A fun and informative book that introduces budding young investigators to the world of forensic science!

Every crime scene has clues if you know where to look. Examining these clues using forensic methods can help you solve even the most mysterious crimes. In this book, you will learn from forensic experts how to analyse all sorts of evidence, from blood and soil to handwriting and fibres.

Filled with colourful illustrations, hands-on activities and true crime cases, **DISCOVER FORENSICS** is your best guide to thinking like a forensic scientist. By applying the correct techniques and inquiry-based principles – and avoiding the myths that are commonly depicted on TV – you might just uncover the truth of what happened!

The Forensic Experts Group (TFEG) is a team of accomplished forensic scientists with more than 80 years of combined experience and specialised knowledge. The first private and independent forensic laboratory in Singapore, TFEG serves as a one-stop centre for a wide spectrum of forensic services. TFEG's forensic scientists have worked on hundreds of cases, including many high-profile ones. Through its Discover Forensics Series™ education kits and its well-received workshops and school talks, TFEG is bringing forensic science literacy to a new generation of young minds.

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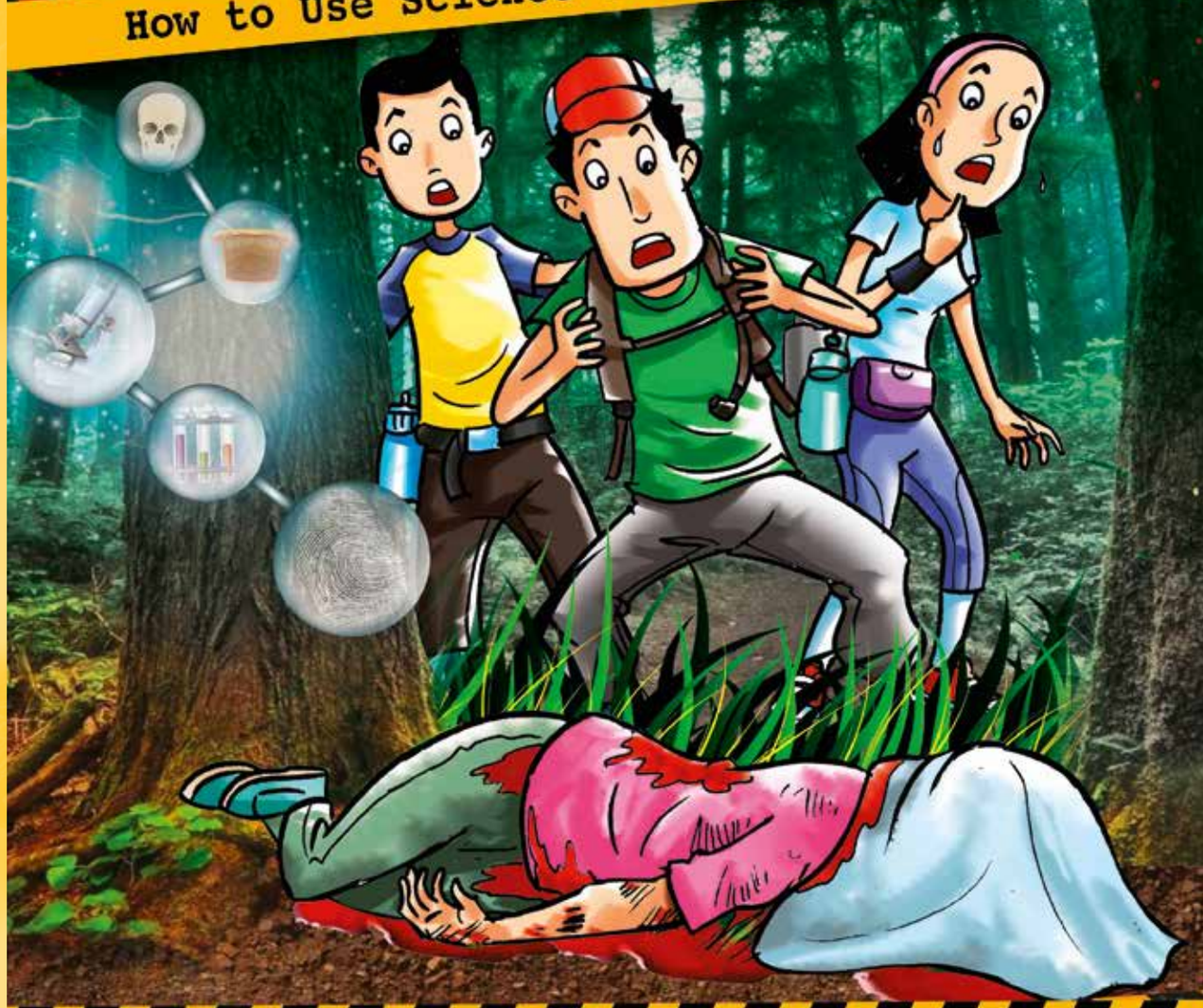

BY THE FORENSIC EXPERTS GROUP

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Contents

WELCOME!

