

HONOURS PROJECT

This project would suit a student with interest and knowledge in virology, cell biology and molecular biology.

Does Respiratory Syncytial Virus Inhibit the Expression of Interferon and/or Interferon-Induced Proteins?

The *Human respiratory syncytial virus* (RSV) infects cells of the lower respiratory tract and can cause a devastating disease especially in young children. One of the viral structural proteins, the matrix (M) protein, enters the nucleus of infected cells. This is a remarkable observation because virus replication and assembly takes place in the cytoplasm. In analogy to other cytoplasmic RNA viruses such as *Rift Valley fever virus*, one might speculate that the M protein inhibits the transcription of cellular genes in order to block the production of and/or response to interferon (IFN). This hypothesis will be tested by using state-of-the-art reporter constructs to measure the promoter activity of type I IFNs and that of IFN-induced genes. For a more detailed analysis cells will be infected with wild-type RSV and mutant viruses expressing genetically altered M proteins. The successful Honours candidate will join a research group that has extensive experience with RSV cell culture systems and the characterisation of viral strategies that have evolved to counteract the IFN-induced antiviral defence.

In this project, you will:

- Transfect cell lines with various reporter constructs
- Infect cells with RSV
- Quantify the expression of renilla and firefly luciferase to analyse the promoter activity of IFN & IFN-regulated genes

Supervisors:

- Assistant Prof Reena Ghildyal, University of Canberra
- Assistant Prof Michael Frese, University of Canberra

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HONOURS PROJECT

This project would suit a student with interest in neuro-biology and molecular biology

Analysing RNA Editing in the Brain

Messenger RNAs (mRNAs) normally contain exact copies of genomic DNA sequences. However, there is an increasing recognition that the modification (editing) of mRNAs drives the evolution of complex biological processes, especially the development of higher brain functions in humans. Of particular interest is the enzymatic activity of a small family of adenosine deaminases, called ADAR proteins. ADAR proteins bind highly structured RNA sequences and catalyse the deamination of adenosine to inosine, which may lead to amino acid changes because inosine is recognised as guanosine by the translational machinery. Thus ADAR-mediated editing can change the amino acid sequence and ultimately the function of proteins. In this project, you will use genetically modified and normal mice to analyse the editing pattern of the serotonin receptor 5HT_{2C} and the ion channel Kv1.1, two brain proteins involved in neuronal signalling.

In this project, you will:

- Work at the JCSMR
- Isolate mRNA and produce cDNA
- Amplify selected sequences by PCR
- Sequence PCR products
- Analyse the editing pattern of important neuronal signalling proteins

Supervisors:

- Assistant Prof Michael Frese, University of Canberra
- Prof Klaus Matthaei, JCSMR, Australian National University

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HONOURS PROJECT

This project would suit a student with interest in microbiology and molecular biology

Differentiation of Anthrax and Environmental *Bacillus* Species

Samples of suspicious substances are commonly contaminated with environmental *Bacillus*. Under the microscope it is difficult to differentiate *B. anthracis* (causative agent of anthrax) from other species. This can cause significant confusion when reporting or interpreting screening test results; the Indonesian embassy incident is a good example of this situation (http://parlinfo.aph.gov.au/parlInfo/genpdf/chamber/hansards/2006-12-07/0141/hansard_frag.pdf;fileType%3Dapplication%2Fpdf). Real-time (RT) PCR provides a rapid means to detect, identify and quantify different *Bacillus* species and thereby avoid confusion that may result from the presence of environmental *Bacillus* in white powders. This project aims to develop procedures to help the Australian Federal Police and other law enforcement agencies discriminate between environmental and pathogenic *Bacillus* species that may be present in suspicious white powders.

