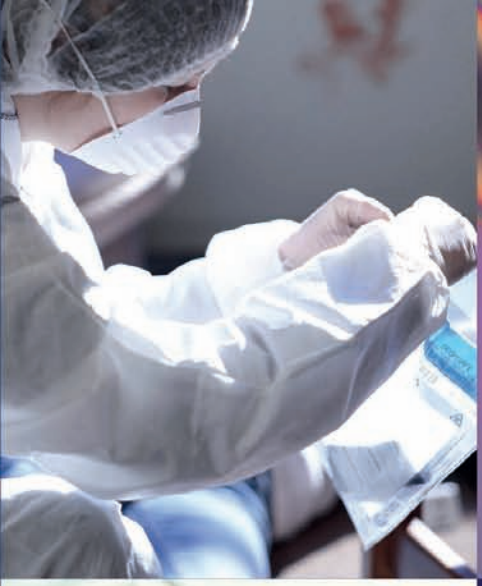
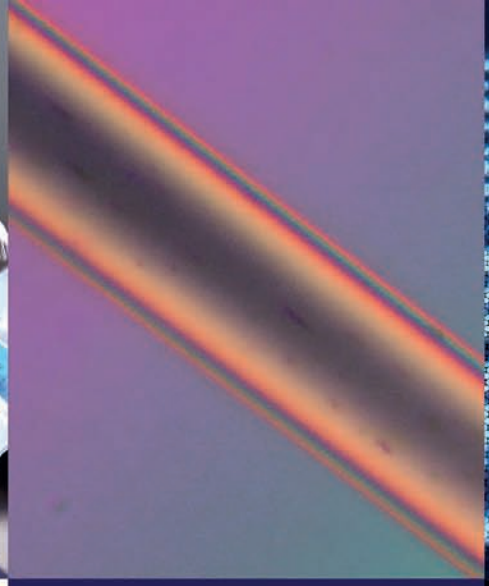

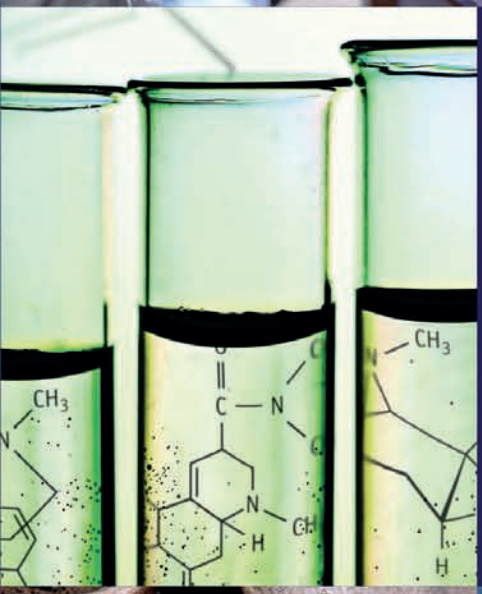

# FORENSIC SCIENCE

FOURTH EDITION

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**Table 4.4** Some commonly observed features that allow discrimination between tears and slash cuts in woven and knitted textile fabrics

| Feature | Woven fabric | | Knitted fabric | |
|---|---|---|---|---|
| | **Tear** | **Slash cut formed by a sharp implement** | **Tear** | **Slash cut formed by a sharp implement** |
| Direction of severance | Exhibits a preference to be parallel to either the weft or warp threads | Shows no directional preference | Exhibits a preference to be parallel to features evident in the construction | Shows no directional preference |
| Marked stretching associated with severance | Often evident | Not usually seen | Often evident | Not usually seen |
| The formation of curved or tubular portions of fabric at the severance edges, the axes of these curves or tubes being parallel to the severance | Often present | Not seen | Often present | Not seen |
| Ability to match patterns formed in or on the fabric during manufacture, yarn ends or fibre ends across the severance | Rare | Common | Rare | Common |
| Ends of yarns | Frayed | Neat | Frayed | Neat |
| Presence of short lengths of thread held within the fabric in the proximity of the severance line | Not seen | Not seen | Not seen | May be present (caused when a loop of thread is severed twice) |
| Cuts on the surface of the fabric at both or one of the ends of the severance. | Not seen | Often seen | Not seen | Often seen |

## 4.7 Summary

- Evidence gathered from an incident scene may take the form of recoverable items (see Chapter 3) or it may involve the recording and preservation of various marks and impressions left at the scene (dealt with in this chapter). Within this latter group, fingermarks are of particular importance, not only because they are commonly associated with crime scenes, but because they can be used to identify the individual(s) involved. In a restricted number of cases, bite marks, either on a victim's body or on inanimate objects such as food items, may be significant in identifying the perpetrator of a crime.

