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Crime Scene Investigation



Murder at the University

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Crime scene

The victim was found face down on the floor of the office belonging to Dr A. Base of the research institute. The body was abnormally limp and the face displayed a pained expression. The victim was gagged using material that was forcibly inserted into the victim's mouth. There was a serious wound to the head resulting in a large pool of blood. Unusually, the left sleeve of the victim's shirt was rolled up.

Victim's biography

Sir Andrew D. John FRSC (Fellow of the Royal Society of Chemistry, UK)

Chair of Appointments for European-wide research institutions, Sir Andrew D. John FRSC held a position of power central to research funding throughout Europe. Educated through the British public schooling system, Sir John obtained his doctorate from Trinity College, Cambridge in the same lab made famous by Watson and Crick. From there he was appointed as the youngest ever Professor of Biochemistry at Oxford University.

His engaging personality and good looks soon became popular both in academic circles and with the media. Known as the life and soul of a party, he was often invited to high profile social occasions and gained a reputation for appearing at all functions with a different and attractive partner. He was known for ruthless efficiency in his professional life and as a result has upset many people during his career.



Suspects' biographies

At the time of the murder, only four people were found to be present in the building. They have been detained, while investigations continue and suitable evidence/samples collected from them for analysis. Those people are:



Director Charles Ribose

Director of a leading international research department since 1996, his reputation as a scientist is second to none. He has been the recipient of many distinguished awards and is now well respected throughout the world. His main role at the Institute is to raise the profile of genetic research and all its applications. Although heavily involved in controversial research in his former days, he is very reluctant to discuss this aspect of his past.



Dr Thomas Base

Head of a dynamic research group, this young scientist has made a name for himself in a remarkably short time. He comes from a respected family, who are known to be connected with large pharmaceutical companies and private clinics. His research has attracted significant press, not all of which has been favourable. Some researchers feel that this may be due to his aggressive attitude to his research and lack of respect for authority.



Dr Alison Base

Dr Alison Base met her now husband, Dr Thomas Base, as a foreign research student in his lab in 2001. The youngest person to receive the prestigious Rosalind Franklin Award for molecular biology, she has gone on to prove herself as a popular and ambitious scientist. This has made her a prime candidate for the high profile and lucrative post at the Institute of Assistant Director. She is expected to be in competition with many candidates from around the world, unfortunately including her husband.



Professor Gillian Phosphate

A visiting professor from America, Gillian Phosphate is a leading light in school education and her particular interest lies in ethics, science and research. She is visiting the Institute as part of a project comparing the ethical standards of European and American research. Previously a researcher at the Institute, she failed to complete her PhD qualification. The reasons for this are still unclear. However, her forceful attitude, sometimes interpreted as vindictiveness, has ensured that she has risen rapidly in the field of education.

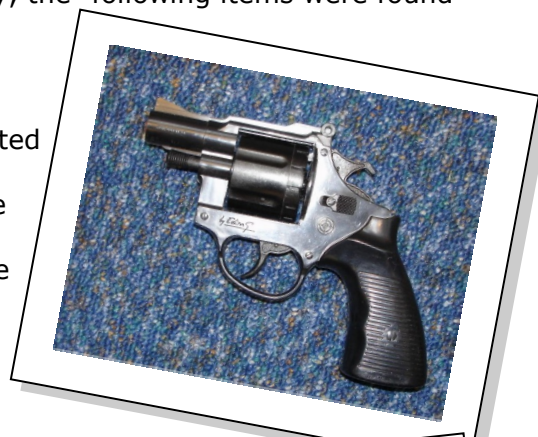
Crime scene evidence

In addition to the body, the following items were found at the crime scene:

Gun

A silencer has been fitted to the gun, which was found lying next to the body.

Ballistics show that the gun had been fired once



Handkerchief

Found stuffed into the victim's mouth.



Syringe and vial

A syringe and a vial were found on the floor. The vial was empty and the syringe used. On the vial an, as yet, unidentified code number.



Laptop

Found on the floor close to the body with a broken keyboard



Soil samples

Muddy footprints were found on the floor throughout the office. Samples have been taken for comparison with the soil found on the shoes of the suspects.



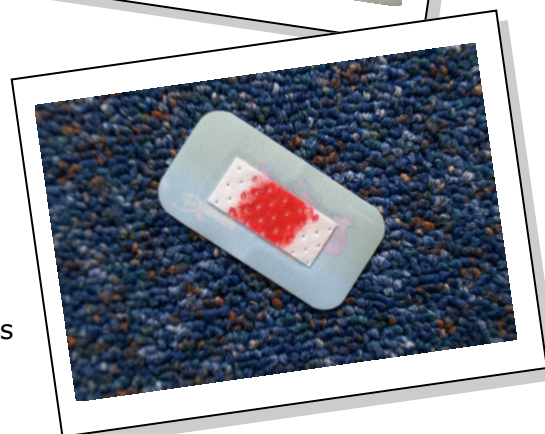
Suicide note

Found in the shirt pocket of the victim. Unusually, this was not hand written but printed from a computer.