In this project, you will:

- Develop and assess specific RT PCR primers and procedures to discriminate between environmental *Bacillus* species and anthrax
- Evaluate and optimise the RT PCR
- Examine the application of the RT PCR on white powders (e.g. flour, gelatin, caster sugar, talc) to determine the sensitivity, reproducibility, robustness and species specificity of the procedure

Supervisors:

- Assistant Prof Michelle Gahan, University of Canberra
- Assistant Prof Dennis McNevin, University of Canberra
- Dr Paul Roffey, Australian Federal Police



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HONOURS PROJECT

This project would suit a student with interest in microbiology and molecular biology

Pathogens in illicit drugs: a health survey

There have been several instances around the world where intravenous heroin users have been killed or badly injured as a result of injection of heroin contaminated with anthrax. It is not expected that this is an intentional act by drug traffickers; rather it is likely to be a result of accidental contamination. If heroin can become contaminated by anthrax there is the possibility that it, and other intravenous drugs, might become contaminated by other pathogens. There has never been a survey of heroin or other illicit drugs to identify how serious or widespread pathogenic contamination might be. The AFP Forensic and Data Centres has recently acquired a new instrument (the Plex-ID) that is designed to identify pathogenic microorganisms using advanced high-resolution mass spectrometry, and with Flinders University has developed methods for the extraction of genomic material from illicit drugs. There is therefore now the capability in the ACT to conduct a world-first survey of illicit drugs for the presence of pathogens.

In this project, you will:

- Extract DNA from illicit drugs
- Identify microorganisms in drug samples using the Plex-ID
- Analyse results in order to establish trends or patterns in drug contamination and health implications for intravenous drug users

Supervisors:

- Assistant Prof Michelle Gahan, University of Canberra
- Assistant Prof Dennis McNevin, University of Canberra
- Dr Paul Kirkbride, Australian Federal Police

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HONOURS PROJECT

This project would suit a student with interest in mechanisms underlying viral disease

Effect of rhinovirus 3C protease on the host apoptotic response

Rhinovirus (RV) is responsible for > 70% of virus-induced asthma exacerbations, accounting for up to 16 deaths/week in Australia alone, where as many as 30% of Australians are believed to suffer asthma. RV is also a major causative virus for the common cold. Rhinovirus belongs to the picornavirus family of viruses. Picornavirus 3C proteases are known to modulate apoptosis in infected cells although RV 3C has not been examined in this regard. Previous work in the group has shown that RV 3C localises to the nucleus of infected cells or when expressed alone in transfected cells it can degrade host proteins essential for nucleocytoplasmic transport; the latter plays a major role in apoptotic response. The aim of this project is to study the effect of RV infection on host cell apoptosis and whether 3C can directly mediate these effects. Data generated will lead to greater understanding of RV pathogenesis with implications for asthma exacerbations.

In this project, you will:

- Use molecular biology and mutagenesis techniques to clone and express derivatives of 3C protease in mammalian cell system
- Use tissue culture, virological and immunochemical techniques to examine 3C's localisation and effect on apoptosis
- Use apoptosis specific fluorescent and immunochemical assays to study the effect of RV infection and 3C protease on apoptosis

Supervisor:

- Dr Reena Ghildyal (working in the Faculty of Applied Science from 10/2010)

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HONOURS PROJECT

This project would suit a student with interest in mechanisms underlying viral disease

Nucleocytoplasmic trafficking in asthma pathogenesis.

Asthma is a significant health problem in Australia, with asthma attacks being associated with 16 deaths per week. Asthmatics have more severe symptoms than non-asthmatic subjects similarly infected with respiratory virus and bacteria. This increased susceptibility and reduced ability to clear the infection efficiently has been attributed to deficient anti-pathogen responses; specifically, reduced signalling responses that are the hallmark of effective innate immunity against pathogens. A key requirement in the innate immune response is *efficient nucleocytoplasmic transport* of cellular signalling molecules in infected cells. Interestingly, we recently found that primary cells from airways of asthmatics have clear differences compared to non-asthmatics in the cellular nucleocytoplasmic trafficking machinery that is likely to result in impaired effective immune response.

The aim of this project is to investigate the differences in primary airway cells from asthmatic and non-asthmatic subjects with respect to the effect of disrupted nucleocytoplasmic trafficking in the reduced innate immune response observed in asthmatics.

