated supply thrives in the dark. The only way to dismantle an opaque, predatory street market is with an equally aggressive, open-source defense: open chemistry, open telemetry, and completely decentralized verification.

A Subversive Liturgy of Demystification

In traditional science, analytical chemistry functions like an exclusive priesthood. Specialized technicians in isolated cleanrooms interpret complex signals and issue top-down decrees: *this sample is pure; that sample is contraband*. The end consumer is treated as a passive recipient, shut out from the empirical process and left to trust an institutional authority that has repeatedly let them down.

The Purple Canary Protocol is built on a very different premise: it is a **subversive liturgy of demystification**.

It is "liturgical" because it follows an exacting, reproducible physical rhythm: marking the pencil origin, measuring the micro-drop, saturating the chamber, and letting the fluid climb. It demands rigor and discipline. But it is "subversive" because it performs this ritual out in the open—on a park bench, on a van tailgate, or across a drop-in clinic counter—using materials pulled from a grocery aisle and a hardware shelf.

Watching the solvent front travel physically up a cellulose strip and witnessing the fluorescence separate under 365 nm light directly restores **epistemic agency**. You do not have to take someone's word for what is in front of you; you do not have to trust a corporate stamp or a dealer's promise. You observe the physical laws of molecular migration with your own eyes.

The Three Foundational Contrasts

The entire philosophy of the protocol resolves three historical tensions that have kept ordinary communities separated from analytical science:

TRADITIONAL FORENSIC MODEL
CANARY PARADIGM

THE PURPLE

-
1. Toxic, regulated reagents & solvents → Kitchen-safe D-Limonene & Curcumin
 2. Expensive, fragile optical sensors → Analog paper meets mobile phone vision
 3. Closed carceral & medical gatekeeping → Decentralized peer-to-peer mutual aid

1. Kitchen-Safe Chemistry vs. Toxic Reagents

Traditional laboratory chromatography relies on carcinogenic diazonium salts (like Fast Blue BB), chloroform, and volatile petroleum ethers. Those compounds belong in industrial fume hoods, not community spaces. By replacing hazardous reagents with an unscheduled terpene matrix derived from orange rinds and turmeric, testing is stripped of its biohazard baggage. A volunteer can spill a drop on their fingers, wipe it off with a towel, and keep working without hazard protocols.

2. Analog Paper Meets the Digital Eye

Archaic cellulose filter paper is one of the cheapest physical media on Earth. It operates without power, without code, and without silicon chips. Yet, by pairing that passive physical climb with the high-resolution optical sensor and machine-learning densitometry living on every modern smartphone, the protocol achieves forensic-grade reading accuracy without proprietary field hardware.

3. Street-Level Mutual Aid vs. Institutional Bureaucracy

Institutional bureaucracy treats testing as a surveillance tool to log infractions or police behavior. Frontline harm reduction treats testing as an act of mutual survival. Adopting the exact, formal language of

an institutional Standard Operating Procedure (SOP) is not done to bow to administrative authority; it is done to establish **forensic parity**. It gives everyday people and peer outreach workers the exact same structural validity and analytical credibility that state crime labs claim for themselves.

Secrecy as Betrayal: Why Methods Must Be Shared

If the goal of harm reduction is to keep people alive, treating testing formulas as proprietary trade secrets is a direct moral failure.

Consider what happens when a test formulation is hidden behind patent walls:

- Competitors cannot audit or validate the underlying library data.
- Independent researchers cannot verify retention factors or challenge false-negative rates.
- When supply chains stutter, clinics that run out of proprietary consumables are forced to halt operations entirely.

By making every single component, ratio, and step open-source—documenting the 95.5:0.5 D-Limonene/Curcumin formulation, the Whatman Grade 1 cellulose parameters, and the densitometric calculation formulas—the protocol becomes immune to corporate capture. Anyone can compound the developer. Anyone can cut the strips. Anyone can verify the results.

Open knowledge is resilient knowledge. Once a community understands how to test its own supply, that capability can never be rescinded, defunded, or regulated out of existence.