- As well as marks and impressions made directly by parts of the human body, others may be left by items of clothing worn by individuals, such as footwear and gloves. Yet other marks and impressions may be left by objects used by, or associated with, individuals engaged in criminal activities. Tool marks and the tyre marks of vehicles both fall into this last category. Textile products may also be of evidential value, not only as the causal agent of scene impressions, but as the bearers themselves of damage marks.

## Problems

1. In the comparison and identification of fingerprints, the Analysis, Comparison, Evaluation and Verification (ACE-V) system is commonly applied in the UK. Describe the various stages of this process and the effect its application is designed to have on the outcomes of fingerprint examination.
2. Latent fingermarks are detected on a beer glass used in an attack in a public house. Describe the different types of technique that may be used in order to make the fingermarks sufficiently visible for subsequent comparison and identification. Why is the order in which these techniques are applied important to their successful recovery?
3. Write an essay describing the challenges involved in using footwear impressions recovered from an incident scene to identify a suspect individual.
4. A Scenes of Crime Officer notices an apple core on the dashboard of a crashed stolen vehicle. Is this particular object of any evidential value to the investigation? Give reasons for your answer.
5. During a forced entry into the back of an off-licence, impressions in the wood of the doorframe indicate that a chisel has been used. Two weeks later, a tool of this type is found in the garage of a suspect. Discuss the steps that need to be taken in order to establish whether this particular instrument could have been used in the break-in.
6. Tyre tracks from a getaway vehicle are found in a snowy coniferous wood. Discuss the information that may be obtained from this type of impression if (a) no suspect vehicle is found and (b) a suspect vehicle is located. In the latter case, expand your answer to include the potential value of any soil and/or vegetation traces found on the recovered vehicle (you may wish to refer to Chapter 3, Sections 3.3 and 3.4).
7. With reference to marks and impressions, explain the potential evidential value of textile products associated with an incident scene.

## Further reading

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# CHAPTER 5

# The examination of body fluids, including bloodstain pattern analysis

## Chapter objectives

After reading this chapter, you should be able to:

- Outline the composition and biological function of each of blood, semen and saliva.
- Describe the presumptive tests used to determine whether a body fluid found at a crime scene is blood, semen or saliva.
- Explain the basis on which serological tests work, with particular reference to their use in various types of blood testing.
- Understand the importance of bloodstain pattern analysis in the investigation of scenes of violent crime.

# Introduction

The scene of a violent crime is often characterised by the presence of certain types of body fluids. Those most commonly encountered are blood, saliva and, in the case of sexual assault, semen. Such materials can be used to establish crucial links between the victim and the perpetrator of a particular crime.

In this chapter, blood, saliva and semen are examined in turn. In each case, the composition and biological functions of the fluid concerned are described, followed by an exploration of the traditional methods used in their forensic analysis. This chapter does not cover DNA analysis, which is dealt with separately in Chapter 6.

This chapter also includes a section devoted to bloodstain pattern analysis. The interpretation of this type of evidence can yield valuable information about the events that took place during a violent assault and, possibly, give some indication of the order in which these events occurred.

# 5.1 Blood

## 5.1.1 The composition and function of blood

Blood is a fluid medium, which in humans, and in other vertebrates, is found within the **cardiovascular system**. This system consists of the heart, which performs as a muscular pump, and the blood vessels, which serve to circulate the blood to different parts of the body. Blood has numerous functions. It acts as an internal transport system carrying, for example, waste products for excretion and nutrients for metabolism. It also plays an important role in maintaining body temperature, defending against infection and protecting the body from the consequences of injury.

**Cardiovascular system**
In mammals, the system comprising the heart and the blood vessels. Through the pumping action of the heart, blood is distributed to all parts of the body.