In this project, you will:

- Use tissue culture, virology and quantitative immunochemical (immunofluorescence, western blotting) techniques to examine the localisation of various molecules involved in innate immune response.
- Use cell biology techniques to separate various subcellular fractions of primary cells.
- Examine the ability of primary cells to respond to specific viral, bacterial and chemical stimuli.

Supervisor:

- Reena Ghildyal

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HONOURS PROJECT



This project would suit a student with interest in microbiology, molecular biology, biotechnology and pharmaceutical application

The First Production of Australian Highly Thermostable Lipase from Thermophilic Bacterium for Industrial Pharmaceuticals applications*

Enzymes have competed well with chemical methods for resolution of right and left handed chiral drugs. This is likely due to the fact that resolution based enzyme platforms such as classic hydrolases have been readily available in large quantities from a variety of suppliers at relatively low costs. Only until recently have synthetic based enzyme platforms such as transaminases, nitrilases, aldolases, and oxidoreductases become more readily available. Indeed, the availability, price, and intellectual property involved with biocatalysts also play a key role in the transition of any enzymatic process into manufacturing. As more and more genomic DNA sequences become available, along with the use of non-natural enzyme libraries generated from protein evolution using ePCR, gene-shuffling, and gene reassembly, it is expected that this spectrum will continue to grow rapidly. One of the biggest challenges still facing the use of these new platforms, however, has been to identify a sound business model that both the pharmaceutical industry and biotech companies can accept. This project aims at producing the first Australian highly thermostable lipase produced from Australian soil for pharmaceutical industrial applications.

In this project, you will:

- Learn about gene cloning and over expression
- Immobilization of enzymes
- Industrial application to access to single drug enantiomer

Supervisors:

- Assistant Prof. Ashraf Ghanem
- Assistant Prof. Reena Gildyal
- Associate Prof. Luby Simson
- Assistant Prof. Alison Shield

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*Priority will be given to those who wish to continue for a PhD in the field.

HONOURS PROJECT



This project would suit a student with interest in Industrial research in Chemistry and/or Pharmaceutical applications

Fabrication of new microsystems with chiral monoliths for pharmaceutical applications*

In general, the pharmaceutical industry is technically advanced and capable of adopting sophisticated new technologies. Nevertheless, the industry is suffering from a crisis in productivity and desperately needs new tools to guide the development of new drugs. Methods to predict the behaviour of potential new drugs in humans from in vitro and animal experiments are also vital. Furthermore, the conventional chiral drug discovery research is plagued by the use of a macroscopic setting, resulting in several constraints, e.g., high sample/reagent consumption, poor precision to control the catalytic experiments and the lack of integrated platforms for accurate enantiomeric excesses measurements. This project aims at developing new micro-systems that consume less of the resources of Nature and minimize the risks on human health or environment, either during manufacture or during or after functional use of the chemicals. These systems will be used in chiral analysis for pharmaceutical industrial applications, solid phase extraction and monitoring of the interconversion of chiral drugs in biological fluids.

In this project, you will:

- Join an international team with strong track record and collaboration with industry working on an industrially supported project dealing with the fabrication of new chiral silica monoliths for micro and nano enantioselective pharmaceutical separations of right and left handed molecules.
- Apply advanced knowledge to resolve problems in relation to the separation of chiral pharmaceutical compounds and the access to single drug form.

Supervisor:

- Assist. Prof. Ashraf Ghanem, University of Canberra (www.chiralitygroup.com)
- A/Prof. Luby Simson

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*Priority will be given to those who wish to continue for a PhD in the field.

HONOURS PROJECT

This project would suit a student with interest in Industrial research in Chemistry and/or Pharmaceutical applications

The Thalidomide tragedy: lessons from the past and future opportunities in micro and nano chiral separation*

Thalidomide is a sedative that was prescribed to pregnant women suffering from morning sickness, from 1957 to the early 60's. It was used in at least 46 countries under different brand names (e.g. Contergan). When taken during the first trimester of pregnancy, thalidomide prevented the proper growth of the foetus, resulting in horrific birth defects in thousands of children around the world. Why? The thalidomide molecule is chiral. There are left and right-handed forms of thalidomide. The drug that was marketed was a 50/50 mixture of both forms. The left handed form was a powerful tranquiliser, whereas the right form was found to disrupt foetal development, resulting in severe birth defects. The tragedy was entirely avoidable, had the physiological properties of the individual thalidomide forms been identified, separated and tested prior to commercialization. The switch from a racemic to single enantiomer is key to managing the life cycle as well as improving the efficacy of racemic drugs. Such switch contributes to the high demand for optically active drugs, which reached \$ 4.9 billion in revenues worldwide in 2010 with an average annual growth of 9.1%.