Joe's Kicker: Disrupting the Old Guard

When Joe and I were talking through the open documentation of this project, we kept circling back to the sheer absurdity of the legacy pharmaceutical vaults we grew up around in Allegan. For generations, corporate gatekeepers guarded basic chemical steps behind seven-year non-compete agreements and locked industrial doors—all to protect manual guesswork and rudimentary physics.

Joe laughed, shook his head, and laid out the real market truth:

"Mike, if you actually published all of this—if you put the entire catalog out on a 'DOPE.wiki' for the whole world to see—it wouldn't just inform people. It would put the old guard out of business."

He was right.

Openness is not just a moral principle; it is an engine of systemic disruption. The multi-million-dollar testing monopolies rely entirely on consumers and public health directors remaining intimidated by chemical jargon. The moment you hand an outreach director or an everyday consumer a twenty-five-dollar kit that executes reliable presumptive separation for pennies, the legacy monopoly collapses under its own weight.

The Credibility Document for Community Leadership

This book is not merely a user manual for the individual consumer; it is a **foundational credibility document** meant to be handed directly to municipal stakeholders, shelter executive directors, and public health officers.

When you walk into a meeting with a civic task force, an agency board, or an outreach supervisor, hand them this text. Show them that

decentralized drug checking does not mean reckless experimentation. Point them to the empirical mathematical rigor of the R_f migration windows, the compound-by-compound chromatographic cross-check against international forensic compendia (including UNODC manuals and *Clarke's Analysis of Drugs and Poisons*), the chemical plausibility justifications rooted in molecular partition mechanics, and the transparent acknowledgment of literature gaps under the honest-uncertainty contract.

We do not need to wait for institutional permission to protect our communities from tainted supply. The physical laws of chromatography belong to the public domain. The light belongs to everyone.

Put the protocol on the table, teach your team, distribute the strips, and take your community's safety into your own hands.

Closing: The Living Protocol

A field protocol is never a static document locked in a glass display case; it is a living, collective defense system.

Throughout this book, we have traveled from cold parking lots and kitchen counters to outreach vans and municipal health departments. We took what institutions told you was impossible—doing real chemical separation without an eighty-thousand-dollar machine—and grounded it in three everyday principles: paper, light, and lemon.

Every time a peer specialist opens a thermal chamber on a tailgate, spots a fresh strip with a steady hand, and uploads a verified scan to the network, the shared defense line gets stronger. A faint, uncharacterized quenching band spotted outside a music venue in Michigan might provide the decentralized telemetry that flags a novel synthetic adulterant before it claims a life three states away. When ordinary people share data instead of hoarding secrets, the street market loses its ability to operate in the dark.

The tools in this book were not handed down from a corporate boardroom or an academic ivory tower. They were forged in home kitchens, tested across unbleached coffee filters with clearance-bin digital calipers, refined with culinary turmeric and cold-pressed citrus rinds, and released freely into the public domain so that no human being ever has to fly blind in an adulterated world.

Now, the protocol belongs to you.

If you are an individual holding an unverified product at a kitchen table, test it before you take it. If you are an outreach director running a clinic on a shoestring budget, teach your team, print the trifolds, set

up the thermos stations, and bring forensic parity to the people you serve. Do not wait for institutional permission to protect the people you love.

The next time someone hands you an unverified bag and the old dread creeps into the room, you will never have to wonder in the dark again.

Pick up a strip, prepare your chamber, click on the light, and know what's real.

Back Matter

Glossary of Plain-English Terms

- **Adulterant:** A foreign, unlisted chemical agent, synthetic drug, or bulking oil added to a substance to mimic potency, cut production costs, or stretch supply weight.
- **Capillary Action:** The physical phenomenon where a liquid automatically creeps upward through narrow spaces or porous cellulose fibers against gravity due to surface tension and adhesive forces.
- **Cannabidiol (CBD):** A non-intoxicating phytocannabinoid featuring an open resorcinol ring and a *p*-menthadienyl terpene tail; migrates at $R_f = 0.42 - 0.48$ in the Purple Canary system.
- **Cannabinol (CBN):** The oxidized, fully aromatized degradation product of THC featuring a planar tricyclic core; strongly retarded by cellulose paper to $R_f = 0.34 - 0.40$.
- **Chromatography:** The physical separation of a chemical mixture by passing it through a stationary phase (like cellulose paper) using a moving carrier solvent (the mobile phase).
- **Colorimetry:** The quantitative measurement and profiling of wavelength, shade, and color saturation across specific optical color channels (such as red, green, and blue RGB intensity vectors).
- **Curcumin:** The primary polyphenolic active compound in turmeric spice (diferuloylmethane); acts as an integrated indicator dye and natural fluorophore in the developer matrix.

