FORENSIC CHEMISTRY:

The field of forensic chemistry involves the application of chemical principles and practical chemical techniques to physical samples taken from a crime scene or a suspect.

As well as needing to be scientifically correct, this analytical work must also meet the needs of the law and of the legal community.

يشمل مجال الكيمياء الجنائية تطبيق المبادئ الكيميائية والتقنيات الكيميائية العملية على العينات الفيزيائية المأخوذة من مسرح الجريمة أو من المشتبه به. وبالإضافة إلى ضرورة أن يكون هذا العمل التحليلي دقيقًا علميًا، يجب أن يلبي أيضًا احتياجات القانون والمجتمع القانوني.

Evidence and comparison samples at a crime scene are collected by a Scenes of Crime Officer (SOCO). Before any evidence is removed the whole area is recorded.

يقوم مسؤول مسرح الجريمة بجمع الأدلة وعينات المقارنة من مسرح الجريمة. قبل إزالة أي دليل، يتم تسجيل المنطقة بأكملها.

In the past this was done by sketching, but now more commonly digital photographs are used. SOCOs are often police officers who have undergone specialist training on evidence collection.

في الماضي، كان يتم ذلك بالرسم، أما الآن، فغالبًا ما تُستخدم الصور الرقمية. غالبًا ما يكون ضباط الشرطة المختصون بجمع الأدلة ضباط شرطة خضعوا لتدريب متخصص في جمع الأدلة.

Forensic Chemistry is the use of Chemistry to support litigation in Civil and Criminal Law Cases.

Forensic Chemistry employs analytical methods for determining within a reasonable degree of scientific certainty the proximate cause of an accident or product failure.

The role of the forensic worker includes two parts:

Part 1: in crime scene// As well as collecting evidence, the forensic scientists, may use some chemical tests, known as presumptive tests, to suggest the presence of substances like blood and drugs at a crime scene.

Full analysis is not done at a crime scene as the equipment is not available and there is a high risk of contamination.

Presumptive tests reduce the workload of the forensic team as it quickly and cheaply helps to identify the evidence that needs to be collected.

تساعد الاختبارات الافتراضية على تخفيف عبئ العمل على فريق الأدلة الجنائية لأنها تساعد بسرعة وبتكلفة منخفضة في تحديد الأدلة التي تحتاج إلى جمع.

Part 2: at forensic laboratory/// The evidence is then transported to the forensic science laboratory for further analysis. Each physical sample that is collected either from the crime scene or from a suspect will have a document with it.

It is important that everybody who comes in to contact with the evidence signs this document so that the collection, transport and analysis of every sample can be tracked.

This makes tampering of the evidence more difficult and improves the strength of the evidence in court.

وهذا يجعل التلاعب بالأدلة أكثر صعوبة ويعزز قوة الأدلة في المحكمة.

The forensic chemist deals with:

1- Undertakes a lot of analytical, quantitative and qualitative work often using instrumental techniques.

2-Much of the analysis is performed in a sterile laboratory to reduce the chance of contamination.

3- Always reflect on their protocols and critically assess their work to ensure that their results and subsequent conclusions are accurate and valid.

There are two groups of techniques:

- **Destructive: the sample is damaged during the process for example, mass spectrometry.**
- **Non-destructive: the sample is undamaged, for example, microscopy.**

Q/ Which is prefer (destructive or Non-destructive)?

Non-destructive methods are preferred as the evidence can then be preserved. This leaves open the possibility that new techniques could be used in the future so that old cases can be re-opened and maybe solved.

q/ Do you want **destructive or Non-destructive? Explain that”””” Which parameter decided that?**

When anyone goes anywhere they leave traces of themselves behind: a fingerprint on a door handle, a stray hair, a fibre from their clothes. Thus:

The sizes of the samples needed for analysis have significantly reduced as technology advances and forensic techniques have developed. **The samples of evidence collected at a crime scene may be very small** and therefore difficult to analyze using standard chemical techniques. Thus:

Forensic science is driving the development of **microscale techniques** that are able to analyze these tiny samples.