Fig 1: Abstract from the German "Focus" magazine (No 45, 30 October 2004)

In this project, you will:

- Join an international team with strong track record and collaboration with industry working on an industrially supported project dealing with the fabrication of new chiral silica monoliths for micro and nano enantioselective pharmaceutical separations of right and left handed molecules.
- Apply advanced knowledge to resolve problems in relation to the separation of chiral pharmaceutical compounds and the access to single drug form.

Supervisor:

- Assist. Prof. Ashraf Ghanem, University of Canberra
- A/Prof. Luby Simson, University of Canberra

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*Priority will be given to those who wish to continue for a PhD in the field.

HONOURS PROJECT

This project would suit a student with interest in molecular mechanisms underlying viral disease.

Title: Role of epigenetic enzymes in cancer and asthma.

Chronic fibrotic diseases like cancer and asthma are the cause of significant global mortality. Epithelial to mesenchymal transition (EMT) is a common characteristic of both cancer and asthma, and is a major factor in the fibrosis that underlies disease symptoms. In the context of the current increasing incidence of both cancer and asthma and the lack of effective treatments, there is an urgent need for new intervention strategies. Study of the functions of these enzymes in normal and disease settings with the view to developing novel epigenetic drugs is an emerging area of epigenetic research. Recent data in the Rao laboratory show for the first time that key epigenetic writer and eraser enzymes are essential for EMT in human breast cancer. In this project, we aim to further delineate the contribution of key writer and eraser epigenetic enzymes in cancer and asthma. The long term goal is to identify new epigenetic drug targets for diseases of high medical significance.

In this project, you will:

- Use high end molecular biology and epigenetic techniques to investigate the role of epigenetic enzymes in models of asthma and cancer.
- Use tissue culture techniques.
- Use quantitative confocal immunofluorescence techniques to examine protein localisation.

Supervisors: Reena Ghildyal
Sudha Rao

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The following projects have been taken but if the project interests you, please speak to the contact person to see if there are similar projects available.

HONOURS PROJECT



This project would suit a student with interest in virology, cell biology and molecular biology

Developing a Cell Culture System for Rabbit Caliciviruses

Rabbit hemorrhagic disease virus (RHDV) is a calicivirus that infects rabbits and multiplies in liver cells. A highly pathogenic RHDV strain is used in Australia to reduce the number of feral rabbits, which has been fairly successful - even if rabbits were not eradicated. In other parts of the world, where rabbits are reared for food and clothing, or make significant contributions to the local ecosystem, the virus may have a negative impact on the economy and ecology. Given the importance of the virus for Australia and other countries, it is surprising that an efficient cell culture system for RHDV has not yet been developed. The present project aims to overcome this road block by testing existing and newly established rabbit cell lines for their ability to support RHDV replication. The project will be lead by Dr Tanja Strive, who is the leading rabbit biocontrol researcher at CSIRO Entomology.

In this project, you will:

- Work in the CSIRO Black Mountain Laboratories
- Establish new rabbit liver cell lines
- Control interferon signalling to increase virus replication in potential host cells
- Quantify virus replication/multiplication

Supervisors:

- Research Scientist Dr Tanja Strive, CSIRO Entomology - Black Mountain
- Assistant Prof Michael Frese, University of Canberra

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HONOURS PROJECT

This project would suit a student with interest in microbiology and molecular biology

Anthrax Detection at Canberra Airport

Transport hubs are natural targets for biological attack. A single attack has the potential to infect a large number of people who then disseminate, transferring disease over wide and/or diverse geographic regions. This dispersal, coupled with a time delay between exposure and disease presentation, makes attack recognition and source identification difficult. Anthrax is endemic in Australia, concentrated in northern Victoria and southern central NSW (“anthrax belt”). Primarily a disease of cattle, sheep and goats, on rare occasions humans, commonly those associated with farming or handling of stock and/or stock products, can acquire anthrax. Given the movement of people and luggage from the “anthrax belt” through our major transport hubs, the presence of anthrax spores is not unlikely. Forensic investigation needs to discriminate “attack” levels of the pathogen from “background” so it is essential data be collected on the background levels of anthrax at our major transport hubs.