Hi there! Thank you for picking up this book!

Are you intrigued by how crimes can be solved using science? Do you want to find out how scientists examine and analyse different types of evidence?

If you do, forensic science is just the thing for you!

In this book, you will get to explore different disciplines in forensic science and find out how everyday objects can provide vital clues in the solving of cases. You will learn to debunk myths commonly depicted in TV programmes and immerse yourself in cases that made Singapore's headlines.

As you progress through the chapters in this book, learn about forensic document examination, damage analysis, trace evidence such as fibres and soil, corrosive liquids, and bloodstain pattern analysis. In the last chapter, we discuss the importance of ethics and integrity.

Armed with this knowledge, which builds on the science you learn in school, you will soon be able to answer the "who", "what", "where", "when" and "how" of crimes.

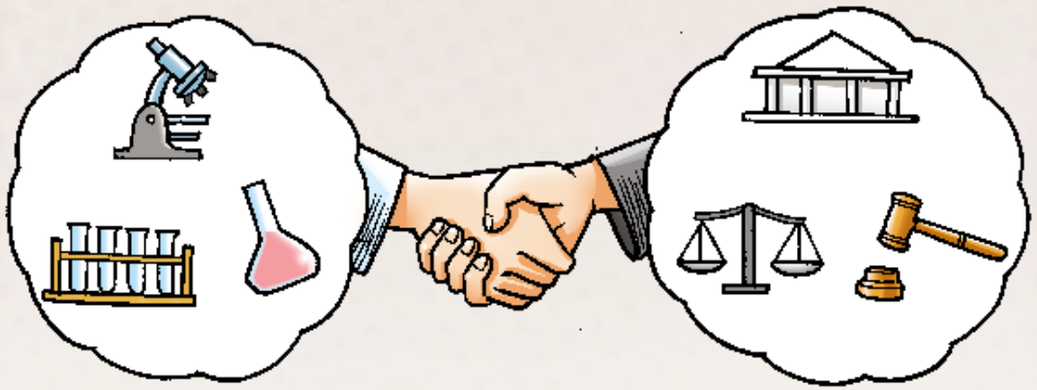
Remember — every contact leaves a trace!

Chapter 1

FORENSICS TO THE RESCUE

What is Forensic Science?

The word forensic [fuh-ren-sik] originates from the Latin word forensics, which means “in open court” or “public”. Today, the term forensics, or forensic science, refers to the application of science to laws.



SCIENCE LAW

Forensic scientists apply scientific methods and techniques to the examination of different types of evidence. The findings and conclusions from these examinations may be used to provide investigative leads and clues or aid in the administration of justice.

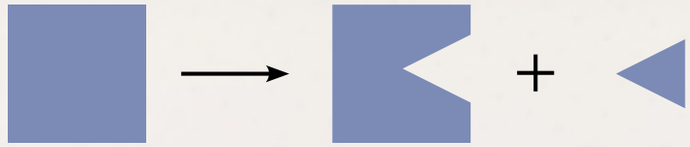
Key Principles in Forensic Science

The three key principles associated with forensic science are:

1. Principle of individuality
2. Principle of divisible matter
3. Principle of exchange

The principle of individuality states that “No two objects are identical” and that each object is unique. While two objects may seem similar at first glance, differences can be observed upon closer inspection or examination.

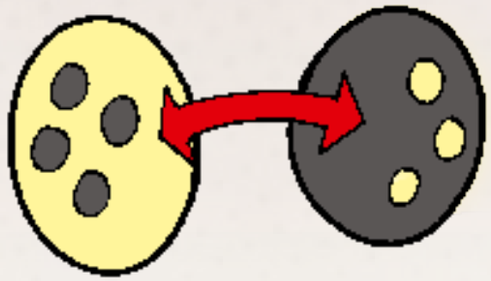
The principle of divisible matter states that “Matter divides into smaller components when sufficient force is applied”.



