Technical Information

Forensic Investigative Genetic Genealogy

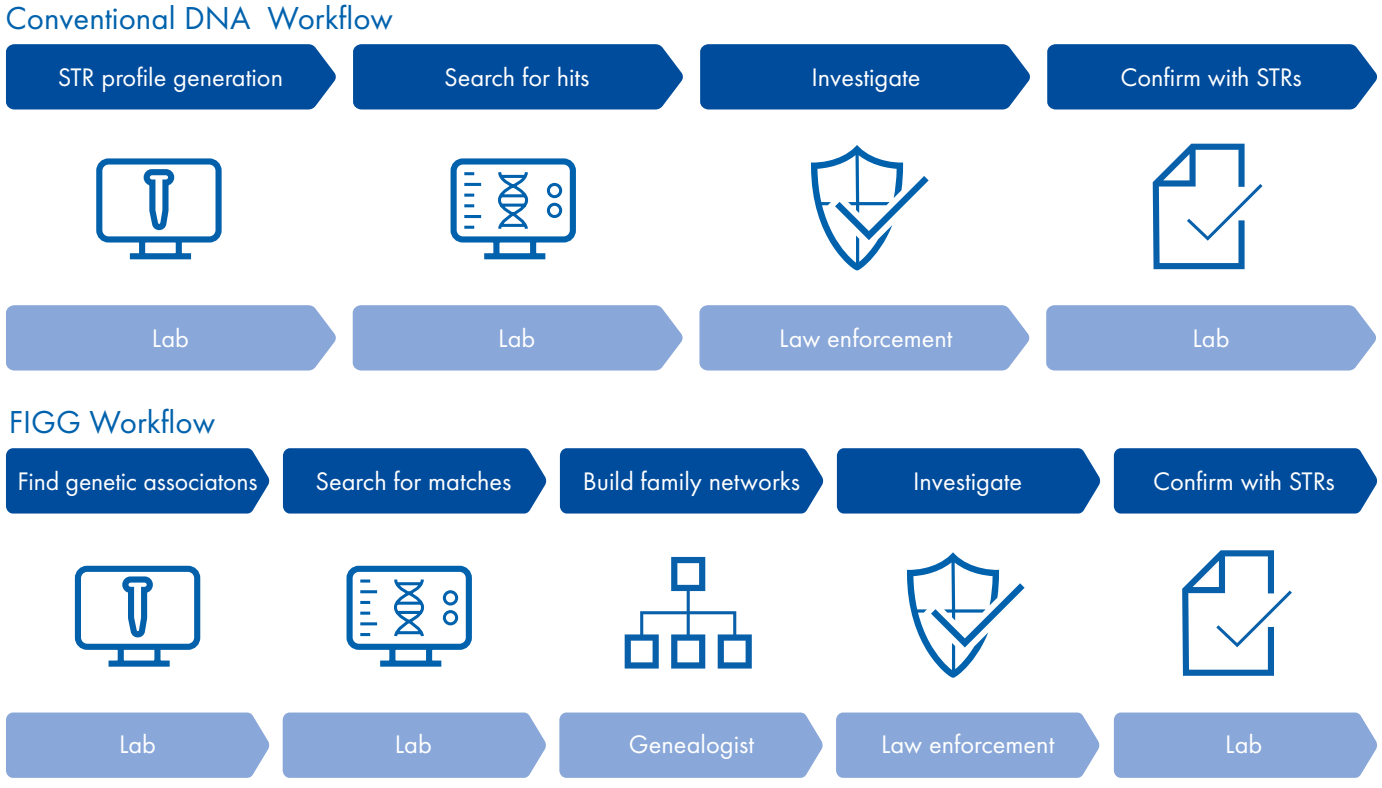
An introduction for crime laboratories

What is Forensic Investigative Genetic Genealogy?

Forensic investigative genetic genealogy (FIGG) is a method of DNA investigation that can generate leads in violent crime or unidentified human remains cases. This technique combines consumer DNA testing with traditional genealogical research to identify potential genetic associations to the sample. The most well-known example of this approach was the 2018 arrest and subsequent conviction of Joseph DeAngelo, also known as the Golden State Killer. Since then, over a thousand cases have been resolved using FIGG (1).

How does it work?