In this project, you will:

- Develop a procedure for DNA extraction from anthrax spores
- Develop and optimise a real time PCR procedure for the quantitation of anthrax DNA
- Collect, extract and quantitate vacuum samples from the Canberra Airport for the presence of anthrax

Supervisors:

- Assistant Prof Michelle Gahan, University of Canberra
- Assistant Prof Dennis McNevin, University of Canberra
- Dr Paul Roffey, Australian Federal Police



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HONOURS PROJECT

This project would suit a student with interest in analytical chemistry and forensic chemistry.

Chiral analysis of methylamphetamine and amphetamine using Agilent Bioanalyzer 2100

A number of clandestine synthetic procedures for the manufacture of amphetamine or methylamphetamine make use of phenyl-2-propanone. This produces racemic product that is not usually treated to isolate the more potent dextro enantiomer. However, a significant proportion of clandestine laboratories use ephedrine or pseudoephedrine as precursor, and either of these yield just dextro-methylamphetamine. Similarly norpseudoephedrine can be used to produce dextro-amphetamine. Chiral analysis of methylamphetamine and amphetamine products is particularly useful for intelligence as the likely precursor can be readily identified and attempts to enantiomerically enrich products can be highlighted.

GC, LC, and CE methods exist for the separation of ATS enantiomers, but all are relatively slow and require high-cost laboratory equipment and sometimes derivatization. The goal of the proposed research is to establish whether the Agilent Bioanalyzer 2100 (a portable instrument for electrophoretic separations) can be used for the chiral analysis of methylamphetamine and amphetamine.

In this project, you will:

- Identify the best chiral analytical strategy (e.g. examine derivatization using chiral fluorophores and separation using an achiral buffer and compare it against achiral derivatization followed by separation using chiral buffer).
- Characterise the performance of the separation with regards to the influence of common cutting agents (e.g. sucrose, glucose, caffeine, dimethyl sulfone, nicotinamide), sensitivity to enantiomeric excess, migration time stability.

Supervisors:

- Assistant Prof Tamsin Kelly, University of Canberra
- Dr K Paul Kirkbride, Australian Federal Police
- In collaboration with ACT Government Analytical Laboratory

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HONOURS PROJECT

This project would suit a student with interest in mechanisms underlying viral disease

Role of the cytoskeleton in respiratory syncytial virus assembly

Respiratory syncytial virus (RSV) is the chief cause of viral pneumonia in infants worldwide and an important lower respiratory pathogen in the elderly. Through its ability to shuttle into and out of the nucleus, the matrix (M) protein is believed to play a role in pathogenesis. M's role in the cytoplasm is to facilitate virus assembly, whereas its role in the nucleus may be to inhibit host transcription; localisation is regulated by phosphorylation and maybe, interactions with the cytoskeleton. The aim of the project is to map the sequences within M responsible for interaction with the cytoskeleton and establish their importance in RSV infection. Detailed understanding of these processes may identify targets for future development of RSV antivirals and/or vaccines.

