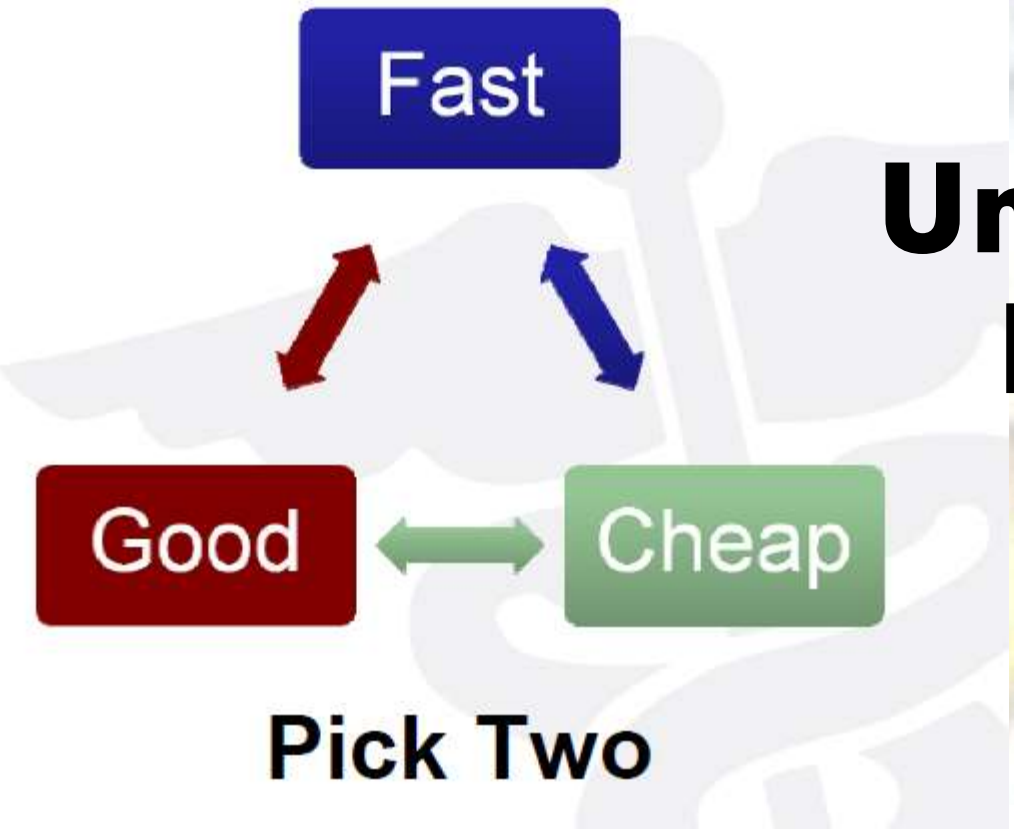
WHAT IS TODAY'S OBJECTIVE?



Understanding how we test for drugs

The Toxicology Laboratory

A toxicologist works in the toxicology lab at the Office of the Chief Medical Examiner in West Baltimore.

The 'CSI gloves' that GLOW when they come into contact with bodily fluids and other chemicals

- **MIT researchers designed wearable sensors from cell-infused hydrogel film**
- **It's a stretchy sheet consisting of living cells genetically engineered to light up**
- **Living material can be added to gloves and bandages to detect target chemicals**

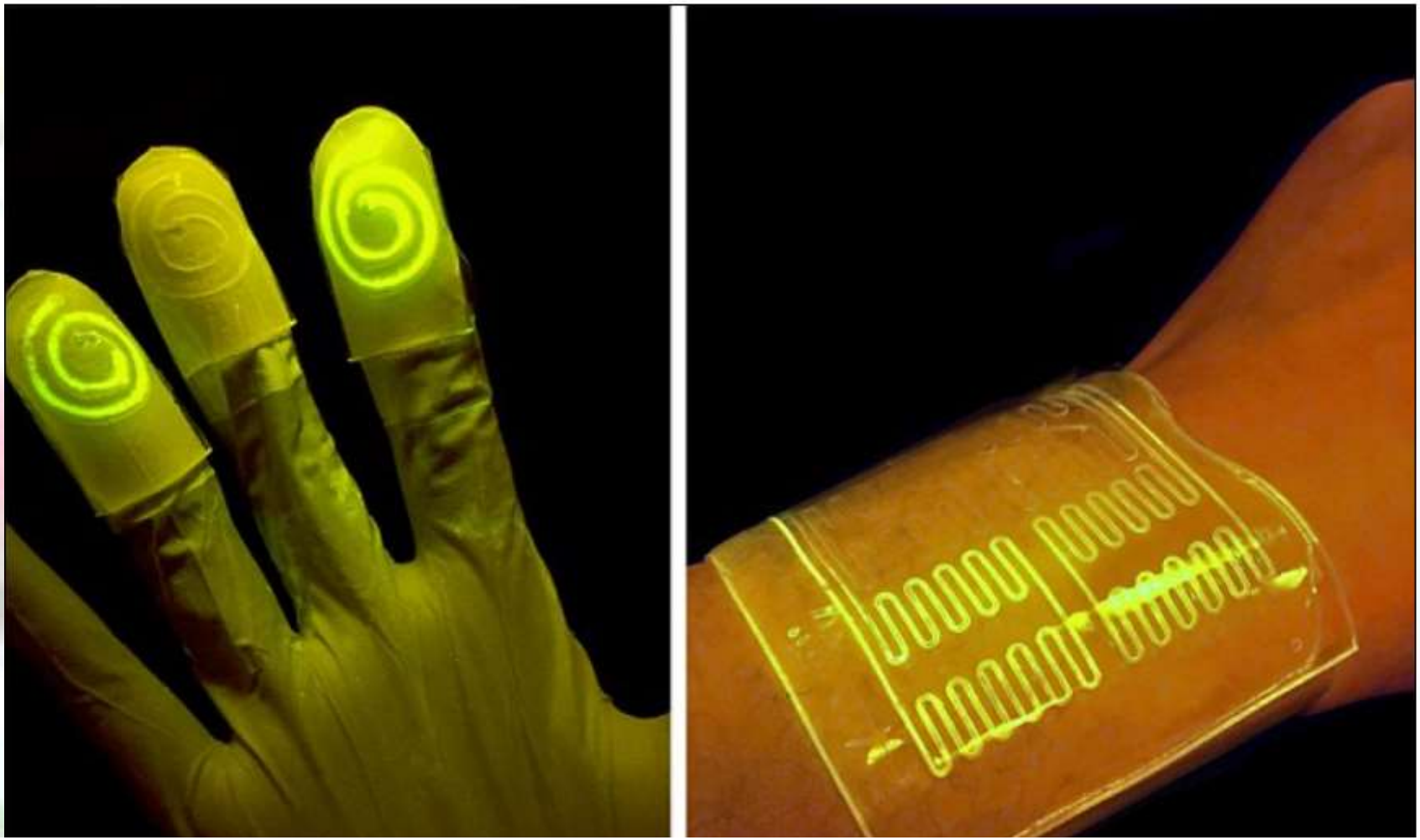
By STACY LIBERATORE FOR DAILYMAIL.COM
PUBLISHED: 17:44 EST, 1 March 2017 | **UPDATED:** 19:16 EST, 1 March 2017