غالبًا ما تكون تقنيات القياس المجهري أسرع من الوسائل التقليدية، ولكنها تتطلب مهارةً ودقةً في التفاصيل لتحقيق نتائج دقيقة. تتيح هذه التقنيات المُعدّلة إجراء بعض الاختبارات في مختبر مفتوح، وهو ما قد يكون غير آمن باستخدام التقنيات التقليدية. مع ذلك، تجدر الإشارة إلى أنه على الرغم من فوائد هذه التقنيات المجهرية، قد تشترط بعض هيئات منح الاختبارات وصفًا للتقنيات العملية التقليدية، ولا تعترف بمناهج القياس المجهري.

Case for study:

For example, water pollution can cause a number of short-term and long-term problems. Animals in a watercourse could be killed or could develop abnormalities, and there may be a direct economic impact by making produce from contaminated farming land too dangerous for human consumption.

Water pollution could be, for example, a one-off event from a recent problem at a metal purification plant, or a systematic failure at the plant leading to long-term pollution.

In the case of metal ion pollution, presumptive tests such as precipitation reactions can help Environmental Health Officers to determine the likely pollutant.

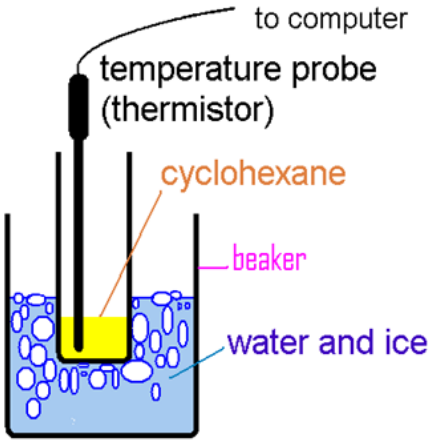
عند وضع أيونات معدنية معينة في اللهب، فإنها تُنتج لونًا مميزًا، ويمكن استخدام هذا اللون لتحديد المعدن الموجود. تُنتج بعض المعادن لون لهب خافتًا للغاية، مثل اللون البنفسجي الناتج عن الليثيوم، وحتى أدنى كمية من التلوث بأيونات معدنية أخرى قد تجعل من الصعب تمييز هذا اللون. تُنتج بعض المعادن ألوانًا متشابهة جدًا، على سبيل المثال، يُوصف الكالسيوم بأنه أحمر قرميدي، ويُوصف الليثيوم بأنه قرمزي، لكنهما يظهران بلون أحمر متشابه في اللهب، مما يجعل التمييز بينهما بالعين المجردة صعبًا.

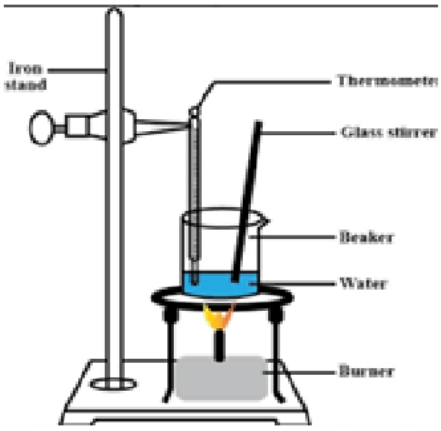
اما مطيافية الانبعاث الذري هي تقنية آلية تستخدم الترددات المميزة للضوء المنبعث من أيون معدني مُثار لتحديد نوع المعدن، ويمكن استخدام شدة الضوء المنبعث لتحديد كمية المعدن الموجودة. مطيافية الامتصاص الذري هي تقنية ذات صلة، تُمكّن من تحليل كمية المعدن في عينة ما من خلال تحديد كمية الضوء التي تمتصها العينة بتردد معين.

IDENTIFYING A PURE CHEMICAL

Chemical residues left at crime scenes are often mixtures. The different chemicals in a mixture must be separated before they can be identified.

