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Original Research Paper

Forensic Dentistry

BIOROBOTS IN FORENSIC GENETICS- A GIFT OF TIME

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ABSTRACT When it comes to identifying the deceased and conducting criminal investigations, forensic genetics has become a crucial component of forensic science. Over the years, deoxyribonucleic acid (DNA) has come to be regarded as the gold standard for human identification. It is imperative to employ automated tools to expedite the extraction, quantification, amplification, and production of DNA profiles in order to fulfil the increasing demand for DNA analysis. Robotic systems boost productivity and decrease backlog. This topic covers incorporation of an emerging trend of forensic Biorobots in the medicolegal field to the ultimate benefit of society

KEYWORDS : Biorobots, Forensic Genetics, DNA Analysis, PCR

INTRODUCTION

Over the years, DNA has come to be regarded as the gold standard for human identification. In 1981, forensic DNA analysis, also known as DNA profiling, was first presented. The procedures for forensic DNA analysis are as follows: Sample preparation and collection: a DNA sample is gathered, prepared, and sent to a forensic lab. DNA extraction: the most time-consuming method of separating DNA. This gives information about the quantity of DNA in the specified sample. DNA amplification: this process creates many copies of a certain DNA fragment. DNA quantification: the measurement of the sample's DNA concentration

There is a growing need for case processing in forensic laboratories every day. Unmanageable case backlogs have resulted from this. Laboratories are trying to address this growing demand for DNA studies by utilising automated equipment that expedites the DNA profiling procedure.

Sample Collection And Preparation

Automation of liquid handling in particular will lessen the need for numerous laborious, repetitive manual procedures and enhance laboratory efficiency in an economical way. Robotic workstations or handheld devices may be used to handle liquids. Workstations for handling liquids exist in a variety of sizes and configurations. They are made up of parts such a substrate deck, mechanical engine, dispensing head, actuators that control liquid flow, control centre for movement governance, and mechanical engine.

Additionally, sensors keep an eye on the dispensing procedure and offer input. Degree of automation needed should be the first considered in selecting a liquid handling system. The micro10x Reagent Dispenser fill multi-well plates with reagents quickly (100ul in 96 wells in 10s) This would be an example for single tasking liquid handling. Multi-tasking liquid handling systems will have single-tasking liquid-handling along with accessories. (Tegally et al,2020)

Dna Extraction

The initial step in the DNA analysis procedure is DNA extraction. The process of solid phase extraction involves lysing the cell to release the DNA and separating it from the substrate material and other cellular constituents. The same approach applies to liquid phase extractions, but there is no binding step. The purpose of the extraction is to separate the DNA from the other components of the cell, get rid of any inhibitors, and preserve the sample so that it can be used for other procedures.

Traditional DNA extraction techniques involved manual processing and the use of organic solvents like phenol-chloroform. The organic solvents required a lot of time and were dangerous. As a result, these extraction techniques are no longer employed. The sample was then subjected to Chelex extractions, which involve the addition of ion-exchange resins (styrene divinylbenzene copolymers). These days, solid phase extraction—as opposed to liquid phase—allows for automation, therefore most extractions are performed by robots. Error and processing time have decreased as a result of automation. Additionally, more samples might be processed simultaneously, increasing productivity and efficiency overall.

The extraction technique of ChargeSwitch Technology entails the binding of charged particles to DNA in a pH-dependent manner. The water-based solutions function as a "switch." The particles are positively charged or "switched on" at low pH values (6.5) and "switched off" at high pH values (8.5). The DNA is gathered into a magnet when they lose their charge. The silicon-coated magnetic beads used in magnetic bead technology bind DNA very well when destabilising chemicals like guanidinium are present. (Witt et al,2012)

Acroflo/ZyGEM Extraction

A combination of mesophilic and thermophilic enzymes is used in the forensic GEM kits4. DNA extraction is aided by the use of temperature change to activate these enzymes. Acrosolv is composed of a blend of chemicals that break down tissue cell membranes and liberate the DNA. Because ZyGEM extraction does not include transfer stages or solid phase extractions, nucleic acid loss does not occur. This extraction method's primary benefit is this. Consequently, the ZyGEM extraction technique can be applied as a reference.

It is crucial to ensure that the nucleic acids are efficiently recovered using the DNA extraction technique selected. The DNA analysis procedure may proceed more slowly and less optimally if the extraction method only recovers half of the DNA that is present.

Quantification Of Dna

Since the QuantiBlot methodology is not automatable, DNA quantification protocols that measure DNA amounts using

PCR have taken its place.It is possible to clone a single DNA segment into millions of copies, which would enable visualisation tools such as fluorescent labelled probe and dye detection to track the amount of PCR product being produced. This method is often used and is known as quantitative real-time PCR (qPCR). The widely used Total Quantifiler Human DNA Quantification kit performs the process in a 96-well plate format.(Stray et al,2010)

Amplification Of Dna

PCR technique was used to amplify up DNA, resulting in the creation of a "blue dot" DNA pattern. This was contrasted with the known individuals' pattern. The "dot technology"'s drawback is that it can be challenging to comprehend for two or more mixes. Short tandem repeat (STR) DNA sequence amplification took the place of the blue dot procedure. An STR profile can now be obtained even with a little sample size. After being denatured and the single strands separated, the STR sequence is amplified. Nucleotides, DNA polymerases, and primers are added throughout the amplification process. The mixture is then subjected to a series of temperature changes. (Jayita et al,2013)

For the amplification PCR procedure, a robot that has been trained for DNA extraction from the evidence and quantification qPCR may also be employed. Each 96-well will have the PCR STR reagents added by the robot to prepare the 96-well plate.STR DNA fragments were separated using electrophoresis after being labelled with a fluorescent dye. These days, DNA amplification is done using the Identifiler PCR Amplification Kit and GeneAmp kit.

Capillary Electrophoresis And Dna Profile Generation

Color-coded capillary electrophoresis devices are used to distinguish amplified STR segments. The devices have tiny glass capillaries or tubes that are filled with a polymer, which is a separation matrix. Following the injection of the amplified DNA sample into the capillary, the fragments are sieved to separate them based on size, resulting in the creation of a DNA pattern with "peaks." Once inside the capillary, the fluorescent dye-tagged STR pieces travel until they arrive at the laser detection window. This is gathered as data, which the device subsequently transforms into a DNA profile. STR profiles are now created using the GeneMapper ID-X programme and the GlobalFiler amplification kit on the 3130 genetic analyzer

CONCLUSION

The many processes of sample preparation, DNA extraction, amplification, quantification, and profile creation make up forensic DNA analysis.To achieve the best outcomes, each step must be completed correctly.Processing the growing volume of cases will require laboratory automation in order to reduce backlogs and boost productivity.Biorobots and automation programmes are two fields that show promise and are making development.These have demonstrated a strong ability to solve forensic cases quickly, hence they ought to be used in forensic laboratories.

In this article a brief overview of the Biorobots in the field of forensic genetics is given. Forensic laboratories are achieving progress day by day. The future of forensic genetics lies on the development of those technologies that improve the quality and quantity of DNA profile generation and databasing.All these advances are ultimately used for the benefit of society.

Conflicts of Interest

The authors declare that they have no conflict of interest.

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