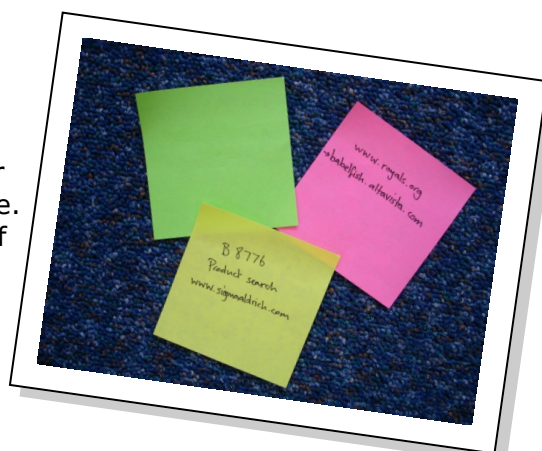
Sticking plaster

Found close to the body and showing evidence of recent bleeding. Blood typing shows that the person from which it came was blood group A. It is assumed that this was left by the murderer.

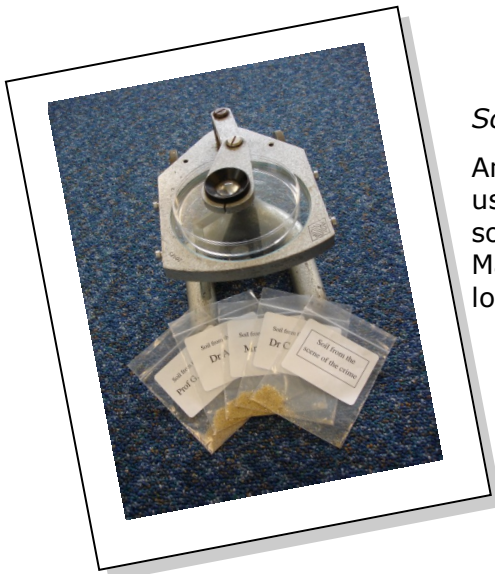


Post-it notes

Found stuck to a desktop computer at the crime scene. The importance of the information found on these notes is yet to be determined, specifically two code numbers B8776 and 1E1H. On other post-it notes a couple of web-addresses were written: www.sigmaaldrich.com, www.rcsb.org and www.babelfish.altavista.com.



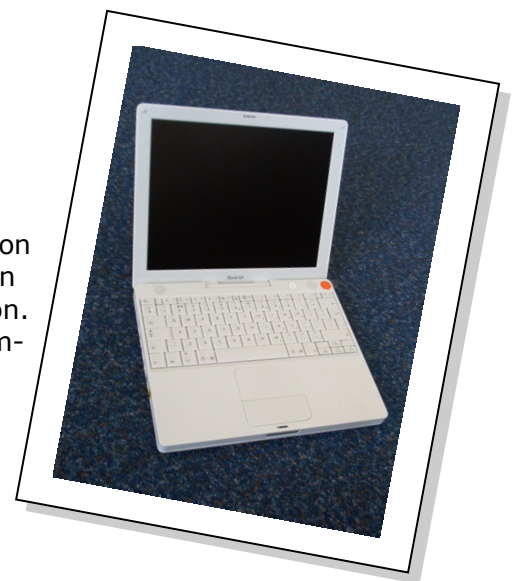
Equipment for analysis of evidence



Soil samples

Analysis of the fine grain structure of the soil samples using a low powered microscope can reveal differences in soil type.

Materials: Soil-samples, low-powered microscope (20-40 x), Petri-dishes, spoon.



Post-it notes

Web site addresses written on the post-it notes may help in the crime scene investigation.

Materials: Post-it notes, computer.



Sticking plaster

Using a simulation blood-typing kit, it is possible to determine the blood group of each of the suspects. This can be compared with the blood on the sticking plaster found at the scene of the crime.

Materials: From the blood-typing kit.



Suicide note

The ink from the suicide note and vial label can be analysed using chromatography. Comparison with the ink from the printer of each suspect could indicate the printer that was used.

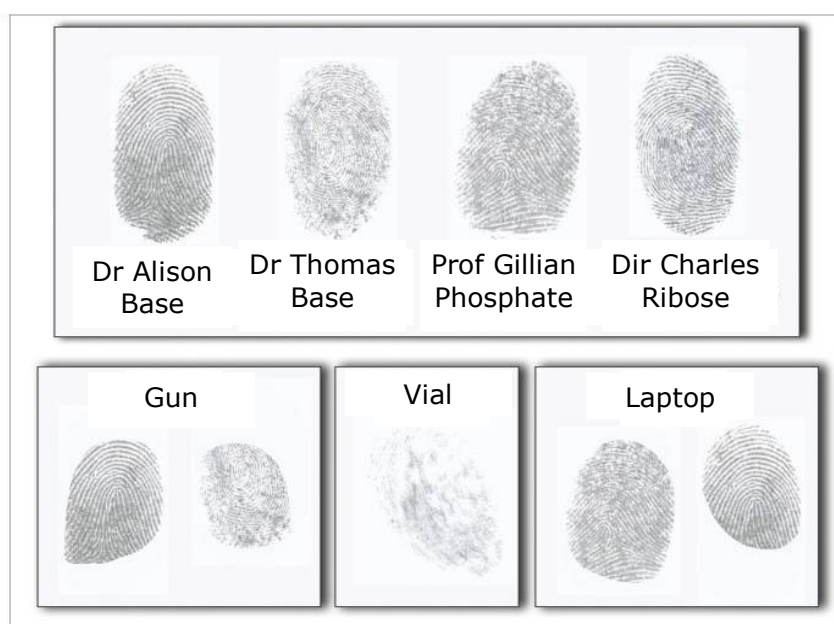
Materials: Eppendorf-tubes with samples of ink from the note and from the suspicious printers, filterpaper, scissors, small pipettes (for one-time use), Petri-dish or some other suitable container, a glass-rod (or similar) to hang the filterpaper over.