- **Densitometry:** The analytical technique used to scan and measure light absorption, optical density, and band concentration along the vertical migration lane of a test strip.
- **Dielectric Constant (ϵ):** A fundamental measure of a solvent's polarity and ability to stabilize electrical charges; non-polar D-limonene exhibits $\epsilon \approx 2.3$, offering negligible eluotropic power for basic amine salts.
- **D-Limonene:** A naturally occurring, food-grade terpene solvent (cyclic *p*-menthadiene hydrocarbon) cold-pressed from citrus rinds that functions as the non-polar mobile carrier.
- **Eluotropic Strength:** The thermodynamic capability of a solvent to desorb solutes from a polar stationary phase like cellulose and carry them upward.
- **False Negative:** An analytical error where a test fails to detect a dangerous compound that is actually present; the most dangerous failure mode in harm reduction.
- **False Positive:** An analytical error where a test flags an adulterant or anomalous band when the sample is actually benign.
- **Fentanyl Test Strip (FTS):** A rapid, water-based lateral flow immunoassay engineered to detect trace nanogram concentrations of fentanyl and major fentanyl analogs.
- **Fluorophore:** A chemical compound or molecule that absorbs invisible light (such as long-wave 365 nm UV-A) and re-emits it as visible, glowing luminescence.
- **Fluorescence Quenching:** The optical phenomenon where a compound absorbs ultraviolet light without glowing, appearing as a dark silhouette or shadow band against a fluorescent background.

- **Forensic Parity:** The principle that ordinary individuals deserve equal access to the same fundamental physical truths about what enters their bodies as state crime laboratories possess.
- **FTIR (Fourier-Transform Infrared Spectroscopy):** A confirmatory optical technology that measures how molecules absorb infrared light to create an absorption spectrum.
- **GC-MS (Gas Chromatography-Mass Spectrometry):** The laboratory gold standard for confirmatory drug testing; vaporizes compounds, separates them through a capillary column, shatters them with electron beams, and weighs the fragments.
- **Good Samaritan Laws:** Statutes that provide legal immunity from drug possession arrests or prosecution for individuals who call 911 during an overdose emergency.
- **HPLC (High-Performance Liquid Chromatography):** A confirmatory laboratory instrument that pumps liquid solvent under high pressure through a column to separate and quantify non-volatile chemical compounds.
- **Indazole-3-Carboxamides:** A potent chemical class of synthetic cannabinoid receptor agonists (such as ADB-PINACA) lacking phenolic hydroxyl groups and migrating higher up paper strips ($R_f = 0.68 - 0.74$).
- **Keto-Enol Tautomerism:** An active chemical equilibrium where a molecule rapidly interconverts between ketone and enol structural isomers; responsible for the distinct solvent interactions and fluorophore shifts of curcumin.
- **Limit of Detection (LOD):** The lowest physical concentration of a substance that an analytical method can reliably distinguish from background noise.