Forget strapping on 'CSI'-style gloves to wipe a crime scene – officials could soon use a 'living material' to instantly find evidence.

MIT engineers have unveiled a hydrogel injected with live cells that are genetically programmed to light up when exposed to certain chemicals.

The technology could be placed on the fingertips of rubber gloves to assist in crime scene investigations and on bandages to help monitor pollution.

Scroll down for video



Numerous sensors were created from the cell-infused hydrogel, or 'living material'.

These senors were attached to gloves and bandages that light up when exposed to certain chemicals.

'With this design, people can put different types of bacteria in these devices to indicate toxins in the environment, or disease on the skin,' Timothy Lu, associate professor of biological engineering and of electrical engineering and computer science, told **MIT News**.

'We're demonstrating the potential for living materials and devices.'

The paper's co-authors are graduate students Xinyue Liu, Tzu-Chieh Tang, Eleonore Tham, Hyunwoo Yuk, and Shaoting Lin.

Prior studies have given researchers the ability to engineer cells that can perform a range of functions – such as glowing when they come in contact with special chemical compounds.

HOW WAS IT MADE?

The hydrogel consists of up to 95% water and polymer, allowing the cells to live outside of the lab.

The material is also resistant to cracking even after being continually stretched and pulled.

Researchers first fabricated layers of hydrogel and cut narrow channels into the layers using 3D printing and micromolding methods.

The hydrogel was then attached to a layer of elastomer, or rubber - giving it protection without sacrificing oxygen.

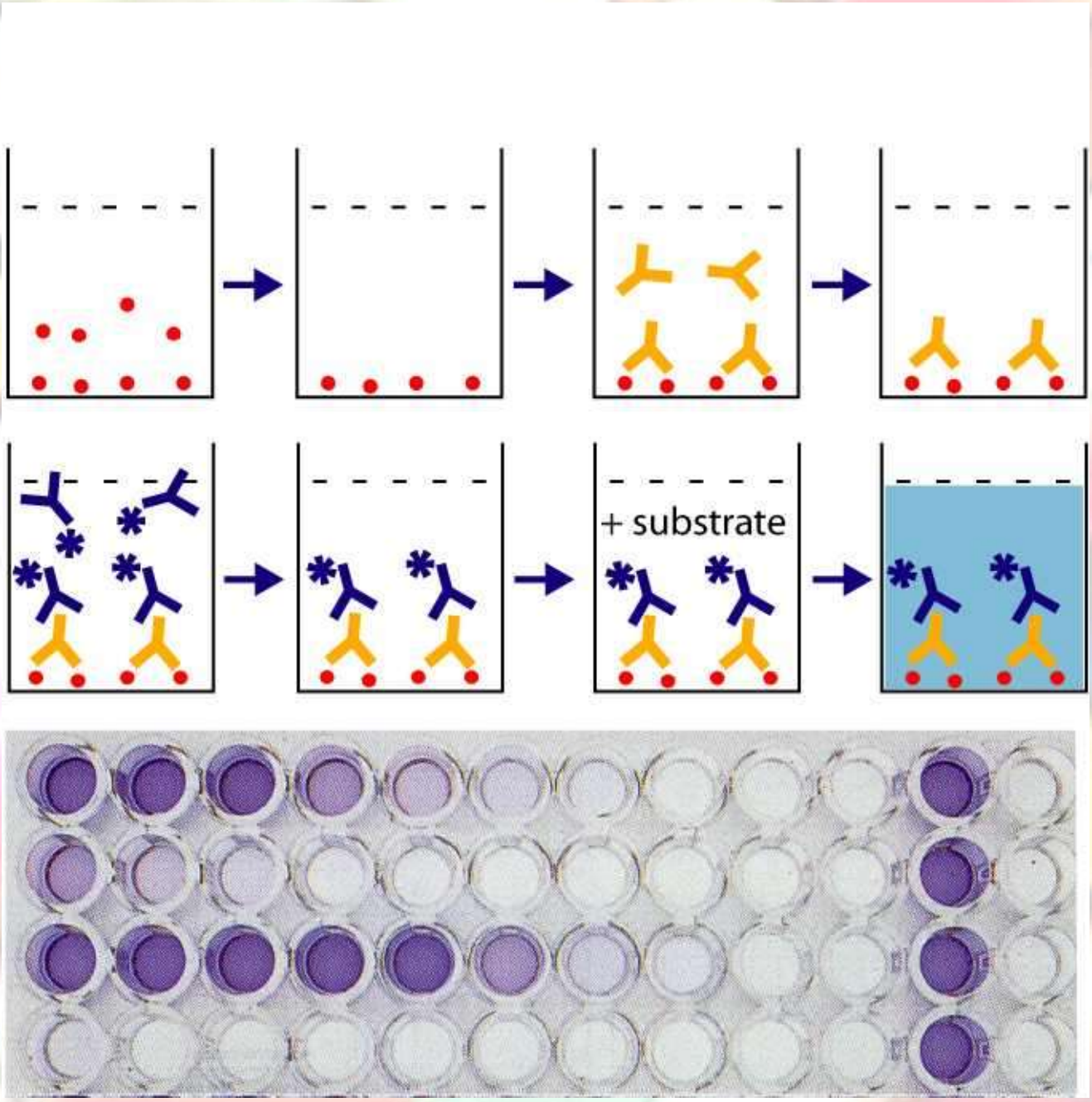
And finally, the team added programmed E.coli, that were designed to glow, into the channels before submersing the material in a nutrient-rich solution.

They found that the new material is able to keep cells alive and active for several days, even when stretched or folded.