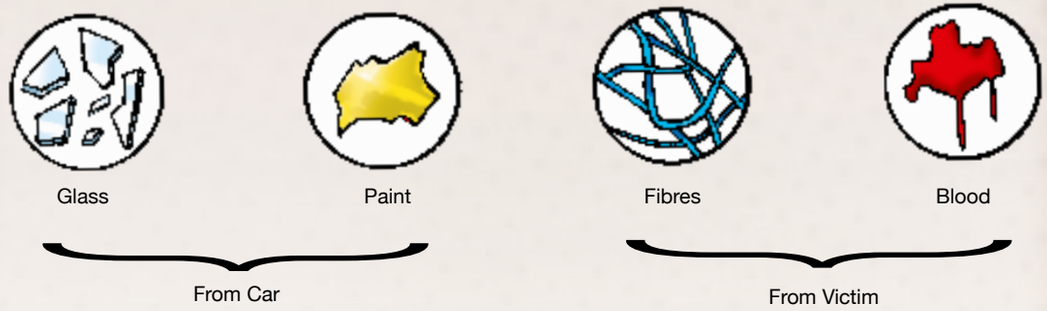
These two principles have a huge bearing on the individualisation or uniqueness of an object. This is particularly important in the examination of toolmarks and shoeprints, physical fitting and in linking or associating an object to a source.

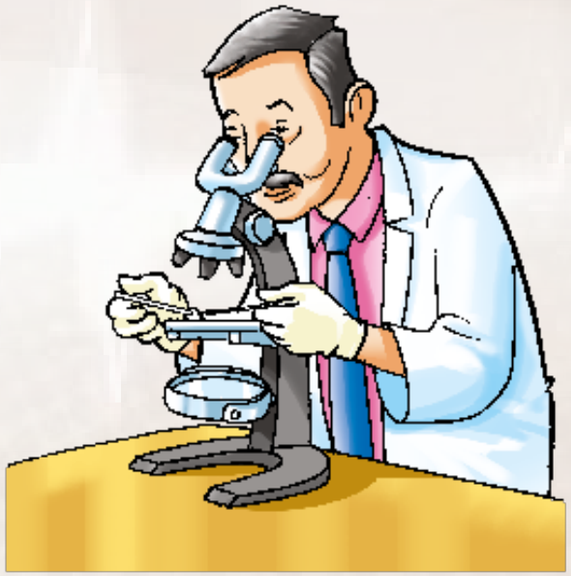
The third principle is more commonly known as Locard's Exchange Principle, which states that "Every contact leaves a trace".

When two objects come in contact, they will add something to or remove something from each other, usually unintentionally and sometimes unknowingly.



This principle provides the basis for transfer evidence such as DNA, fibres, paint, glass and soil. In a traffic collision where there is forceful contact, trace amounts of paint or glass may be transferred between the vehicles involved, or from the vehicle onto the victim. Similarly, in a fight where there is bodily contact between persons, fibres may be transferred from a person's clothing to another object/person.





The pioneers of forensic science

Dr Edmond Locard (1877–1966), a French criminalist and a pioneer in the field of forensic science, is often regarded as the “Sherlock Holmes of France”. He studied medicine and was interested in how science could be applied to the legal field. Hence, he went on to pursue a career in law.

Locard worked as a medical examiner in the French Secret Service during World War I and was able to determine the cause of death of soldiers and prisoners based on the bloodstains and damage on their uniforms.

He also made great contributions in the area of fingerprint identification but his greatest and most influential work was the development of Locard’s Exchange Principle.

Another renowned scientist, Dr Paul L. Kirk, hailing from the USA, expanded on this principle in his book, Crime Investigation (1953):

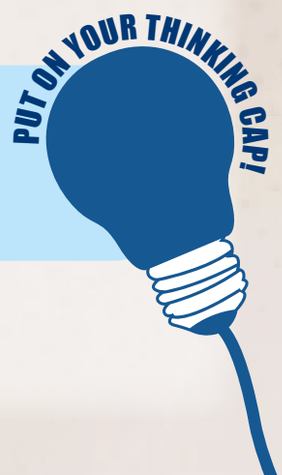
> “Wherever [a person] steps, whatever he touches, whatever he leaves, even unconsciously, will serve as a silent witness against him.
>
> Not only his fingerprints or his footprints, but his hair, the fibres from his clothing, the glass he breaks, the tool mark he leaves, the paint he scratches, the blood or semen he deposits or collects.
>
> All of these and more bear mute witness against him. This is evidence that does not forget. It is not confused by the excitement of the moment. It is not absent because human witnesses are. It is factual evidence.
>
> Physical evidence cannot be wrong, it cannot perjure itself, and it cannot be wholly absent. Only its interpretation can err. Only human failure to find it, study and understand it can diminish its value.”