(a) You can put the filterpaper on top of the Petri-dish. Add a drop of the ink and then some drops of water. The colours in the ink dissolve more or less easily in the water and separate when the water moves.

(b) A better method; Cut 1-cm wide filterpaper ribbons. Put a small drop of the sample about 1-1,5 cm from the bottom of the paper. Hang the paper ribbon upright in a beaker with a little water at the bottom, so a few mm of the filterpaper is dipping into the water. *The water must not reach up to the ink.* When the water is sucked up through the paper the colours in the ink will dissolve in the water and move with the water.

Fingerprint evidence

Fingerprints taken from the gun, the vial, the laptop and the handkerchief. These were examined and compared to those of the suspects:

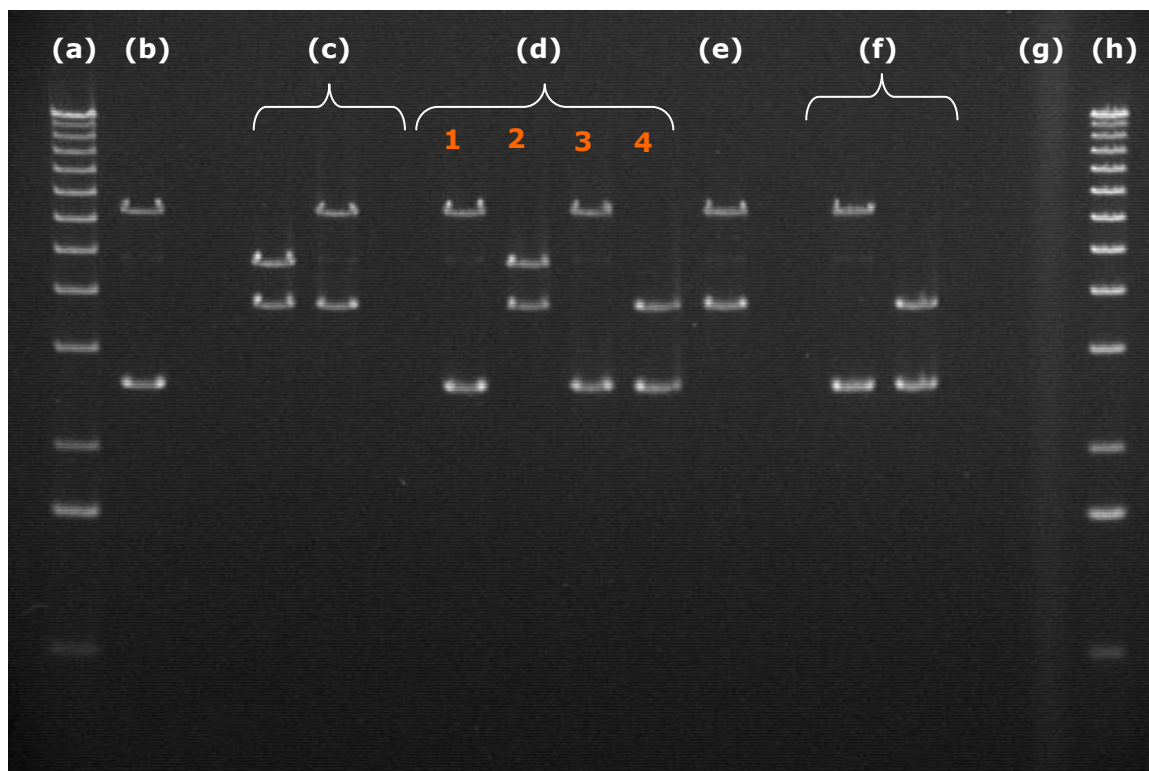


Due to the nature of the material, no fingerprints could be obtained from the handkerchief.

DNA-evidence

The photos of the agarose gel was examined and the DNA samples found on the weapons compared to those of the suspects and the victim.

Note: From each person the gene is in two copies - one from the mother and one from the father - that means two bands on the gel.