One of the oldest techniques for identifying a pure chemical is by finding its melting and boiling point. The term 'pure' in chemistry has a specific scientific meaning – a pure chemical contains only one element or compound, and is known as a substance. A pure chemical, or substance, has a distinct melting point and a distinct boiling point at a given pressure. Lists of this information for many thousands of substances can be found in books of data or databases, from which the identity of unknown substances may be determined.





Instrumental analysis techniques that can be used in forensic work include:

1-Chromatography: Gas or column chromatography may be **used to identify the components in mixtures and to separate mixtures before they are further analyzed**. A sample is passed through a medium in which different substances travel at different speeds.

تُستخدم لتحديد المكونات في المخاليط وفصل المخاليط قبل تحليلها بشكل أكبر.

2-**Mass spectrometry**: A sample of the material is vaporized and bombarded with electrons to fragment the molecules and create ions. **The masses of the**

charged fragments are determined, and this gives characteristic information about the original material.

يتم تحديد كتلة الشظايا المشحونة، وهذا يعطي معلومات مميزة عن المادة الأصلية.

3- **Atomic emission and absorption spectroscopy**: Metal ions emit characteristic frequencies of light when excited, and absorb characteristic frequencies when in the ground state. **These can be used to identify metals and to determine the amounts present.**

من خلال هذه التقنية يمكن تشخيص مختلف العناصر الفلزية واللافلزية مع إمكانية تحديد نسب تواجدها في مزيج من المواد.

4- **Infrared spectroscopy**: This measures the absorption of a range of frequencies of infrared radiation by a sample. The infrared radiation causes bonds in the sample to vibrate, and **the frequencies of the radiation absorbed gives information about the types of bonds present, which can help in identifying the substance.**

يحدد نوع الاواصر الموجودة في المركبات وبالتالي إمكانية الكشف عن هوية المركب .

5- **Ultraviolet spectroscopy:** This looks at the absorption of ultraviolet radiation by a sample. UV radiation has a higher frequency than visible light and can cause higher energy electron transitions. **It is used for quantitative determination of transition metal ions or complex organic substances such as DNA or proteins.**

يتم استخدامه لتحديد كمية أيونات المعادن الانتقالية أو المواد العضوية المعقدة مثل الحمض النووي أو البروتينات.

6-**Nuclear magnetic resonance spectroscopy**: This looks at the frequencies of radiation absorbed when an atomic nucleus changes from one spin state to another in a magnetic field. **It gives information about the functional groups in the molecule and can thus help in determining its structure.**

يعطي معلومات عن المجموعات الوظيفية في الجزيء وبالتالي يمكن أن يساعد في تحديد بنيته.

q// Is using just one of these techniques sufficient to identify materials at a crime scene?

Answer: // Absolutely NO, most of cases required many techniques which mentions above to reach for final identification or materials.

Scope of forensic chemistry:

1- **Forensic chemistry can be seen as practical analytical chemistry, this as it deals with collecting samples and doing qualitative and quantitative analysis on them.**

2- forensic chemistry deals with matching the results of the analyzed evidences with the suspected people in order to solve crimes and help the laws.

3-determine the provenance of a sample, and link it to a person or a thing.

4-Forensics use science, psychology, accounting, computer science, engineering science …..etc to solve crimes.

Forensic chemistry vs. analytical chemistry

o There are similarities between the two, such as they deal with finding the composition of the samples (like the whole compound or a proportion in a mixture). Also, they use similar instruments.

o However, there are few differences between the two. The source of the samples in forensic needs to be determined whereas it is known in the case of analytical chemistry.

Fingerprint

fingers, toes, feet, and palms are covered in small ridges. These ridges are arranged in connected units called dermal, or friction, ridges. These ridges help us get or keep our grip on objects. Natural secretions plus dirt on these surfaces leave behind an impression (a print) on those objects with which we come in contact.