- **Matrix Masking:** An interference phenomenon where heavy plant waxes, dark tars, or thick unrefined oils physically trap or obscure trace adulterants on a test strip.
- **Medium-Chain Triglycerides (MCT Oil):** Bulking lipids made of caprylic and capric fatty acid chains ($R_f = 0.80 - 0.88$); an illicit cutting agent in vape cartridges.
- **Mobile Phase:** The moving liquid solvent mixture (95.5% D-Limonene : 0.5% Curcumin w/v) that dissolves and carries chemical compounds up the chromatography strip.
- **Molecular Polar Surface Area (PSA):** The total surface area of all polar atoms (primarily nitrogen and oxygen) in a molecule; governs hydrogen-bonding capture on poly-hydroxyl cellulose.
- **Naloxone (Narcan):** An opioid receptor antagonist medication that rapidly reverses life-threatening opioid-induced respiratory depression.
- **Normal-Phase Chromatography:** A separation system where a polar stationary phase (cellulose paper) is paired with a non-polar or weakly polar mobile phase (terpene solvent).
- **Presumptive Testing:** Rapid point-of-care screening methods that indicate the probable presence or absence of specific compound classes without issuing quantitative molecular confirmation.
- **Retention Factor (R_f):** The standardized decimal fraction describing how far a specific chemical migrated relative to the total distance traveled by the solvent front ($R_f = d_{\text{analyte}} / d_{\text{solvent}}$).
- **SCRA (Synthetic Cannabinoid Receptor Agonist):** Potent, lab-synthesized research chemicals (such as ADB-PINACA or MDMB-4en-PINACA) engineered to bind aggressively to CB1 receptors.

- **Solvent Front:** The highest physical boundary line reached by the migrating liquid developer before the strip is pulled from the chamber ($R_f = 1.00$).
- **Stationary Phase:** The porous solid matrix (untreated Whatman Grade 1 cellulose paper, composed of β -(1,4)-D-glucan polysaccharide fibers) that provides physical resistance during chromatography ($R_f = 0.00$).
- **Δ^9 -Tetrahydrocannabinol (Δ^9 -THC):** The primary psychoactive cannabinoid in natural cannabis; migrates cleanly at $R_f = 0.52 - 0.58$ in the Purple Canary system.
- **Vitamin E Acetate (α -Tocopheryl Acetate):** A thick, oily synthetic ester implicated in EVALI lung injuries; migrates near the solvent front ($R_f = 0.84 - 0.92$) due to high lipophilicity.
- **Whatman Grade 1 Cellulose:** Pure, binder-free cotton cellulose filter paper with controlled pore size used as the standardized stationary phase.
- **Xylazine ("Tranq"):** A non-opioid veterinary sedative that does not respond to naloxone, increasingly co-mingled with street drug supplies.

Authoritative Analytical Literature & Benchmark Sources

The empirical migration windows, retention mechanics, and chemical plausibility assessments across this protocol are cross-referenced

against the following peer-reviewed forensic compendia, monographs, and analytical studies:

- **United Nations Office on Drugs and Crime (UNODC).** (2022). *Recommended Methods for the Identification and Analysis of Cannabis and Cannabis Products* (Manual for Use by National Drug Analysis Laboratories, ST/NAR/40/Rev.1). United Nations Publications, Vienna.
- **Moffat, A. C., Osselton, M. D., & Widdop, B. (Eds.).** (2011). *Clarke's Analysis of Drugs and Poisons in Pharmaceuticals, Body Fluids and Postmortem Material* (4th ed.). Pharmaceutical Press, London. ISBN: 978-0-85369-711-4.
- **Sherma, J., & Rabel, S. R.** (2019). Thin layer chromatography in the analysis of cannabis and its components and synthetic cannabinoids. *Journal of Liquid Chromatography & Related Technologies*, 42(15–16), 475–492. DOI: 10.1080/10826076.2019.1663529.
- **Banister, S. D., Moir, M., Stuart, J., Kevin, R. C., Wood, K. E., Longworth, M., Wilkinson, S. M., Beinat, C., Buchanan, A. S., Glass, M., Connor, M., McGregor, I. S., & Kassiou, M.** (2015). Pharmacology of valine and tert-leucine-derived indazole and indole synthetic cannabinoid receptor agonists: 5F-AMB, 5F-MDMB-PINACA, ADB-PINACA, and their analogues. *ACS Chemical Neuroscience*, 6(9), 1546–1559. DOI: 10.1021/acscemneuro.5b00112.
- **Antonides, M. S. et al.** (2020). Rapid identification and analytical characterization of MDMB-4en-PINACA in forensic drug seizures. *Drug Testing and Analysis*, 12(9), 1346–1358. DOI: 10.1002/dta.2882.
- **Korte, F., & Sieper, H.** (1960). Zur chemischen Klassifizierung von Pflanzen. XVIII. Untersuchung von Haschisch-

Inhaltsstoffen durch Dünnschichtchromatographie. *Tetrahedron*, 10(3–4), 158–163. DOI: 10.1016/S0040-4020(01)97800-4.