(a) DNA marker
(DNA-samples of
different size)

(b) Laptop

(c) Handkerchief

(d) Suspects

1 Dr A. Base

2 Dr T. Base

3 Prof G. Phosphate

4 Dr C. Ribose

(e) Victim

(f) Vial

(g) Gun

(h) DNA marker

Forensic report form

to be filled in by students
(You should fill in the following report and come to some conclusions)

Blood typing results:

Blood group of:

Sticking plaster:

Dir C. Ribose:

Dr T. Base:

Prof G. Phosphate:

Dr A. Base:

Conclusion:

.....

.....

Ink chromatography results

Component colours found in the ink from:

Suicide note:

Dir C. Ribose's printer:

Dr T. Base's printer:

Prof G. Phosphate's printer:

Dr A. Base's printer:

Conclusion:

.....

.....

.....

Soil analysis results

Particle description for soil of:

Crime scene:

The shoes of Dir C. Ribose:

The shoes of Dr T. Base:

The shoes of Prof G. Phosphate:

The shoes of Dr A. Base:

Conclusion:

.....

.....

.....

DNA-profiling results

(Study the photo of the electrophoresis gel)

Identity of the DNA from:

Laptop:.....

Handkerchief:.....

Vial:

Gun:

Conclusion:

.....

Fingerprinting results

(Study the photos of the fingerprints)

Identity of the prints from:

Laptop:.....

Handkerchief:.....

Vial:

Gun:

Conclusion:

.....

Post-it note analysis

Observations:

.....

Conclusion:

.....

Forensic report (results for the teacher)

Do not hand out

Blood typing results:

Sticking plaster: A

Dir C. Ribose: A

Dr T. Base:0

Prof G. Phosphate: A

Dr A. Base: A

Conclusion:

The sticking plaster is not from Dr T. Base

Ink chromatography results

The following colours could be detected (can be different if other inks are used)

Suicide note: red + blue

Printer of Dir C. Ribose: red + blue+ yellow

Printer of Dr T. Base: red + blue

Printer of Prof G. Phosphate: red + blue

Printer of Dr A. Base: red + blue

Conclusion:

The letter is not written on the printer of Director C. Ribose.

Soil analysis results

Description of soil particles

Footprints on the floor of the crime scene:.. ...*Depending on how it is mixed*

The shoes of Dir C. Ribose:... ..*Depending on how it is mixed*

The shoes of Dr T. Base:*Depending on how it is mixed*

The shoes of Prof G. Phosphate:... ..**Different** from the others

The shoes of Dr A. Base:... ..*Depending on how it is mixed*

Conclusion:

Soil from the crime scene is not from Prof G. Phosphate's shoes.



DNA-profiling results

(Study the photograph of the electrophoresis gel)

Identity of the DNA on the:

Laptop:*Dr A. Base and/or Prof G. Phosphate*

Handkerchief:*Dr T. Base and the victim*

Vial:*Dr A. Base and/or Prof G. Phosphate, Dr C. Ribose*

Gun:*No conclusive DNA samples could be found*

Conclusion:

DNA-samples from the different suspects fit to different possible murder weapons. DNA-sample from Dr A. Base and Prof G. Phosphate are identical since they are identical twins.

Fingerprinting results

(Study the photos of the fingerprints)

Identity of the prints on the:

Laptop:*Fingerprints from Prof G. Phosphate and Dr A. Base*

Handkerchief: *.Due to the nature of the material, no fingerprints could be obtained*

Vial: ... *There is no specific match/no conclusive fingerprints that could be obtained*

Gun:*Fingerprints from Dr T. Base and Dr A. Base*

Conclusion:

Fingerprints from the different suspects fit to different possible murder weapons.

Post-it note analysis

Observations:

Number code B8776 : ordering number for botulinus toxin with Sigma-Aldrich (www.sigmaaldrich.com).

Number code 1E1H: number for the structure of botulinus toxin in the Protein Data Bank (www.rcsb.org).

The address www.babelfish.altavista.com is a web site for translations between different languages

Conclusion:

Someone (probably Dr A Base) has searched for information about botulinus toxin on the Internet, and also ordered it from Sigma Aldrich.

Accusation report (presented to the court)

Preliminary investigation court report

Which of the suspects do you think committed the murder?

- Director C. Ribose
- Dr T. Base
- Professor G. Phosphate
- Dr A. Base

What evidence implicates the murderer?

What was the murder weapon?

What evidence connects the murderer to the murder weapon?

What circumstances may have caused the death of the victim?

Court proceedings

Who committed the crime?

- Soil excludes Prof Gillian Phosphate

She is a visiting Prof. and has different soil on her shoes.

It is coincidence that she has the same blood group as the murderer. (As it happens it is quite possible that she has the same blood group as the murderer because they are twin sisters).

It is coincidence that she uses the same type of printer ink as the murderer.

- Blood excludes Dr Thomas Base

He has a blood group of O while the plaster found at the scene of the crime (and assumed to be left by the murderer) has a blood group of A.

It is likely that he has the same type of soil on his shoes as the murderer, if the murderer works in the same building.

It is coincidence that he uses the same type of printer ink as the murderer.

- Ink excludes Director Charles Ribose

The ink from his printer is the only one that is different to that of the fake suicide note.

It is likely that he has the same type of soil on his shoes as the murderer if the murderer works in the same building.