تُغطى أصابع اليدين والقدمين والكفّين بخطوط صغيرة. تُرتّب هذه الخطوط في وحدات متصلة تُسمى خطوطًا جلدية أو خطوط احتكاكية. تُساعدنا هذه الخطوط على الإمساك بالأشياء أو الحفاظ عليها. تترك الإفرازات الطبيعية والأوساخ على هذه الأسطح بصمةً على الأشياء التي نلامسها.

Formation of Fingerprints:

An animal's external tissue (skin) consists of (a) an inner dermis and (b) an outer epidermis.

The creation of fingerprints occurs in a special layer (the basal layer) in the epidermis where new skin cells are produced.

Fingerprints probably begin forming at the start of the 10 th week of pregnancy. Because the basal layer grows faster than the others, it collapses, forming intricate shapes.

من المرجح أن تبدأ بصمات الأصابع بالتشكل في بداية الأسبوع العاشر من الحمل. ولأن الطبقة القاعدية تنمو أسرع من غيرها، فإنها تتوسع، مشكّلةً أشكالًا معقدة.

Principles of Fingerprints

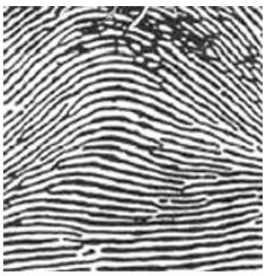
First Principle: A fingerprint is an individual characteristic; no two fingers have yet been found to possess identical ridge characteristics.

Second Principle: A fingerprint will remain unchanged during an individual's lifetime.

Third Principle: Fingerprints have general ridge patterns that permit them to be systematically classified.

Characteristics of Fingerprints :

There are 3 general fingerprint distinctions:



ARCH



WHORL



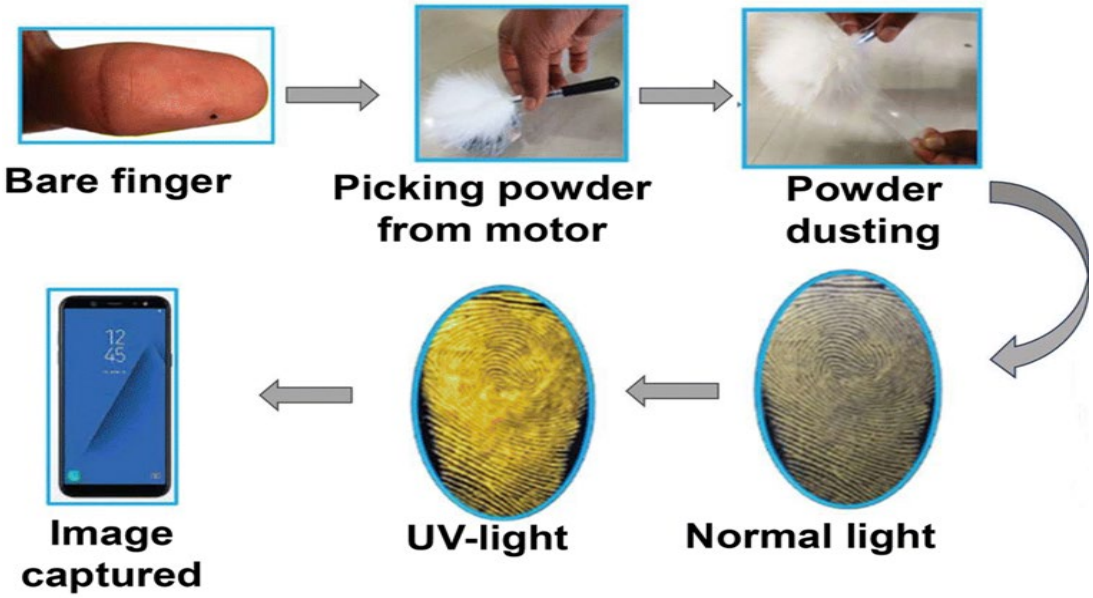
LOOP

About 5% About 30% About 65% of the population

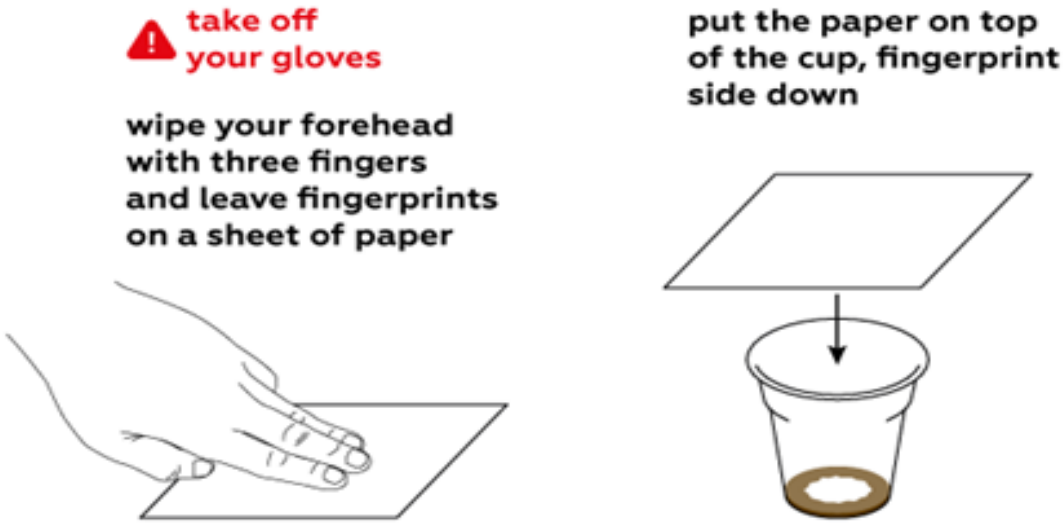
Developing Latent Prints

Developing a print requires substances that interact with secretions that cause the print to stand out against its background. It may be necessary to attempt more than one technique, done in a particular order so as not to destroy the print.

1-Powders—adhere to both water and fatty deposits. Choose a color to contrast the background.



2-Iodine—fumes react with oils and fats to produce a temporary yellow brown reaction.



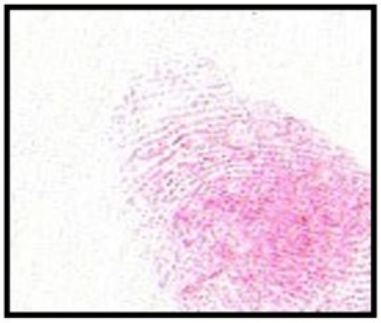
3- Ninhydrein:: reacts with amino acids to produce a purple color.

4- Silver nitrate—reacts with chloride to form silver chloride, a material which turns gray when exposed to light.

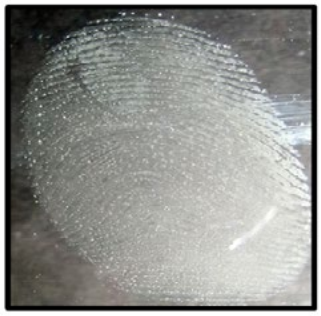
5-Cyanoacrylate—"super glue" fumes react with water and other fingerprint constituents to form a hard, whitish deposit.