HOW DO WE TEST FOR DRUGS?

Immunoassays (aka ELISA): tests in which antibodies (Ab) are used

- Ab is made against the analyte (ex. anti-morphine)
  - Ab is used to recognize analyte if it is present
  - objective, relatively specific, can be highly sensitive


+ substrate

Experimental Fingerprint Test Detects Traces of Cocaine on Skin

February 4, 2020 — An experimental fingerprint detection approach can identify traces of cocaine on human skin, even after someone has washed their hands — and the test is also smart enough to tell whether an individual has actually consumed the class A drug, or simply handled it.

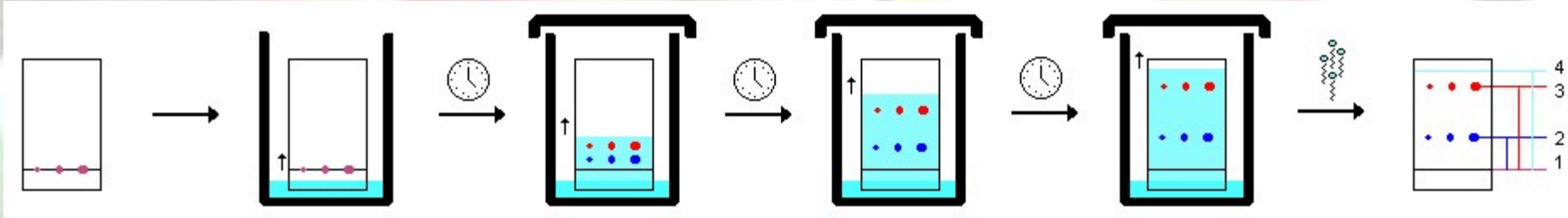
In a paper published in Nature Publishing Group's Scientific Reports, a series of experiments by the University of Surrey detail how it is possible to carry out drug testing accurately and painlessly using a single fingerprint sample. For drug testing, it is necessary to be able to distinguish those who have handled cocaine from those who have ingested it because the legal ramifications are different (for example, consider drug driving). The new research demonstrates that this is possible for the first time using high resolution mass spectrometry techniques.

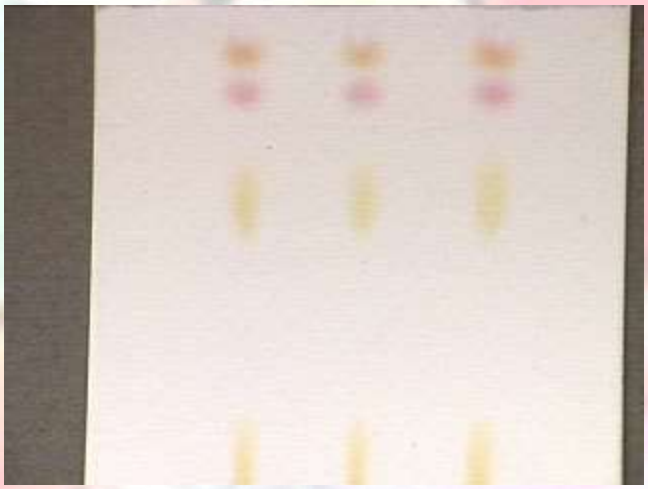
A successful, commercially-available fingerprint drug screening system, using lateral flow assay technology and fluorescence-labelled antibodies to selectively detect specific drugs or their metabolites in eccrine sweat collected from fingerprints, is already available for point of care use from Intelligent Fingerprinting — who also offer a fingerprint-based laboratory confirmation service which uses Liquid Chromatography Mass Spectrometry techniques.

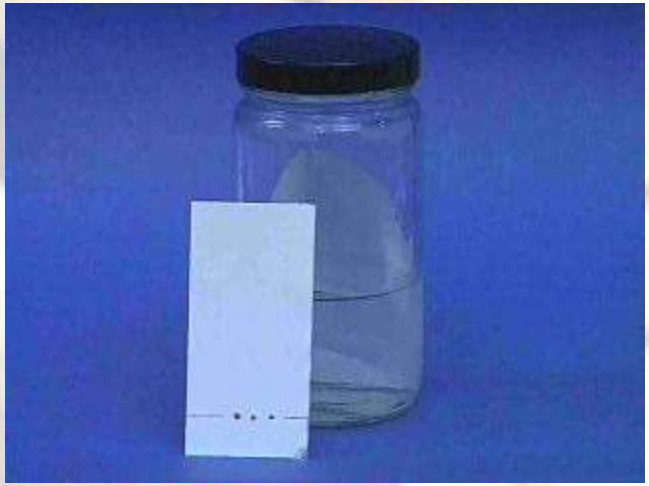
TLC: *Thin Layer Chromatography*

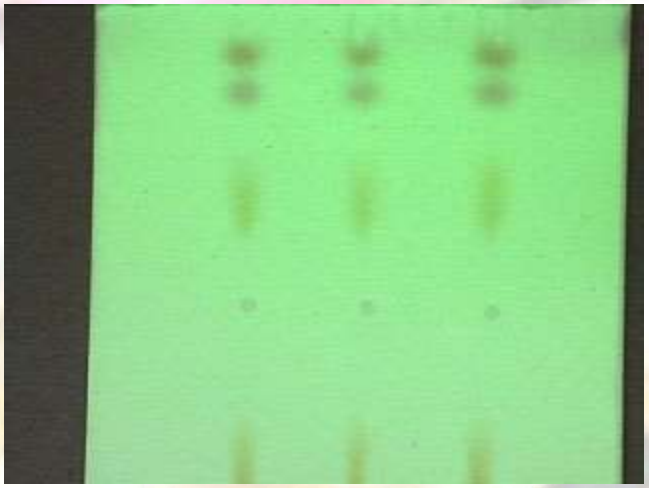
specimen is placed on chromatography paper, and will separate and migrate when placed in mobile phase fluid

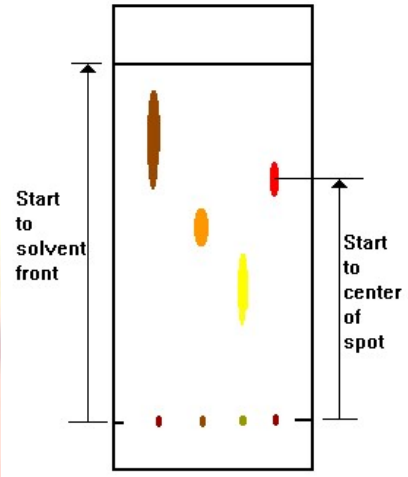
- Can ID 100's of compounds @ once
- Inexpensive
- Labor-intensive & experience needed