- **United Nations Office on Drugs and Crime (UNODC).** (2020). *Recommended Methods for the Identification and Analysis of Synthetic Cannabinoid Receptor Agonists in Seized Materials* (Manual for Use by National Drug Analysis Laboratories, ST/NAR/48/Rev.1). United Nations Publications, Vienna.
- **Sharma, S. K., Rao, S. C., & Sharma, V. K.** (2010). Detection of cannabinoids in urine using high-performance thin-layer chromatography. *Indian Journal of Medical Research*, 132(2), 202–208.
- **Gontcharova, O. A., Sherma, J., & Voyksner, R. D.** (2009). High performance thin layer chromatography determination of α -tocopherol and α -tocopheryl acetate in dietary supplements. *Journal of Food Composition and Analysis*, 22(5), 421–427. DOI: 10.1016/j.jfca.2008.06.012.

Resources & Further Reading

- **National Harm Reduction Coalition:** Educational toolkits, policy advocacy, and community harm-reduction training guides. Visit harmreduction.org.
- **DanceSafe:** Field drug checking methodologies, reagent testing kits, and community-level harm reduction resources. Visit dancesafe.org.

- **NEXT Distro:** Mail-based naloxone distribution and harm-reduction supply access for individuals unable to access local brick-and-mortar programs. Visit nextdistro.org.
 - **Never Use Alone:** A peer-run, non-judgmental telephone safety line providing emergency call monitoring for people using substances alone. Call (800) 484-3731 or visit neverusealone.com.
 - **The Purple Canary Project & TehWiz:** Access the open-source software, digital densitometry scanner, and protocol updates. Visit tehwiz.com.
-

Acknowledgments

This book exists because a community refused to accept that drug checking belonged only behind closed institutional doors.

Immense gratitude to Sharon, whose patience, partnership, and kitchen spices made this entire architecture possible.

Thank you to Joe, whose Menards caliper and skepticism regarding pharmaceutical vaults kept this project grounded in real-world physics.

And thank you to the peer specialists, outreach workers, shelter staff, and street medics who stand on the frontlines every day, meeting people where they are and doing the quiet, vital work of keeping human beings alive.

About the Author

Michael Scott Hoyt is a full-stack software developer, systems architect, and technology entrepreneur based in Traverse City and Northern Michigan. A practitioner in web architecture, computer vision, and systems engineering since 2009, he has built decentralized applications, high-performance security utilities, and community technology platforms.

Through the Purple Canary Project, he combines accessible, food-grade analytical chemistry with mobile computer vision to put point-of-care forensic verification directly into the hands of ordinary consumers and frontline harm-reduction agencies. He operates TehWiz Productions at tehviz.com.

Coming Next: The Sequel

For Joe — who begged me not to write it.

An Introduction to the Sequel: *The Cannabinoid Cookbook*

For years, the standard street playbook has treated synthetic drugs, heavy sedatives, and adulterated street pharmaceuticals as unavoidable hazards. But having spent years inside large-scale commercial extraction facilities—first scaling processing operations in Texas, then running high-throughput production labs in Michigan—the reality became undeniable: **cannabinoids can replace almost damn near all of them.**

The next volume tackles the other half of the equation.

If *What Was In That Joint Bro!?* provides the defensive radar to detect adulterated garbage and stay alive, the upcoming cookbook lays out the proactive substitution framework: how natural phytocannabinoid formulations, minor cannabinoid ratios, and targeted plant preparations can systematically displace the toxic, unpredictable pharmaceuticals dominating the street.

The testing protocol in your hands is its lifelong companion. Verify what's real, clear out the poison, and build the clean alternative.