Human blood, in common with that of other mammals, consists of 55 per cent (by volume) blood plasma and 45 per cent (by volume) cellular material (i.e. blood cells and platelets). Blood plasma is a pale yellow fluid composed of approximately 90 per cent water and 10 per cent dissolved materials, including antibodies, enzymes, hormones, blood proteins, waste products (e.g. carbon dioxide) and nutrients such as amino acids and glucose. Substances, for example drugs (including alcohol), can also be found in blood plasma and may be tested for as part of a criminal investigation (Chapter 7, Section 7.5). **Blood serum** is blood plasma minus its protein content. This clear liquid is exuded when whole blood or plasma is clotted. The clotting process involves the use of blood proteins, such as fibrinogen, which, as a result, are removed from the plasma, thus producing the serum.

**Blood serum**
The clear fluid that remains after blood proteins have been removed from blood plasma by the clotting process.

The cellular components of blood may be divided into the three main types listed below:

- *Erythrocytes* (red blood cells). These are the commonest type of blood cell and account for over 44 per cent of the total blood volume. They occur in concentrations in the following ranges: $3.8–5.8 \times 10^{12}$ cells $1^{-1}$ of blood in women and $4.5–6.5 \times 10^{12}$ cells $1^{-1}$ in men. They contain haemoglobin, an iron-containing protein, responsible for the carriage of oxygen (and carbon dioxide) in the blood. In contrast to most other mammalian cells, erythrocytes lack nuclei.

- *Leucocytes* (white blood cells). These cells together with thrombocytes (see below) constitute less than 1 per cent of the total blood volume. They occur in concentrations of 4.0–11 $\times$ $10^9$ cells $1^{-1}$ of blood in healthy adults. White blood cells are involved in protecting the body from infection. They may be further subdivided into phagocytes and **lymphocytes**, which are responsible for the capture and ingestion of foreign substances (such as bacteria) and the production of antibodies respectively.

**Lymphocytes**
White blood cells responsible for the production of antibodies in response to the presence of antigens (foreign substances) in the body.

- *Thrombocytes* (platelets). These are non-nucleated cell fragments, which are formed from the fragmentation of very large cells called megakaryocytes in the bone marrow. Adult humans normally have 1.5–4.0 $\times$ $10^{11}$ platelets $1^{-1}$ of blood. Thrombocytes are involved in the process of blood clotting.

## 5.1.2 Presumptive tests for blood

At the scene of a crime, presumptive tests may be used to detect the presence of blood that might otherwise be overlooked, either because it occurs in minute amounts or because it merges well with its background. In some cases, attempts may have been made to clean up the blood at a crime scene prior to the arrival of the investigating authorities. Even under these circumstances, however, traces often persist, for example in cracks in the walls and floors. Presumptive tests may also be employed to indicate whether a particular stain is probably composed of blood (and not of some other substance, such as ink, rust or chocolate) before other, more complicated, blood-specific tests are carried out (Section 5.1.3). Presumptive tests, with the exception of the luminol test (see below), are not usually carried out directly on the objects bearing, or suspected of bearing, bloodstains. Instead, they are performed on filter paper, or another suitable absorbent material, that has been rubbed either over a designated search area or over the stain itself.

The presumptive tests used for blood are based on the ability of the haemoglobin present in red blood cells (Section 5.1.1) to catalyse the oxidation of certain reagents. In most cases, the oxidising agent used is a solution of hydrogen peroxide ($H_2O_{2(aq)}$). Many of these tests use reagents that change colour as a result of oxidation. One example that is widely used is phenolphthalein, which is colourless in its reduced form but bright pink when oxidised. The stain to be tested may be prepared in the following manner: a small circular piece of absorbent card or paper (~25 mm in diameter) is folded in half and then in half again to form a point. A small amount of the stain is then scraped onto this point and the chemicals administered in the correct order. In the phenolphthalein test (also known as the Kastle–Meyer or 'K–M' test), a drop of the dye in its reduced form is added to the test material. The presence of blood is indicated by the development of a pink coloration when a drop of hydrogen peroxide solution is subsequently added. Another reagent that is used for this purpose is leuco-malachite green (LMG), which is also colourless in its reduced state but blue-green when oxidised.

Colour-change tests are capable of detecting tiny amounts of blood present at a crime scene. However, caution should be applied in the interpretation of their results as some vegetable materials, such as horseradish and potatoes, which contain the enzyme peroxidase, may give positive results. Such results are known as false positives. Moreover, it should be noted that, as colour-change tests give positive results in the presence of haemoglobin, they do not distinguish between human blood and that of other animals. This discrimination requires the application of specific tests, notably the precipitin serological test (Section 5.1.3) or the analysis of blood DNA (Chapter 6).