It is coincidence that he has the same blood group as the murderer.

Only Dr Alison Base cannot be excluded from the scene of the crime making her the murderess.

Which murder weapons are linked to the murderer?

- Fingerprint evidence ties the following suspects to each potential murder weapon:

Gun:	Dr Thomas Base and Dr Alison Base
Handkerchief:	No fingerprints
Laptop:	Prof. Gillian Phosphate and Dr Alison Base
Vial:	Inconclusive/no match

- DNA evidence ties the following suspects to each potential murder weapon:

Gun:	Inconclusive/no match
Handkerchief:	Dr Thomas Base and the victim
Laptop:	Prof. Gillian Phosphate and Dr Alison Base
Vial:	Prof Gillian Phosphate and Dr Alison Base and Director Charles Ribose

***Dr Alison Base is therefore directly
linked with the:***

***Gun: Due to fingerprints
Laptop: Due to fingerprints and DNA
Vial: Due to DNA***

How does the murderer have access to each weapon?

- Gun

The gun is privately owned by Dr Alison Base and her husband. This explains why both their fingerprints are on the gun. DNA testing was inconclusive due to poor quality DNA being recovered.

- Handkerchief

The handkerchief belongs to Dr Thomas Base (the husband of the murderess). It is for this reason that it possesses his DNA and that of the victim down whose throat it was found. Dr Alison Base could have simply taken it from her husband. The material of the handkerchief does not lend itself to fingerprint analysis, hence none were found.

- Laptop

The laptop belongs to the visiting Prof. Gillian Phosphate who is also the twin sister of Dr Alison Base. This explains why the computer is found at the scene of the crime (Dr A. Base's office) and why the DNA appears to belong to Dr A. Base. Dr A. Base may have used or moved her sister's laptop in the office, explaining why her fingerprints are found on it.

- Vial

There are no conclusive fingerprints on the vial of Botox as it may have been used by many people in the research labs for scientific investigations. However, all the scientific researchers have left detectable traces of their DNA on the vial.

Dr Alison Base would therefore have access to all the potential murder weapons.

Why are some weapons linked to other suspects?

- Dr Thomas Base

The gun belongs to him and his wife, explaining the fingerprints (although no DNA of sufficient quality could be obtained for testing).

The handkerchief belongs to Dr T. Base.

- Dir. Charles Ribose

His DNA is found on the vial. Still being actively involved in research, Director C. Ribose could have been using the Botulinum toxin in his studies. As many other researchers could have used the vial, this explains why no conclusive fingerprints could be obtained.

- Prof. Gillian Phosphate

Her fingerprints are found on the laptop that belongs to her.

Her DNA also appears on the laptop that belongs to her.

Her DNA apparently appears on the vial of poison. However, this is not her DNA, but her twin sister's (Dr Alison Base) who may have used the vial in her research and/or for the murder.

Links between possible murderer weapons and other suspects than Dr A. Base can have other possible explanations.

What possible series of events led to the murder?

How did Dr Alison Base kill the victim? Was the victim shot with the gun, suffocated with the handkerchief, hit over the head with the laptop, poisoned with Botox or a combination of some/all these possibilities?

Dr Alison Base used the gun belonging to her and her husband to threaten the victim and so make him do whatever she wanted. She fired a warning shot to prove that she was willing to use the gun. This explains why the gun had been fired once.

She used her husband's handkerchief to gag the victim, preventing him from shouting and drawing attention from other people in the building.

She then injected him with a fatal dose of the Botox poison in his left arm, explaining why his sleeve was rolled up and he had a pained expression on his face. She had investigated which poison to use, as is evident from the post-it notes stuck to her computer, and even had the ordering details for the poison from Sigma's website.

When the Botox took effect, the victim would have writhed in pain and collapsed. In doing so the laptop was knocked onto the floor and the victim hit his head on the corner of the desk. This explains the injury to the victim's head and the pool of blood. The laptop was therefore incidental and explains why it does not have any blood/DNA from the victim on it.

Dr Alison Base then tried to make the murder look like a suicide by placing the suicide note on the body. However, not thinking clearly, she fled the scene of the crime leaving the gun, handkerchief, plaster, vial and syringe behind. She also forgot the post-it notes still stuck to her computer implicating her in researching the effects of and buying the Botulinum toxin.

What is the possible motive for the murder?

Dr Alison Base is an extremely ambitious woman and has placed her career above all else in her life. She has made no secret of the fact that she views herself as the natural candidate for the position of Assistant Director at the Institute. The final decision for this appointment lies with Sir Andrew D. John.

Interviews for the position were finalised a month ago. In order to influence Sir John's decision and to ensure her appointment to the post, Dr Alison Base had a meeting with Sir John one week ago and offered him a bribe. However, Sir John did not take kindly to such pressure and told her that under no circumstances would she be appointed to Assistant Director and that disciplinary measures would be taken to ensure that she lost her current post at the Institute.

In her anger, she devised the murder of Sir John and tried to engineer it to look like suicide. With Sir John out of the way, Dr Alison Base hoped that his successor would promote her to the post of Assistant Director. How wrong could she be?!