In this project, you will:

- Use molecular biology and mutagenesis techniques to clone and express derivatives of M protein in mammalian and bacterial cell systems
- Use tissue culture, virological, immunochemical and specific cytoskeleton techniques to examine M's interaction with cytoskeleton
- Use *in vitro* assays to determine the sequences in M involved in its interaction with cytoskeleton

Supervisors:

- Dr Reena Ghildyal (working in the Faculty of Applied Science from 10/2010)
- Dr Michelle Gahan

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HONOURS PROJECT

This project would suit a student with interest in mechanisms underlying viral disease

Regulated nucleocytoplasmic transport of respiratory syncytial virus matrix protein: role in infection

Respiratory syncytial virus (RSV) is the chief cause of viral pneumonia in infants worldwide and an important lower respiratory pathogen in the elderly. Through its ability to shuttle into and out of the nucleus, the matrix (M) protein is believed to play a role in pathogenesis. M's role in the cytoplasm is to facilitate virus assembly, whereas its role in the nucleus may be to inhibit host transcription. Previous work within the group has defined the minimal nuclear localisation signal (NLS) as well as two Casein kinase 2 phosphorylation sites that are important for regulation of M's nuclear transport. Recombinant infectious RSVs have been generated by reverse genetics techniques wherein the NLS and the phosphorylation sites are individually mutated. The aim of the project is to characterise these recombinant viruses in cell culture and in an animal model to determine the role of the mutated sites in RSV pathogenesis. Detailed understanding of the protective immune response to these RSVs may have implication for future development of vaccines.

In this project, you will:

- Use tissue culture, virological, molecular and immunochemical techniques to study replication kinetics of the recombinant RSVs and the host cell response
- Work with RSV infection in mice to study the *in vivo* pathogenesis and host response to the recombinant RSVs

Supervisors:

- Dr Reena Ghildyal (working in the Faculty of Applied Science from 10/2010)
- Dr Michelle Gahan

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Analysis of Smokeless Powder Residues in Firearm Discharge Residue (FDR) Collection Kits

Zeichner *et al.* ("A Novel Method for Extraction and Analysis of Gunpowder Residues on Double-Side Adhesive Coated Stubs" *Journal of Forensic Sciences* 2004, 49(6): 1194-1206) has reported that stubbing for primer FDR also recovers smokeless powder residues that can be extracted and analysed. As extraction will dislodge primer residues, and SEM will most likely remove volatile organics, Zeichner's method forces the analyst to choose between either organic or inorganic analysis of stubs. Analysis of the stubs by SPME (solid-phase microextraction) followed by GC-MS is an alternative that requires evaluation.

Objectives:

- Assess whether SPME is capable of recovering smokeless powder residue volatiles from FDR stubs prior to SEM analysis.
- Conduct experiments with mock FDR stubs "seeded" with a small number of smokeless powder fragments. Optimize headspace SPME recovery with regards to temperature, fibre type and absorption time, and optimize GC-MS conditions.
- Conduct test firings and stubbing of hands. Conduct headspace recovery and GC-MS, followed by SEM-EDX. Repeat SPME-GC-MS and compare results with analysis prior to SEM-EDX.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Dr Paul Kirkbride (Australian Federal Police; AFP)
- Mr David Royds (University of Canberra, ex-AFP)

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HONOURS PROJECT



This project would suit a student with interest and knowledge in analytical chemistry.

Comparison of the Analytical Techniques used for the Examination of Black Document Toners

To date, Fourier Transform Infrared Spectroscopy (FTIR) has been the most common technique used for the chemical comparison of toners. This project will determine whether this is still the most appropriate technique to use, given the availability of new analytical techniques and the changes in the formulations of toners over the last 5-10 years (from a mechanical process to an emulsion process). For the AFP lab, this work will allow the team to review current methods and allow strategic goals to be set for the validation of other potential analytical techniques for analyses of this type.

Objectives:

The project will examine a number of traditional (mechanical) and contemporary (emulsion) toners to determine if differences can be detected between the two groups and between each sample using a structural technique (FTIR), an elemental technique (suggestions would be LA-ICP-MS or XRF) and optical techniques (Polilight or VSC). To assess the effectiveness of new technologies (and if time permits), the same samples should also be analysed by a portable FTIR and the results compared to the traditional FTIR results to determine whether there is any significant difference in sensitivity/specificity.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Kylie Jones (Australian Federal Police; AFP)
- Rochelle Epple (AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Evaluation of fingerprint detection sequences on porous substrates

At a recent meeting of the International Fingerprint Research Group (IFRG), held in Sweden in June 2011, it was suggested by one research group that the sequence DFO → ninhydrin may actually develop more latent fingerprints than the sequence indanedione-zinc → ninhydrin on porous surfaces such as paper. This is despite the fact that it is now generally accepted that indanedione-zinc is the single best detection technique for porous substrates. In addition to the above, recent work completed at UTS (Karl Braasch, Honours 2010) highlighted the potential of Nile Red (NR) to be used after physical developer (PD) as a complementary detection method. We need to investigate the relative merits of various detection sequences on paper substrates.