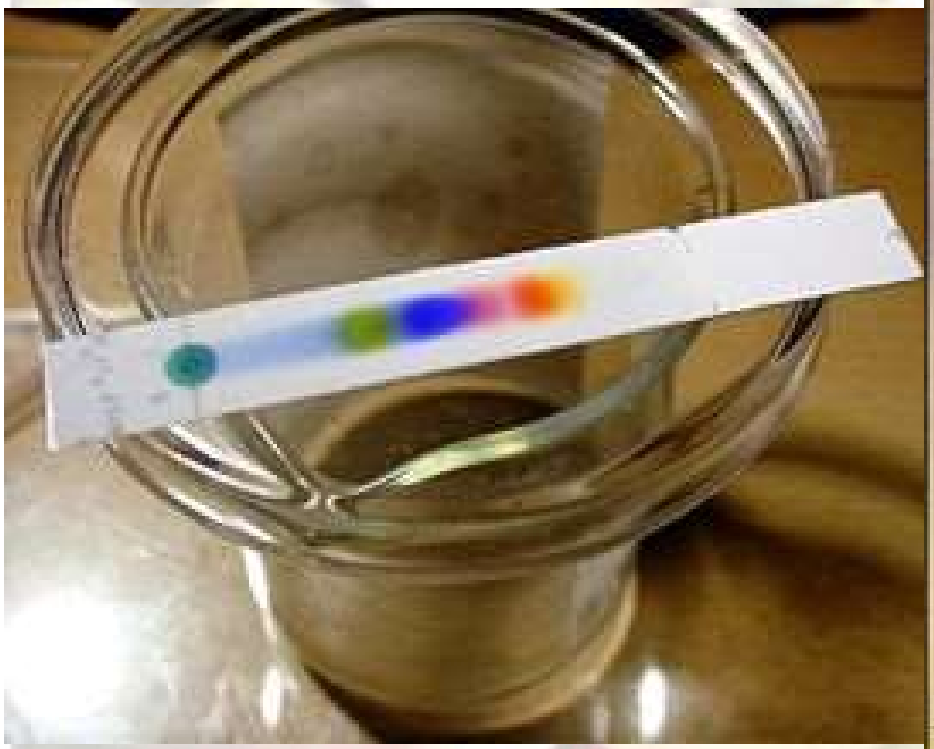




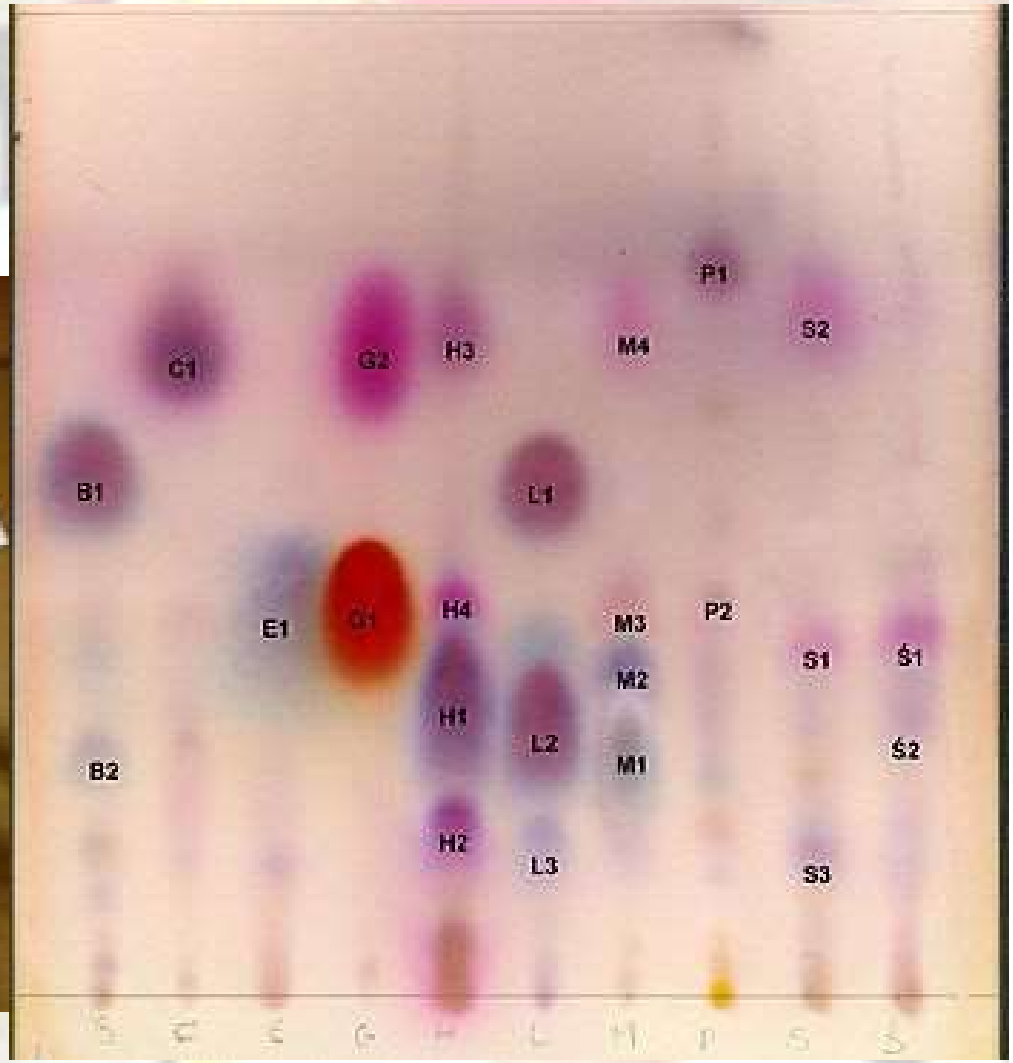





Start to solvent front
Start to center of spot



TLC of black ink



TLC of essential oils

Tests reveal 8 Canadian drug deaths from ecstasy laced with PMMA

By Marcus Hondro
Jan 13, 2012 in Health

The drug-related deaths of 8 young Canadians, 3 in the Vancouver area, 5 in Calgary, in the past two months are now being blamed on ecstasy laced with a drug called Paramethoxy-methamphetamine, or PMMA.