***So it was Dr Alison Base
with the poison,
for reasons of her career!***

Ideas and Posters

Before the students start the investigation an introduction to the case with a power-point presentation is very useful.

A school (Spyken) in Lund, Sweden, has used the experiment as a station-investigation. The students have worked two by two and circulated between 6 stations. At the stations material and information about the investigation have been displayed.

The posters for working at stations are made by Charlotta Lorentzen, Spyken, Lund, Sweden.

Resource information

Post-it notes

Sigma Aldrich

www.sigmaaldrich.com

Sigma-Aldrich is one of the largest life science research suppliers. They provide antibiotics, buffers, carbohydrates, enzymes, forensic tools, histology and haematology materials, nucleotides, proteins/peptides/amino acids and their derivatives.

Search for the code B7886. This will provide ordering details for the *Clostridium botulinum* toxin used as the poison in this activity.

Protein Data Bank

www.rcsb.org

The PDB is the single worldwide repository for the processing and distribution of 3-D structure data of large molecules of proteins and nucleic acids.

The web address and code imprinted on this post-it note can only be read clearly if rubbed with a pencil. Search for the code 1E1H and this will lead to the structure of the *Clostridium botulinum* toxin used as the poison in this activity.

Altavista

www.babelfish.altavista.com

This site will allow you to translate any website from and to most common world languages. Using this tool, the Sigma-Aldrich and Protein Data Bank websites above can be used in almost any country.

Simulation blood analysis

The kit used in this activity was purchased from Carolina Biologicals in the USA (www.carolina.com):

Kit name:	ABO-Blood Typing with Synthetic Blood
Catalogue number:	70-0101
Price:	\$22.50
Refill:	
Catalogue number:	70-0108
Price (jan -08):	\$13.00

There is also a kit that includes Rh Blood typing, but it is not necessary for this experiment.

Be aware that you may have to pay import duty on the cost of this kit if you buy it from a distributor in the US.

A similar, but more expensive kit can be obtained from Phillip Harris in the UK (www.philipharris.co.uk)

Kit name:	ABO Blood Simutype Kit
Catalogue number:	B8A20953
Price (Jan -08):	£46.94

Ink chromatography

The simulation printer inks were made by mixing different food dyes. The five common samples were made by mixing blue and red dyes together (Ratio: 2x Blue food dye E133, E122 and 1x Red food dye E122). The odd sample (Director Charles Ribose) was a mixture of blue, red and yellow dyes (Ratio: 2x Blue; E133 and E122 1x red; E122 and 1x yellow; E102).

At Spykens Gymnasieskola in Lund, Sweden, they used: 500 µl blue ink (Parker Quink) + 500 µl red food dye and mixed it. From this mixture they saved 200 µl for Director Charles Ribose printer ink and mixed it with 100 µl yellow food dye.

To the remaining 800 µl they added 400 µl water, and mixed. They added it to 3 tubes (as printer ink for A. Base, T. Base and G. Phosphates printers).



Acknowledgement

The Volvox project is funded by the Sixth Framework Program of the European Commission

Soil samples



*Use a stereomicroscope
to look at
the different soil samples*

- . Take a sample from each pair of shoes and place the samples in small heaps in a Petri dish (round plastic dish).
- . Place the Petri dish under the microscope. Use direct light and adjust the magnification so the grains of sand are in focus and can be seen clearly.
- . Make notes on the different soil samples.
- . Are all samples alike or is there one that is different from all the others?
- . What can you deduce from the soil examination?
- . Record your conclusions.

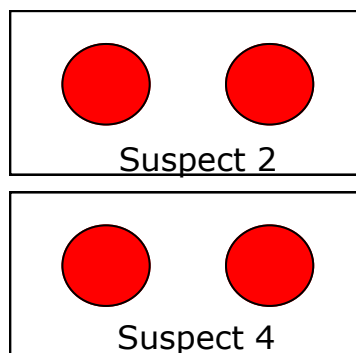
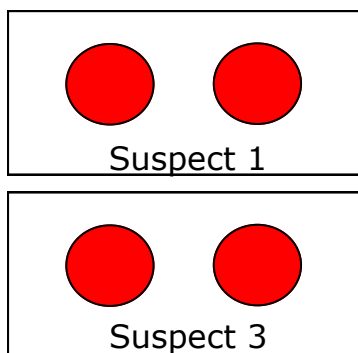




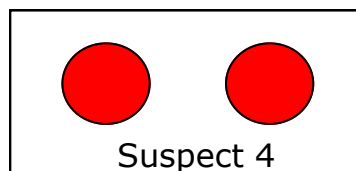
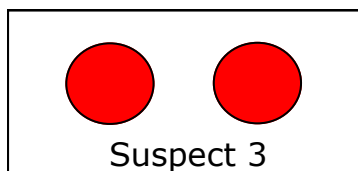
Sticking plaster

(Blood typing)

By working out the four suspects' blood groups and comparing each to the blood found on the sticking plaster at the crime scene, it might be possible to deduce who could or could not have committed the murder.



The blood group found on the sticking plaster was type A.



