Forensic Profiling from a Radiologically Contaminated Scene

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Contents

- Overview of the forensic DNA project
  - Nuclear forensics meets conventional forensics
- Project objectives
- STR analysis
- Work to date
- Future work
Types of radiological Incident

- Broad range of potential scenarios involving nuclear and other radioactive material out of regulatory control

- Since the early 1990’s there have been a number of cases of illicit smuggling/trafficking of nuclear material
  - e.g. The interdiction of a small quantity of uranium at the Bulgaria border in 1999 (case-study given in Moody, Hutcheon & Grant, CRC Press (2005))

- Potential for the malicious use of nuclear or radiological material in a radiological dispersal device (RDD)
Crime committed

Biological material transferred

Evidence (Question)
Sample ‘Q’

Suspect

Reference (Known)
Sample ‘K’

May match another

Radiological contaminant

Collection
Sample storage
Characterisation
Extraction
Quantitation
Amplification
STR Markers
Separation/Detection

Data Interpretation
Statistical Interpretation

Court
Plea

Biology
Serology
Technology
Genetics

Evidence (Question)
Sample ‘Q’

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Conventional Forensic Analysis Capability (CFAC) at AWE

- Home Office have funded the development of a specialist laboratory at AWE to enable the conventional forensic analysis of radiological contaminated items

- Laboratory licensed to handle radiological material
- Laboratory designed for operations with radiological materials
- Broad range of traditional forensic science examinations possible:
  - Record photography
  - DNA
  - Trace evidence recovery
  - Digital data recovery
  - Fingerprints
  - Questioned Documents
Project overview

- To gain an understanding of the potential effects on human DNA recovered from a crime scene/incident where an ionising radiation source or radioactive contamination could be present.

- To establish a DNA laboratory capable of researching radiological material interactions with DNA.
STR profile summary

- Short Tandem Repeats
- Areas of repeated ‘junk’ DNA
- Variable between individuals
- 15 loci and gender identification
- $1:1 \times 10^{18}$ probability of DNA match of non related individuals
## Short Tandem Repeats (STR)

### Area of chromosome of interest (loci)

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**Repeat Region**

### The number of STRs in a given loci

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- Random match probability between individuals of $\sim10^{-18}$

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Previous work done at AWE

- Assessment of gamma irradiation on Buccal cells
- General decline in STR profile with increasing dose, as expected
- However, issues in STR amplification observed for both samples and controls
- Standard cells (BJ-5ta) will be undergoing irradiation

DOI 10.1007/s10967-012-2088-0
Previous issues with irradiation work

- Quantification
  - Different prior to and post irradiation
  - At high doses, containers became brittle

- Solution
  - Avoid freeze thaw cycles
  - Irradiation to 60 kGy only with smaller increments between
  - Different containers used
Current irradiation work

- A further cell irradiation is planned
- Gamma irradiation undertaken at:
  - 0, 10, 20, 30, 40, 50 and 60 kGy
- Cells will be in two formats:
  - PBS solution
    - hTERT cell line BJ5tA
    - Buccal cells
  - Whatman FTA card
    - hTERT cell line BJ5tA
    - Buccal cells
    - Blood cells
## Improvements to techniques

### OLD
- Identifiler
- Quantifiler
- Ethidium Bromide
- MRC-9 and MRC-5 cell line

### RETAINED
- QIAGen mini

### NEW
- Identifiler plus
- Identifiler direct (needs ABI 3500)
- Quantifiler duo
- ChargeSwitch
- Gel Red
- BJ-5ta cell line
- QIAgem investigator
- Whatman FTA card
Decontamination of DNA

- Standard DNA extraction procedures may not allow decontamination.

- Contaminants can cause degradation of DNA molecules or interfere with the extraction or amplification processes.

- Removal of the contaminant will allow for storage of evidence for long periods of time without continued degradation.
Initial Decontamination trial methods - AWE

- Qiagen DNA extraction kit/investigators kit
- ChargeSwitch®
- Standardised cell line (BJ-5ta)
- Initial experiment with known concentration at known timescale
- Increase timescale/concentrations
Suggested initial experiment

1. Known volume/concentration of cells
2. Known volume and concentration of solution added to cells
3. Leave for set time
4. DNA extraction
5. Determine concentration

DNA extraction waste
Decontamination scheme - ChargeSwitch

1. Sample, lysis buffer and resin
2. Resin
   - Remove solution
3. Lysis buffer containing radioactive contaminant
   - Wash resin
4. Resin
   - Remove solution
5. Supernatant containing radioactive contaminant
   - Wash containing radioactive contaminant
6. Supernatant containing DNA
   - Remove supernatant
7. Supernatant containing DNA
   - Collect DNA from resin
Any Questions