Toxicology tests revealed PMMA, a drug police say is 5 times stronger than ecstasy, was present in all of those who died. Calgary police say the ecstasy on the streets in that city is more often from dealers in the Lower Mainland area so all the victims may have died from the same 'batch' of the drug. They also say the scenario of young people ingesting a drug they did not intend to ingest, is something they frequently warn about.

"This is a prime example of the gamble people take when they use illegal drugs," Staff Sgt. Mike Bossley from the Calgary drug unit said. "You never know what is in your drug: yesterday it was MDMA, today it's PMMA, and tomorrow it could be something else. There is no safe street drug, and no safe dose of a street drug."

Heroin laced with powerful prescription drug fentanyl causing fatal overdoses

Published February 16, 2014 / Associated Press

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POINT PLEASANT, N.J. – Authorities say more than 80 people have died this year due to an increase in heroin laced with a powerful prescription drug.

The drug fentanyl is typically used to ease the pain of end-stage cancer patients or in anesthesia, but can kill quickly when coupled with. Authorities in New Jersey, Maryland, Pennsylvania and Rhode Island say dozens have died in recent weeks.

Officials say dealers sell the heroin as a super high because fentanyl is so potent. But just a small amount can stop someone's breathing.

As more people are turning to heroin because of crackdowns on prescription drugs, officials worry more may be exposed to fentanyl.

It's been in bags of heroin stamped with "Bud Light," "Theraflu" and "Income Tax."

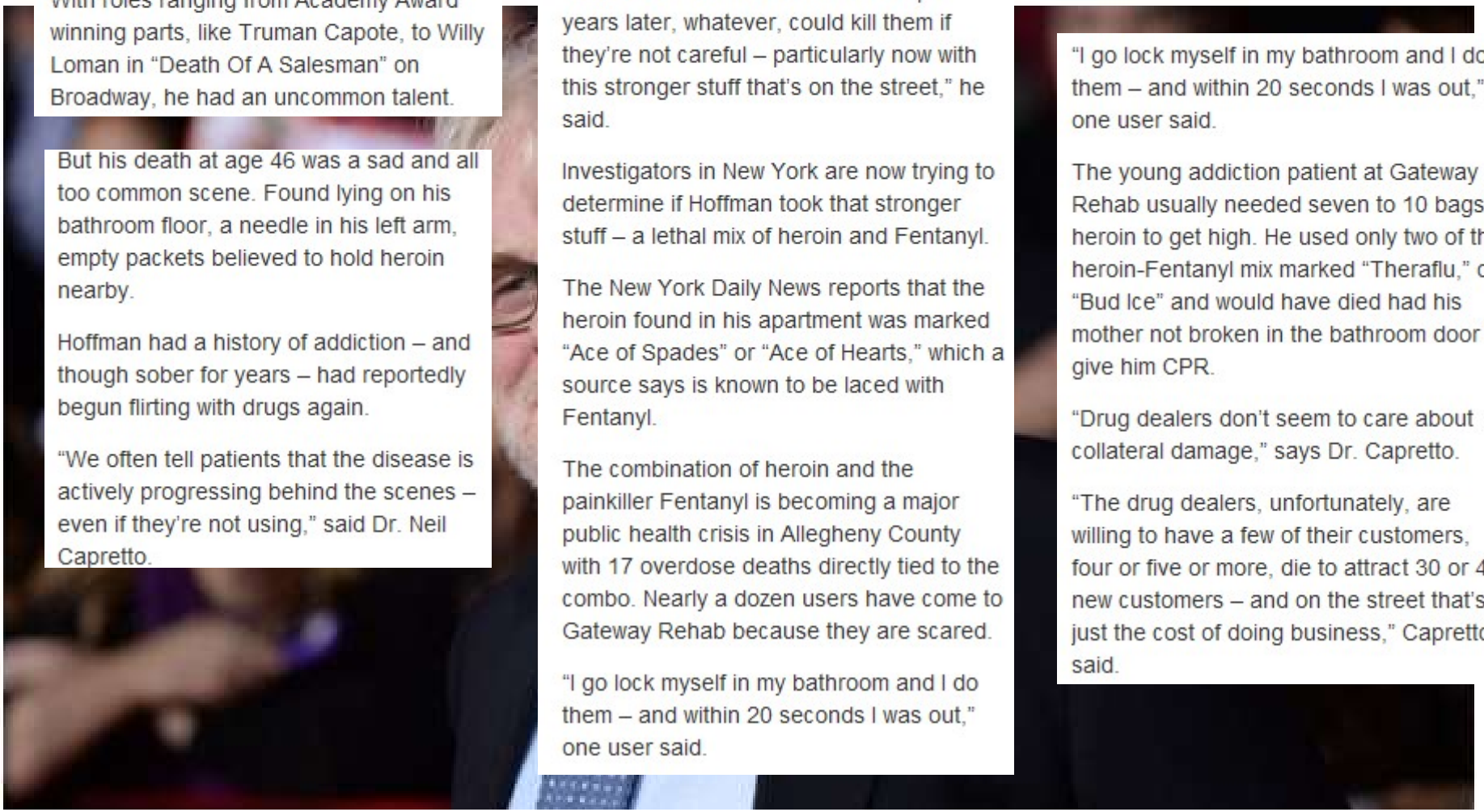
The last outbreak killed hundreds of people in 2006.

Actor's Overdose Death Sheds New Light On Fentanyl-Lac ue

February 3, 2014 5:03 PM

PITTSBURGH (KDKA) — Philip Seymour Hoffman was a fearless actor.

With roles ranging from Academy Award winning parts, like Truman Capote, to Willy Loman in "Death Of A Salesman" on Broadway, he had an uncommon talent.



But his death at age 46 was a sad and all too common scene. Found lying on his bathroom floor, a needle in his left arm, empty packets believed to hold heroin nearby.

Hoffman had a history of addiction – and though sober for years – had reportedly begun flirting with drugs again.

"We often tell patients that the disease is actively progressing behind the scenes – even if they're not using," said Dr. Neil Capretto.

Capretto, Medical Director of Gateway Rehabilitation Center, says brain cells are actually changed by substance abuse and that especially with heroin, a person's tolerance for the drug goes down with sobriety.

"If they try to use what they did back in their addiction – that amount a couple years later, whatever, could kill them if they're not careful – particularly now with this stronger stuff that's on the street," he said.