Iodine Fingerprint



Ninhydrin Fingerprint



Cyanoacrylate Fingerprints

The specificity of chemical compounds to reveal fingerprints

خصوصية المركبات الكيميائية لاضهار بصمة الأصابع

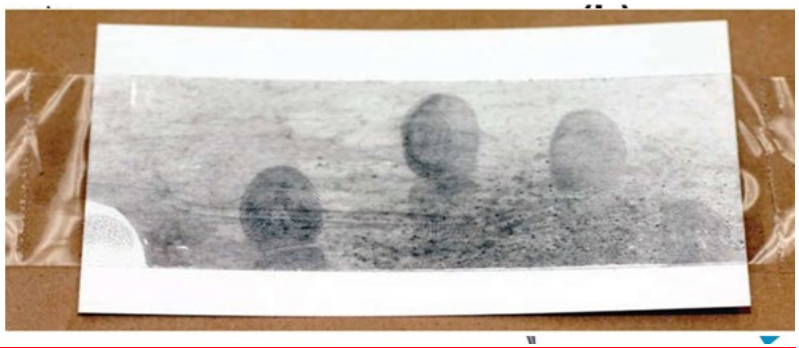
1- **Most black powders are made from fine carbon or iron. Light-colored gray or white powders can be made of any number of substances, such as finely divided aluminum.**
2- **Fluorescent powders in red, green, yellow, or orange, some of which may also contain iron particles.**
3- **Any powder containing iron maybe applied with a magnetic applicator. Once the powder has been applied and contrast can be seen, the fingerprint can be lifted and preserved using fingerprint tape, a high-quality transparent tape typically at least an inch wide.**

يمكن وضع أي مسحوق يحتوي على الحديد باستخدام أداة مغناطيسية. بعد وضع المسحوق وظهور التباين، يمكن رفع بصمة الإصبع وحفظها باستخدام شريط بصمات الأصابع، وهو شريط شفاف عالي الجودة، عادةً ما لا يقل عرضه عن بوصة واحدة.

The lifted fingerprint can then be placed onto a fingerprint lift card that offers the greatest contrast (black for white-powder lifts and white for black-powder lifts).

Identifying information such as the name of the investigator, date and time of collection, location of fingerprint, and case number all should be recorded on the card. Figure below shows a fingerprint lift of a black powder impression.





How are latent fingerprints collected?

Chemical	Uses	Application	Theory	Print
Dust	Glass, metal, plastic, hard non-porous surfaces	Dusted with powder	Will be attracted to oils in sebaceous secretions	Will be the color of the dust
Cyanoacrylate vapor	Household itesm, plastic, glass, metal, skin	Heat sample in vapor tent	Vapors attracted to amino acids in eccrine secretions	White, crystalline print
Ninhydrin	paper	Object dipped in ninhydrin Wait 24 hours.	Attracted to amino acids in eccrine secretions	Purple-blue
Silver nitrate	Wood, Styrofoam, cardstock	Dip, spray, or paint surface	Reacts with chlorides in eccrine secretions	Black, or red brown under UV light
Iodine vapors	Paper, cardboard, unpainted surfaces	In vapor tent, heat solid iodine crystals, use starch solution to fix print	Reacts with oils and fats in sebaceous secretions	Brownish print

Mobile Multispectral Fingerprint Detection Set



The world's first Evidence Friendly Mobile Blood, GSR and Body Fluid Detection System. This high-tech integrated mobile device detects Invisible potential blood spots, gunshot residues, body fluids such as semen, saliva and urine on dark or complex surfaces. This device is excellent for document examination.

أول نظام متنقل في العالم للكشف عن الدم وسوائل الجسم والعينات المأخوذة من الجسم، متوافق مع الأدلة. يكشف هذا الجهاز المتنقل المتكامل عالي التقنية عن بقع الدم المحتملة غير المرئية، وبقايا طلقات نارية، وسوائل الجسم كالسائل المنوي واللعاب والبول على الأسطح الداكنة أو المعقدة. هذا الجهاز ممتاز لفحص الوثائق.

System Features :

- **Environment Friendly**
  1. **Fast & contactless fingerprint imagining**
  2. **Does not require finger print powder, chemicals, smoke or respirable dust**
  3. **Secures working environment**

- **Evidence Quality**
    1. **No chance of contaminating or destroying the DNA of latent capability within the marker**
    2. **Does not affect or destroy the fingerprint itself allowing the it to be used for DNA analyzes**
- **Mobility**
    1. **High powered batteries**
    2. **Easy to handle, lightweight device**
    3. **Taking the lab to the scene, not the scene to the lab**

https://www.youtube.com/watch?v=1OPkfCengWs

https://www.youtube.com/watch?v=ZCIoUsj9SmQ