Dr Locard put his principle to test when investigating several cases. One notable case occurred in 1912, when a Frenchwoman, Marie Latelle, was found dead in her parents' home. Her boyfriend, Emile Gourbin, was an initial suspect. However, he told the police that he had been playing cards with his friends on the fateful night and when the police questioned his friends, it appeared that Gourbin was telling the truth.

Locard, however, believed otherwise. Upon examination of Latelle's body, it was evident that she had been strangled to death. Taking a closer look at the scrapings from the underside of Gourbin's fingernails under a microscope, Locard found a pink dust-like material which appeared to be cosmetics.

Knowing that cosmetics were not mass manufactured during that time, Locard decided to dig a little deeper. Soon enough, he managed to find the chemist who had developed Latelle's custom-made powder and bingo, it matched the pink powder found under Gourbin's fingernails. Gourbin finally confessed to the murder and said that he had in fact tricked his friends into believing that he was with them at the time of the murder by adjusting the clock in the room to run ahead of time. With the conclusion of this case, Locard had once again proven that his Exchange Principle was spot on.

Recall your journey between two places today, e.g. from home to school. What are some types of materials you may have left behind or picked up along the way?

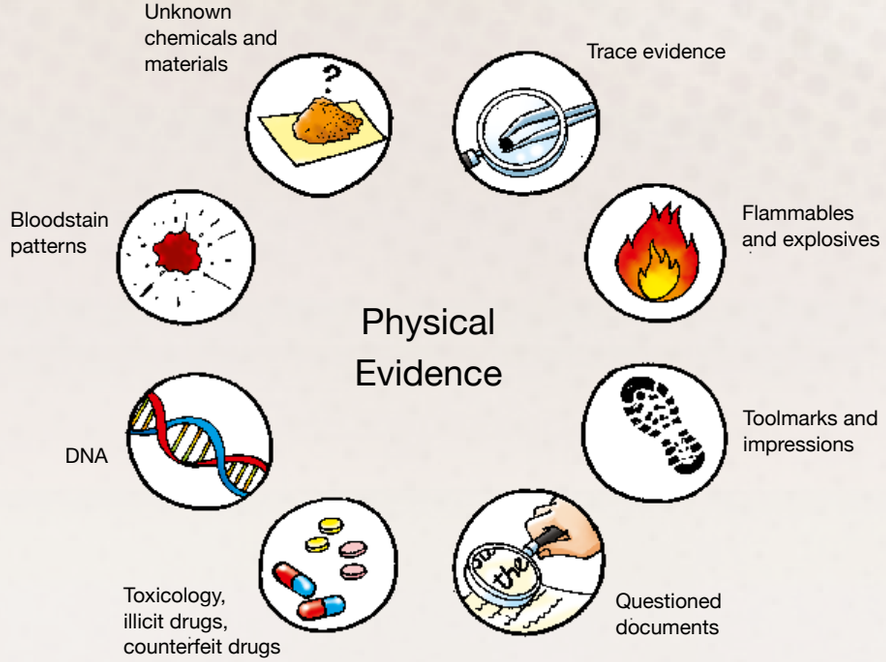


What types of evidence are there?

There are two types of evidence: testimonial evidence and physical evidence.

Testimonial evidence refers to statements given by a person or persons under oath.

Physical evidence refers to anything with shape and size. This means that everything around you can potentially be a piece of physical evidence. Even though the list may seem inexhaustible, forensic scientists have categorised the different types of physical evidence.



Bloodstain patterns

- The type of bloodstain pattern present at a scene can provide clues on the movement of persons, weapons used and events that occurred.

DNA

- One of the most well-known types of evidence, DNA can be extracted and analysed from hair roots, saliva, skin cells, tissues, semen and blood to identify the person(s).

Flammables and explosives

- In a fire or explosion, evidence such as fire debris, post-explosion materials or flammable[1] liquids may be collected.
- Analysis can help determine the identity of flammable liquids used, type of explosives used, or the origin of the fire/explosion.

Questioned documents

- Handwriting and signatures on disputed documents may be examined to determine authorship.
- Inks can also be analysed to link them to a particular source.

Toolmark and impression evidence

- Toolmark evidence include firearms, tools (e.g. a crowbar), and other items on which toolmarks are left.
- Forensic analysis of toolmarks may help determine if a bullet was fired from a particular firearm or if a particular tool was used in a break-in to damage a lock.

1. Flammable: Easily ignited and capable of burning quickly

- Impression or prints evidence include footprints, shoeprints and fingerprints, which are sometimes left at a crime scene or on items that the suspect touched.