Investigators in New York are now trying to determine if Hoffman took that stronger stuff – a lethal mix of heroin and Fentanyl.

The New York Daily News reports that the heroin found in his apartment was marked "Ace of Spades" or "Ace of Hearts," which a source says is known to be laced with Fentanyl.

The combination of heroin and the painkiller Fentanyl is becoming a major public health crisis in Allegheny County with 17 overdose deaths directly tied to the combo. Nearly a dozen users have come to Gateway Rehab because they are scared.

"I go lock myself in my bathroom and I do them – and within 20 seconds I was out," one user said.

"I go lock myself in my bathroom and I do them – and within 20 seconds I was out," one user said.

The young addiction patient at Gateway Rehab usually needed seven to 10 bags of heroin to get high. He used only two of the heroin-Fentanyl mix marked "Theraflu," or "Bud Ice" and would have died had his mother not broken in the bathroom door to give him CPR.

"Drug dealers don't seem to care about collateral damage," says Dr. Capretto.

"The drug dealers, unfortunately, are willing to have a few of their customers, four or five or more, die to attract 30 or 40 new customers – and on the street that's just the cost of doing business," Capretto said.

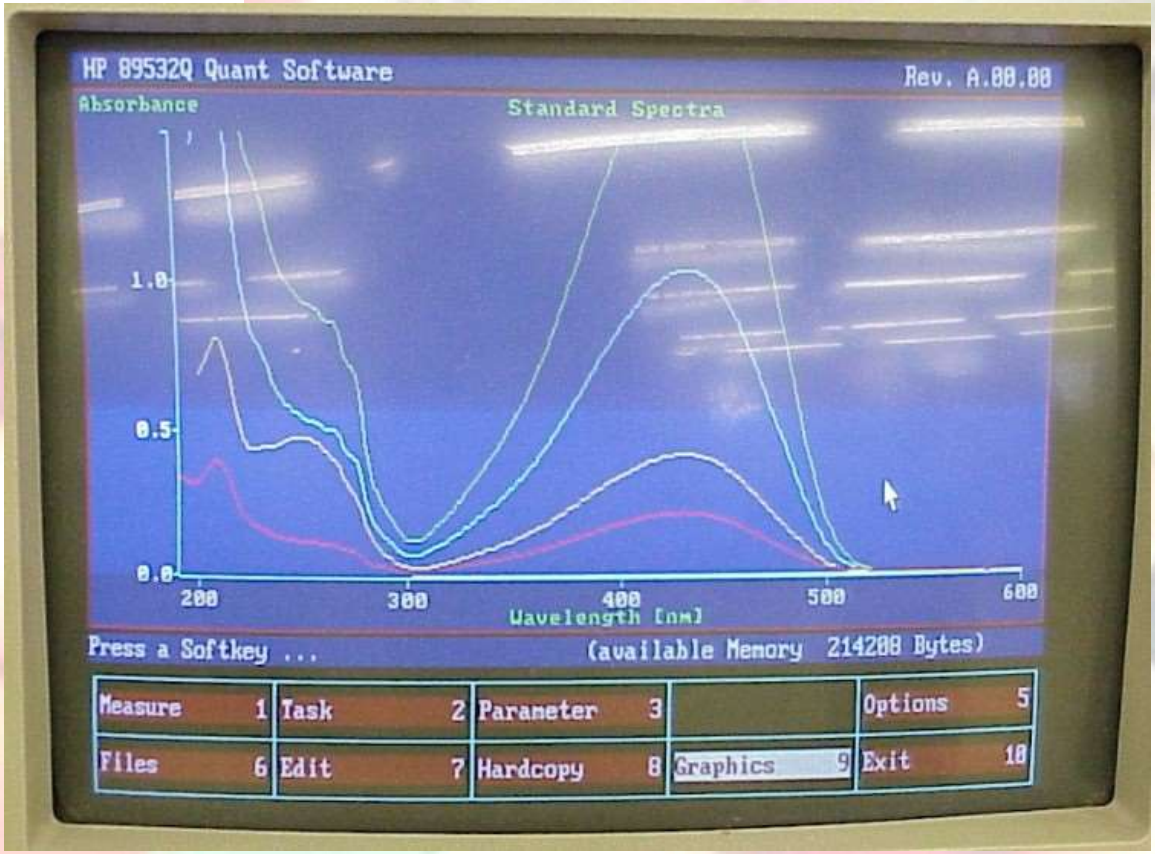
UV- VIS:

UV Visible Spectrophotometry

- many drugs absorb light and produces unique spectrum

- can ID drug because of its peak at a certain wavelength

- can get false results if testing 2 drugs that are close in wavelength


HP 89532Q Quant Software
Rev. A.00.00
Absorbance
Standard Spectra
1.0
0.5
0.0
200
300
400
500
600
Wavelength [nm]
Press a Softkey ...
(available Memory 214208 Bytes)
Measure 1
Task 2
Parameter 3
Options 5
Files 6
Edit 7
Hardcopy 8
Graphics 9
Exit 10

CONFIRMATORY ANALYSES

They provide answers that are essentially incontrovertible

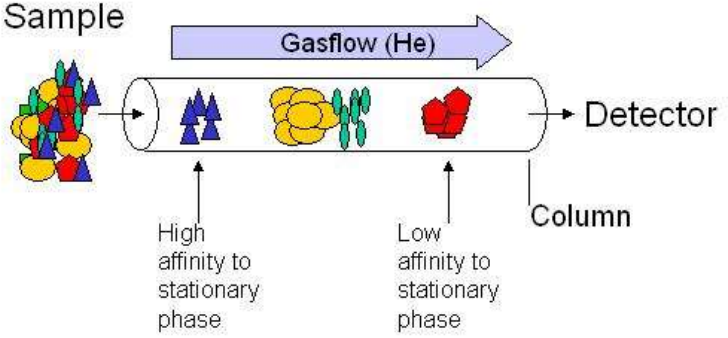
- They must be sensitive, specific, and reliable
- Are the last analytical step

GAS CHROMATOGRAPHY (GC):

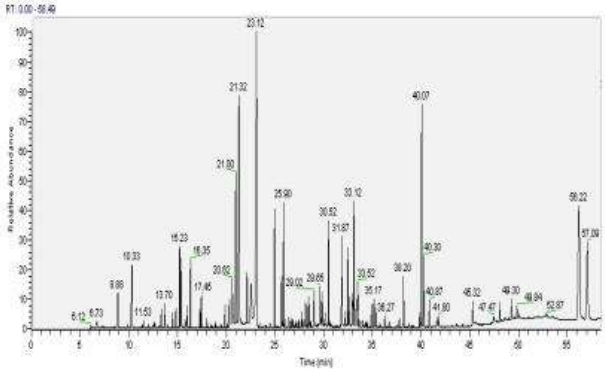
Substance tested is separated from other components of a mixture on a column

Each compound will emerge from the column at a time based on their retention times ***(problem: similar retention times, must be in gas phase)***

A Sample


Gasflow (He)
Detector
Column
High affinity to stationary phase
Low affinity to stationary phase

B



Murder charge filed in Pa. drug-laced chili death

Posted: Feb 29, 2012 4:10 AM PST
Updated: Feb 29, 2012 4:10 AM PST

YORK, Pa. (AP) - A central Pennsylvania woman accused of having killed her elderly grandmother with drug-laced chili almost four years ago is now charged with first-degree murder.