Objectives:

Evaluation of the following sequences on a range of porous substrates and with fingerprints from a range of representative donors:

- DFO → ninhydrin → PD → NR
- Indanedione-zinc → ninhydrin → PD → NR

The evaluation will need to be undertaken on split “natural” impressions, as well as on a statistically significant number of pseudo-operational samples.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Prof Claude Roux (UTS)
- Dr Xanthe Spindler (UTS)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Evaluation of LIBS (Laser-Induced Breakdown Spectroscopy) for the Forensic Analysis of Trace Evidence

The elemental analysis of trace evidence – including paint chips, glass fragments, and textile fibres – can be undertaken using a range of analytical methods. Such methods include SEM-EDX, micro-XRF, and ICP-MS. An emerging technique that requires evaluation is LIBS (Laser-Induced Breakdown Spectroscopy).

Objectives:

Evaluate LIBS (Laser-Induced Breakdown Spectroscopy) for its ability to conduct elemental analyses on a range of trace evidence types (eg. paint chips, glass fragments, and textile fibres).

Compare the results obtained by LIBS with those obtained by other methods such as SEM-EDX, micro-XRF, and ICP-MS.

Determine the relative advantages and disadvantages of the LIBS technique.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Dr Simon Foster (UC)
- Dr Paul Kirkbride (AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Identification of Nitrocellulose using Direct Injection Ion Trap Mass Spectrometry

Nitrocellulose in solution is a difficult molecule to detect. It cannot be analysed using conventional GC-MS as it has too high a boiling point and becomes stuck in the front of the column, while LC-MS analysis is also difficult as the molecule is too large to effectively travel through the column. This project will try to fill this gap by allowing nitrocellulose to be analysed while still in solution, reducing the need to isolate, recrystallise and identify the compound using IR.

Objectives:

- Optimise Ion Trap MS parameters for the detection of nitrocellulose.
- Determine the limit of detection for analysis.
- Analyse single, double and triple base propellants to determine if additives will interfere with analysis.
- Determine if current laboratory procedures to extract nitrocellulose from solution removes any effects from additives.
- Provide an opinion as to whether nitrocellulose extraction should still be part of the standard laboratory procedure.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Ben Cabot (Australian Federal Police; AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Ignitable Liquid Markers in Arson Investigation

Although it is usually simple to detect the presence of an ignitable liquid residue in arson debris and identify it (eg. petrol, kerosene, etc.), standard methods do not allow a link to be drawn between the residue and its suspected origin (eg. a can of fuel in the possession of the suspect). Ignitable hydrocarbon liquids derived from petroleum contain minute traces of polycyclic hydrocarbons that are very resistant to weathering. These have been shown in arson and environmental forensic contexts to have potential for linking ignitable liquids. Although evaporation or combustion (as would take place during a fire) act to remove the more volatile hydrocarbons from ignitable liquids, standard forensic headspace recovery techniques are not sensitive enough to allow detection of these markers. Liquid extraction followed by high-sensitivity mass spectrometry would appear to offer the best chance of success.

Objectives:

- Develop techniques for the extraction and GC-MS analysis of naphthalenes and diamantanes present in neat, evaporated petrol and kerosene.
- Conduct test burns of petrol and kerosene and assess effectiveness of extraction/GC-MS procedures.
- If time permits, conduct a small market survey of petrol or kerosene marker variance.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Kylie Jones (Australian Federal Police; AFP)
- Rochelle Epple (AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Exploration of alternative extraction and mobile phase components for the analysis of different ink types using Thin Layer Chromatography (TLC)

Thin Layer Chromatography (TLC) is a method that is used to differentiate inks by chemical means when optical filters and microspectrophotometry have reached their limits. In one recent case within the AFP, forensic staff were asked to compare the chemical composition of specialist printing inks to establish a link between seized drug shipments. The extraction techniques employed were primarily developed for the analysis of writing implements, such as ballpoint pen ink, and therefore were not as suitable for the separation of the specialised printing inks examined.