Unlike traditional forensic DNA typing, which focuses on short tandem repeat (STR) markers to identify an individual, FIGG uses single nucleotide polymorphisms (SNPs) to create a unique DNA profile. This SNP profile is uploaded into a genetic genealogy database, such as GEDmatch PRO™, and compared against other profiles that have been opted-in for law enforcement to find genetic associations. These genetic associations are used, often by genealogists, to create family trees that might lead law enforcement to their person of interest. In unidentified human remains cases, a generated family tree may be used as the identifying data. In violent crime cases, a confirmatory sample from the suspect is then processed using STRs and compared to the reference.



Testing methods for FIGG

If the conventional DNA workflow doesn't return any hits, you can initiate FIGG testing to generate additional leads. There are three main options for generating a SNP profile suitable for FIGG.

- Large scale SNP arrays: Microarray-based assay that targets hundreds of thousands of SNPs
- Whole genome sequencing (WGS). Next-generation sequencing (NGS)-based test that aims to amplify the entire genome
- Targeted sequencing: NGS-based test that selectively amplifies specific regions in the DNA

Each technology has limitations and an appropriate application.

Which method, when and why?

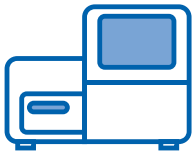
	Arrays	Whole genome sequencing	Targeted sequencing (ForenSeq® Kintelligence Kit)
PROs	• Used to generate most of public data in genetic genealogy databases • Can quickly generate SNP profile • Least expensive	• Generates the most information • Potential to reach more distant relatives	• Performs well on DNA that is low input, degraded, inhibited or contains microbial contamination • Targets only kinship-informative SNPs • Leverages a forensically validated platform
CONs	• Needs the most DNA • Doesn't perform well on DNA that is degraded, mixed or contaminated with microbial material • Privacy concerns with medical data	• Most expensive • Reveals genetically sensitive information • Difficult to perform • Can require extensive bioinformatic analysis prior to genealogy	• May not reach the most distant relatives for samples with very little DNA available
When to use	For reference samples that populate public databases	For more data when Kintelligence isn't enough	As the primary FIGG analysis for all in-house forensic samples

How distant a relationship does my analysis need to determine?

The further you extend your kinship search, the more likely it is to find a match to the profile of interest. However, the level of investigative effort and cost is increased. Fifth-degree relatives (e.g., great-great-great-grandfather, second cousin) are readily identified using ForenSeq Kintelligence tools in GEDmatch PRO.

Which technology is right for your lab?

While FIGG has traditionally been outsourced, operational laboratories can now bring this technology in house. When choosing a platform, you'll want to consider the following factors: instrument, assay workflow and analysis.

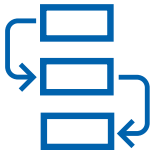


Instrument

How do you validate it? Is it manufactured according to forensic standards? What kind of maintenance is required?

Analysis

Will you need to hire a bioinformatician to manage the data analysis? Is additional data storage required?



Assay workflow

Will it work for your sample conditions? Can other DNA workflows be run? Is training available? Are other labs using the workflow successfully? Is effective support accessible?

The ForenSeq Kintelligence Kit plus GEDmatch PRO workflow was designed for forensic laboratories and optimizes the balance of cost, time to result and bioinformatic effort.

Table 1. Indicated timelines for FIGG analysis

Steps	Tasks involved	Timeline – approximate turnaround time
Lab processing	Array testing	2 weeks
	Whole genome sequencing	4–6 weeks
	Targeted sequencing (Kintelligence)	2–3 weeks
Data analysis	Array testing: Raw data analysis and upload	2–3 days
	Whole genome sequencing: Bioinformatics	1–2 weeks
	Targeted sequencing (Kintelligence): Analysis	2–3 days

Ordering Information

Product	Contents	Cat. no.
ForenSeq Kintelligence Kit	Includes all the required reagents to prepare up to 12 low-quality forensic samples for forensic investigative genetic genealogy	V16000120
MiSeq® FGx Sequencing System	Desktop instrument with two run modes for a range of forensic genomics applications within a validated NGS workflow	15048976
ForenSeq Universal Analysis Software (UAS)	Software pre-installed as a dedicated server specific for forensic genomics for run setup, sample management, analysis and report generation	9003364
MiSeq FGx Reagent Micro Kit	Supports up to 5 million paired-end reads for small batch sizes and faster turnaround times	20021681

References

1. This number is based on cases that have been publicly disclosed or covered by the media. The true number is likely higher.

Learn more about FIGG for your lab. Visit **qiagen.com/Kintelligence**