Forty-year-old Shelby Lyn Adams of York appeared Tuesday in York County Court to waive formal arraignment on a criminal homicide charge, but prosecutors amended the charge to first-degree murder. She is also charged with forgery, theft by deception and receiving stolen property.

Prosecutors allege that the defendant stole checks from 90-year-old Ada Adams and forged and cashed them, then killed the victim with morphine-laced chili in April 2008 to cover up the thefts. Authorities say she was working in a hospital emergency room and had access to leftover morphine.

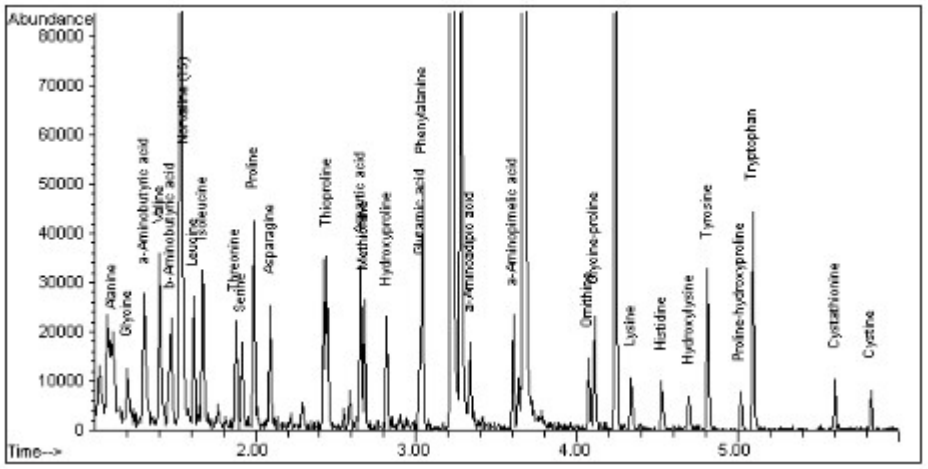
Chief Public Defender Bruce Blocher said his client maintains her innocence.

GCMS:

GC-Mass Spectrometry

Unique "fingerprint" to each molecule, though a few molecules have similar readings

- Can't use w/ 80% of organic chemicals



Ohio BCI scientist fired, five suspended for fa

Chemists use the results of the color tests to guide them through the process of using a gas chromatography/mass spectrometry machine to test the sample. The machine determines a more precise identity of the drugs present in samples, Stickrath said.

If the GC/MS result is different than the color test result, the chemist is supposed to run a third test -- either a color test or another toxicology test. If the chemist chooses to run another color test, he or she must document the results of both color tests.

Stickrath said his review showed that chemists were instead updating the results of the first color test, rather than documenting both tests.

Criminal cases will not be affected because the crime lab sends the results of the more accurate GC/MS tests to law enforcement agencies, Stickrath said.

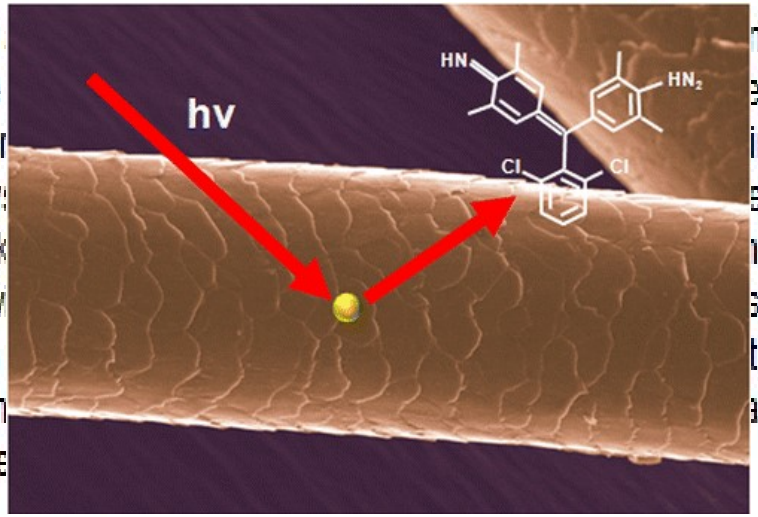
But the BCI sent a letter to county prosecutors overseeing cases related to the 140 improperly-documented tests, saying that the crime lab is willing to retest any drug samples to ensure they are accurate.

"Although we have no reason to believe that any suspects were overcharged as a result of the departure from documentation policy, BCI will re-test prior casework evidence related to your affected cases upon request," the letter reads.

color tests, which are presumptive tests that indicate the drugs present in samples.

Hair Dye 'CSI' Could Help Police Solve Crimes

Criminals with a penchant for dyeing their hair could soon pay for their vanity. Scientists have found a way to analyze hair samples at crime scenes to rapidly determine whether it was colored and what brand of dye was used. Their report appears in the American Chemical Society journal Analytical Chemistry.