Objectives:

The aim is to identify suitable extraction solvents and solvent systems (mobile phases) for the analysis of specialist printing inks including (but not limited to):

- lithography
- inkjet inks
- flexography and
- screen printing

The completion of this project will allow improvements in the methodology of specialised ink analysis and enhancements to existing procedure manuals.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Kylie Jones (Australian Federal Police; AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Investigation of fingerprint “lifting” methods to remove developed fingerprints from various surfaces

Significant research has been directed at developing and enhancing fingerprints on various coloured and patterned backgrounds. This has generally relied on the use of luminescence to overcome background interference problems. What remains to be fully explored, however, is to what extent a chemically developed fingerprint can be “lifted” from a surface to provide a transferred mark on a clean, non-interfering background. Such a “transfer” might be possible with a gelatine lifter, gelatine film (as is possible with marks developed with gentian violet), or nitrocellulose membranes (or other blotting membranes used in biochemistry), for example. As an extension of this, it may be possible to use a chemically-treated lifter that can both transfer and develop latent fingerprints or fingerprints in blood. (There is apparently a commercially available system for lifting and enhancing fingerprints in blood, using such a process, that needs validation.)

Objectives:

Develop and evaluate a range of “lifting” techniques for chemically developed fingerprints on a range of porous and non-porous surfaces. Also investigate to what extent chemically-impregnated “lifters” could be used to both transfer and develop latent fingerprints deposited on various substrates.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Prof Claude Roux (UTS)
- Dr Xanthe Spindler (UTS)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

Applications of pyrolysis GC-MS to the forensic analysis of soot

After a fire, soot is found either deposited on objects or in fuel cans that have been involved in the fire. It is already known that soot from flammable liquids carries some identifiers of the liquid. Conventional flammable liquid residue (headspace) analysis techniques are not particularly informative, so other methods have been developed that use aggressive solvent extraction. These are not particularly simple methods to implement. There are suggestions that pyrolysis GC-MS may be a useful technique for analysing soots in order to determine the presence of characteristic hydrocarbons that may indicate if a flammable liquid was present during a fire.

Objectives:

The aim of this work is two-fold:

- to conduct an assessment of pyrolysis-GC-MS as to its suitability for soot analysis; and
- to investigate the feasibility of identifying the flammable liquids through the analysis of their soot pyrograms.

Supervisors:

- Prof Chris Lennard (University of Canberra)
- Dr Paul Kirkbride (Australian Federal Police; AFP)
- Mr David Royds (University of Canberra, ex-AFP)

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HONOURS PROJECT

This project would suit a student with interest and knowledge in analytical chemistry.

What is the relative performance of wet powder suspensions compared to cyanoacrylate fuming for fingerprint detection on plastic substrates?

A number of presentations at the 2009 and 2011 meetings of the International Fingerprint Research Group (IFRG) highlighted the surprising efficiency of wet powder suspensions for fingerprint detection on a range of non-porous surfaces, particularly plastic substrates. In addition, a survey undertaken in the UK indicated that the types of plastics available on the market have changed significantly over the last 20 years due to the introduction of new polymer blends and the increased use of recycled plastics. This has resulted in decreased fingerprint detection success rates with techniques such as CA fuming and VMD. Wet powder suspension may actually be the best choice for some of the more problematic plastic substrates. However, while this is the situation in the UK, we don't know whether the same applies in Australia.

Objectives:

Collect a range of common plastic substrates available on the Australian market and classify these (ie. determine major polymer type; this could be done by FTIR). Deposit fingerprints from a range of representative donors and age these over certain time periods. Using split impressions, determine the relative performance of wet powder suspensions (eg. commercially available white and black powder suspensions) compared to conventional CA fuming plus rhodamine 6G staining.

Supervisors:

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