Toxicology, illicit and counterfeit drugs

- Toxicology involves the study of adverse effects that drugs and chemicals have on humans and animals. Forensic toxicology thus plays an essential role in investigations involving poisoning, drug use or death, and suspected cases of doping.
- In the analysis of illicit[2] drugs, forensic scientists determine if the evidence contains controlled drugs that are stated in the Misuse of Drugs Act, and if so, quantitate the amount present. The quantity determined has a significant impact on the punishment imposed.
- Counterfeit[3] drugs are fake medicines. A forensic scientist can examine a suspected sample and through scientific analysis, determine if it is indeed a counterfeit or a genuine product.

Trace evidence

- Usually present in very small amounts and not readily visible to the naked eye.
- Easily transferred from one source to another.
- Examples include paint, fibres, soil and glass.
- Useful in providing associations or linkages between persons, objects and locations.

2. Illicit: Not permitted legally
3. Counterfeit: Made to look like the original of something, usually for illegal purposes

Unknown chemicals and materials

- May be encountered in cases of adulterated food, contaminated pharmaceutical products, or suspicious white powders.
- Analysis can help determine the identity of adulterants, contaminants or unknown substances.

Did You Know?

The field of forensic science is vast and the types of evidence that forensic scientists examine are not just limited to those above. Some of the other forensic disciplines include the following:

Forensic entomology is the scientific study of insects or other arthropods that are found on decomposing corpses. The stage of growth of the insects can provide an estimated time of death.

Cyber forensics involves investigation of information retrieved from digital devices such as computers and mobile phones.

Forensic pathology is the field where medical doctors perform autopsies on dead bodies to find out the cause of death.

Forensic accounting is the area where fraud, e.g. embezzlement of funds, is investigated. Forensic accountants usually apply their accounting and auditing skills to examine tax records, business invoices, financial statements, etc.

Find out More!

What other forensic disciplines can you think of?

What is it about physical evidence that makes it useful?

Firstly, physical evidence helps investigators establish the key elements of a crime: intent, conduct, concurrence, causation.

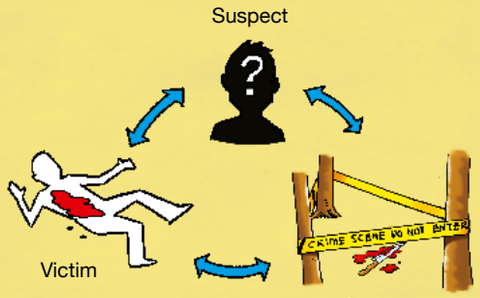
- Intent, also known as mens rea or “guilty mind”, requires someone to have an intention to commit a crime, and to have the mental capacity to have intent.
- Conduct refers to actions taken by the accused, in the commission of the crime.
- Concurrence is often defined as the happening of two or more events at the same time.
- Causation refers to the intent and conduct of the accused that led to the crime.

Secondly, physical evidence is used in crime scene reconstructions and forensic simulations to answer the “who”, “what”, “when”, “where”, “why” and “how” of a crime or incident.

Did You Know?

Answering a "why" question in crime scene reconstruction does not refer to finding out the intent of a person associated with a crime or incident. Instead, forensic scientists seek to uncover the reason or explanation for an observed effect, such as "Why were there bloodstains observed at a particular height on the wall?"

The **identities of the persons** involved can also be established, and **linkages and associations** can be formed, connecting a suspect to a victim or a crime scene.



Physical evidence is also useful in **determining the reliability of testimony** from the victim or eye-witness, aiding in refuting or corroborating claims.

When confronted with physical evidence, suspects may make **admissions or confessions**. Conversely, physical evidence can also **exonerate the innocent** or prevent wrongful convictions.

Level Up! – True or False?

1. The more samples submitted for a case, the longer it takes to complete it.
2. DNA is the most important evidence in solving a crime.
3. You do not need a degree in forensic science to become a forensic scientist.
4. Results obtained from analyses are always absolute and definite.

Answers

1. False. The duration of analysis depends on the type of evidence, complexity of the case and scientific methods used. Therefore, a case with few samples may sometimes take longer to complete than a case with many samples. A case report can be completed within a day, or it may take weeks or even several months.

2. False. Other than DNA, which tells us the "who" of a case, there are several other types of evidence such as trace evidence, and damage and marks evidence, which can tell us the "what", "when", "where", "why" and "how" of a crime.

3. True. It is not necessary to have a degree in forensic science. Forensic science requires the application of knowledge from different domains of science such as chemistry, physics, biology and mathematics. The skills and knowledge needed are acquired through on-the-job training and attending specialised courses in specific forensic areas.

4. False. The results obtained from analysing evidence may not always provide an answer. Sometimes, inconclusive results may be obtained due to degradation of the evidence, insufficient evidence or wrongly collected evidence.