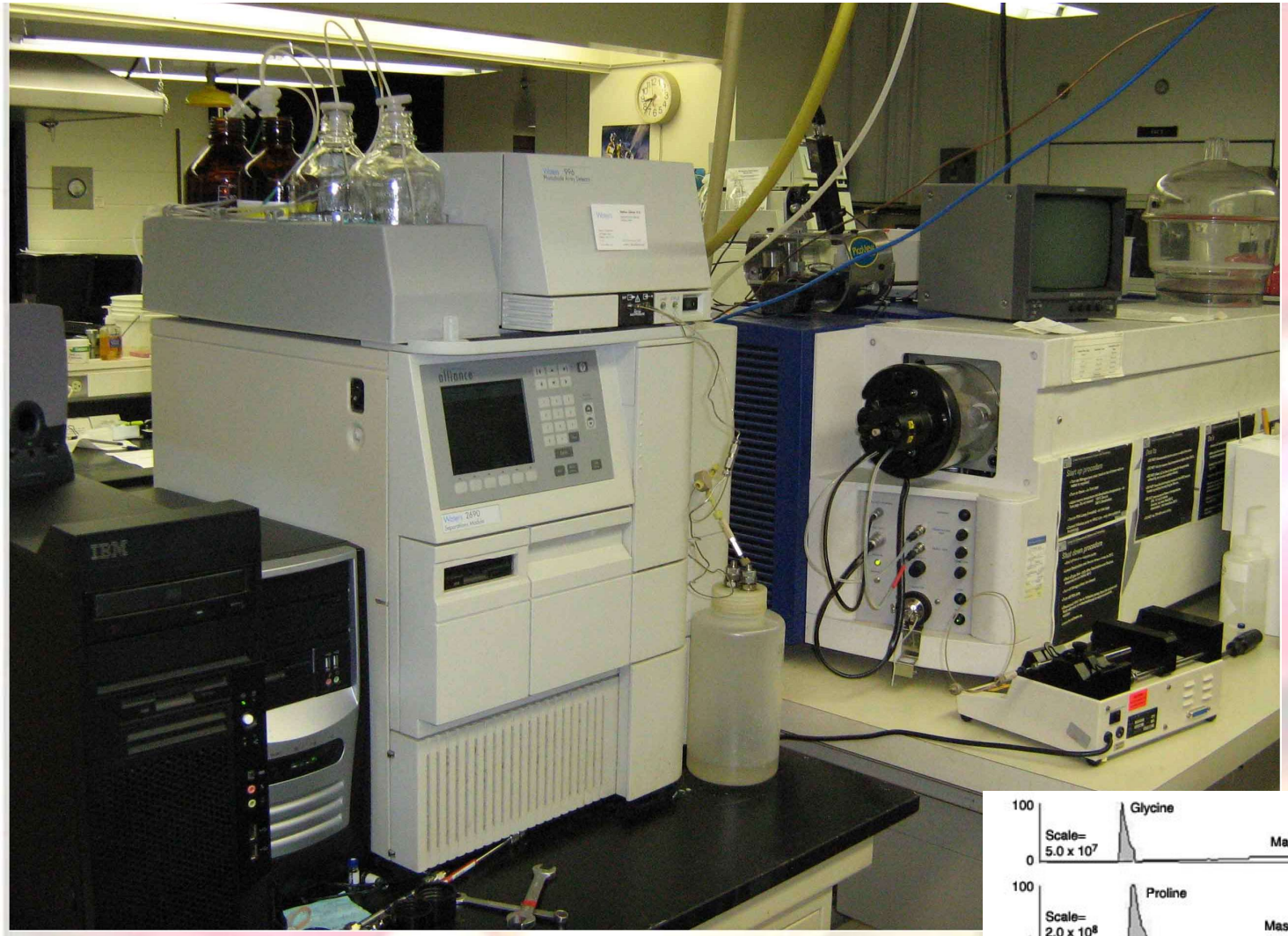
Richard P. Van Duyne ng hairs for forensic investigations, despite eve, can be a labor-intensive and flawed pr ires an intact bulb or root, which isn't alway e-consuming, which can cause a large back opt to use the more traditional method of v scene with samples from suspects using a t necessarily provide conclusive results. Van a more practical and accurate way to analyze

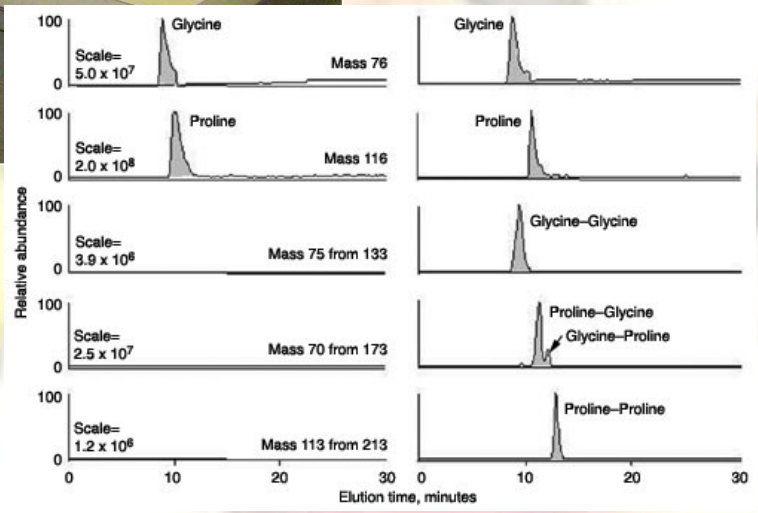
The researchers turned to surface-enhanced Raman spectroscopy (SERS) with a portable Raman spectrometer. SERS can detect minute amounts of illicit drugs, explosives, gunshot residue and body fluids. With this method, the team could rapidly confirm whether hair samples, even microscopic ones, were dyed and what brand of colorant was used. This highly sensitive technique could help forensic investigators analyze hair quickly in the field, the researchers say.

LCMS:

Liquid Chromatography-Mass Spectrometry

- Can be done in liquid phase
- Is expensive **(3 x $GCMS)**
- New technique, so not really established


alliance
IBM


Glycine
Scale= 5.0 x 10^7
Mass 76
Proline
Scale= 2.0 x 10^8
Mass 116
Scale= 3.9 x 10^6
Mass 75 from 133
Scale= 2.5 x 10^7
Mass 70 from 173
Scale= 1.2 x 10^6
Mass 113 from 213
Glycine–Glycine
Proline–Glycine
Glycine–Proline
Proline–Proline
Relative abundance
100
0
0
10
20
30
Elution time, minutes

METAL ANALYSES

Most metal toxic to humans

How do we test for them?

- Colorimetric Assays
- Atomic Absorption Spectrophotometry (AAS)
- Neutron Activation Analysis (NAA)
- Inductively Coupled Plasma-Mass Spectrophotometry (ICP-MS)

Interpreting Postmortem Results

Collaborate w/ forensic pathologist in determining the **cause** and **manner of death**

- Infer that death is due to a toxin and no other apparent cause of death is discovered