- Carefully pipette two blood samples for each of the suspects on to a test-slide (use two drops of blood to make each sample). *Use a new tip for each blood sample.*
- Add **one drop** of Anti-A to one blood sample.
- Add **one drop** of Anti-B to the second blood samples (Squeeze a drop of the Anti A and Anti B from the bottle. Do not use a pipette).
- Stir the samples. Do not use the same stick for all the samples. *Use a new stick for each sample!*
- Record your results.
- Do any of the suspects have the same blood group as the blood group found on the sticking plaster?
- Since the sticking plaster was found at the crime scene, what do the results tell you?



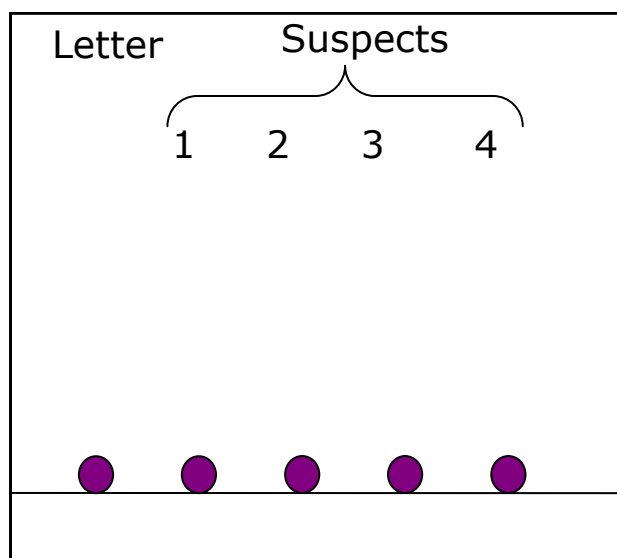
Suicide note

Using chromatography it is possible to analyse the ink from the suicide note and compare it with ink from the suspects' printers

- Using a pencil draw a line 1 cm from the bottom of a piece of filter paper.
- With a pencil label and mark where each sample is to be placed.
- For each ink sample, add a very small drop ($1\ \mu\text{l}$, about $1\ \text{mm}^3$) with a pipette on the mark you have made.
- Place the filter paper into a Petri dish base, which has water in the bottom.
- Wait for 5 minutes. Observe the results!

Can the results tell you who might have committed the murder?

Record your results and conclusions!

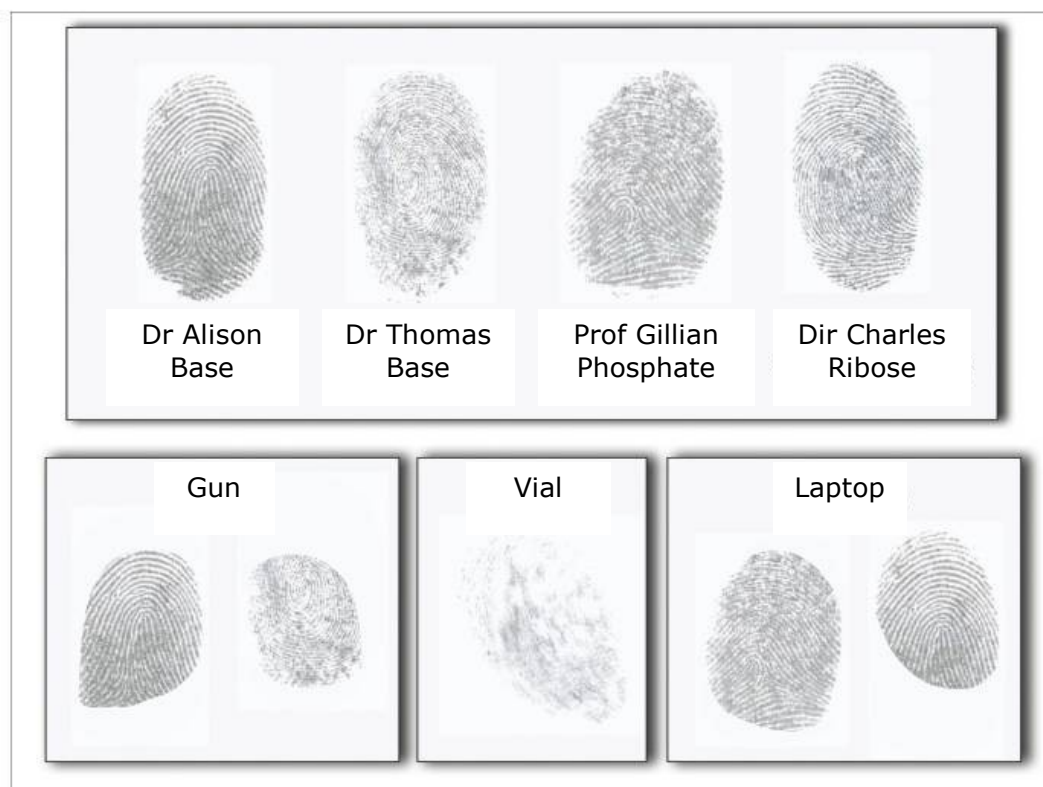


Fingerprints

Fingerprints were taken from the gun,
the vial and the laptop.

Study the photos to find out if any of the
fingerprints obtained match the fingerprints
of the suspects?

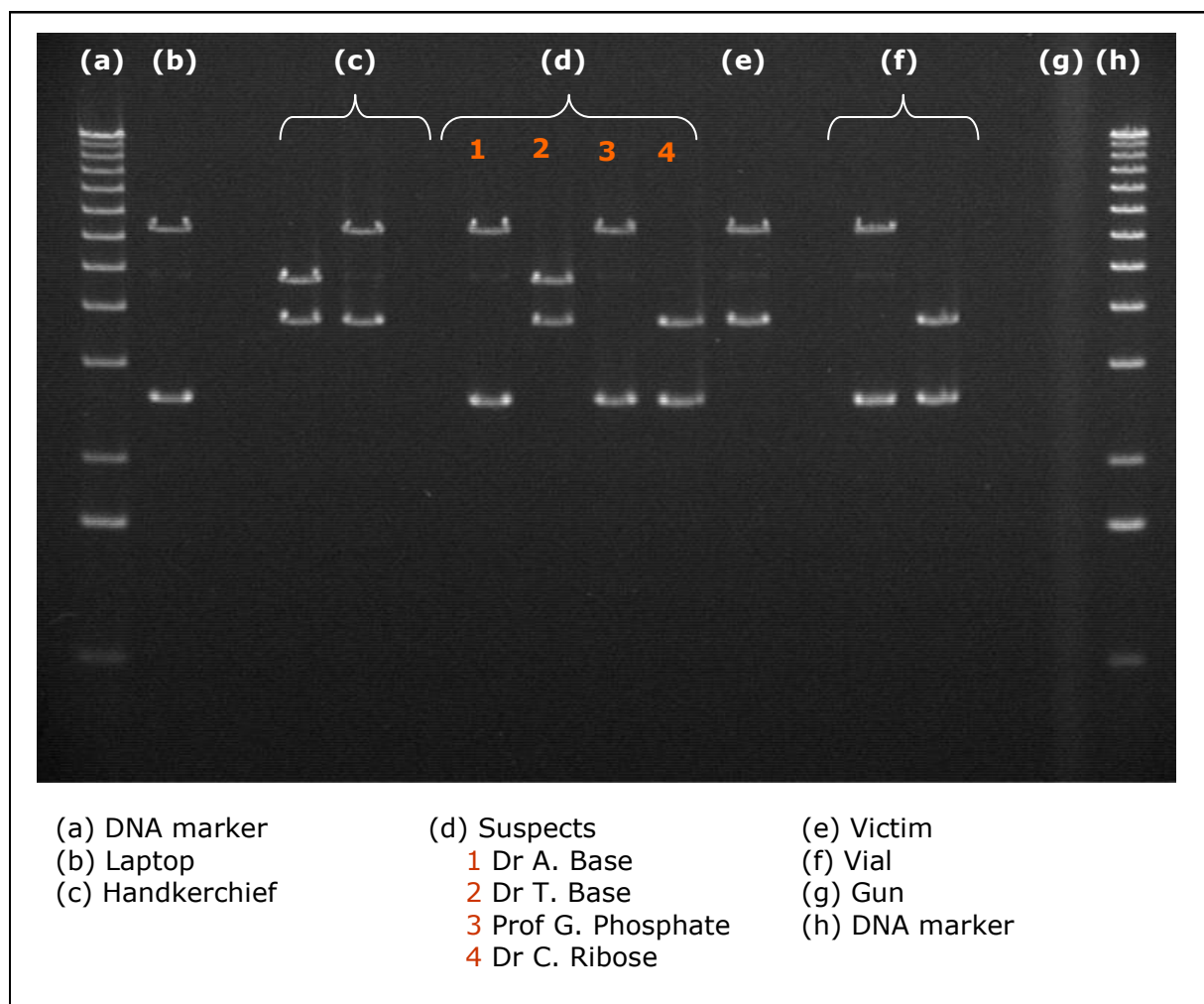
- You will need to use a magnifying glass
to see the fingerprints clearly.
- What deductions can you make?



DNA-Fingerprints

Samples from the gun, the vial, the laptop and the handkerchief were taken for DNA-analysis. The samples were amplified using PCR and then run on an agarose gel using gel electrophoresis. It is then possible to compare the different suspects' DNA with samples found at the crime scene

- Below is a photograph of the results.
- Are any suspects under suspicion for, or excluded from, the murder? *Clue: workout which samples are identical.*



Post-it Notes

Post-it notes were found on Dr Alison Base's desktop and they have been taken for forensic examination.

On two of them, the code numbers B8776 and 1E1H were found. The meaning of the code numbers is unknown.

On other post-it notes were some web site addresses:

www.sigmaaldrich.com,
www.rcsb.org, and
www.babelfish.altavista.com

- . Use the Internet to find out about these web sites.
- . Do the web sites help you understand the code numbers?
- . Do they have anything to do with the murder?

If so, explain fully!